TECNOTION®

THE LINEAR MOTOR COMPANY

Ironless linear motor manual

[INTRODUCTION]

A linear motor system is a part of a specific machine. Tecnotion's Ironless linear motors are components that can be combined with numerous application devices. This manual is intended for technicians who want to construct a machine that includes a linear motor system.

It gives insight in the basic components of a Tecnotion ironless linear motor and additional components to complete the whole motion system. The manual further informs about important design and installation aspects of the linear motors. The settings required before starting up are discussed.
In the appendix the important dimensions for designing the construction that will hold the linear motor can be found. Finally, the glossary gives insight in the definition of all specifications of a Tecnotion linear motor.

When installing a linear motor system one should be familiar with some important safety remarks. In the first chapter these remarks are made. Please, read them carefully.

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1. [BEFORE YOU START]

Please read the following instructions very carefully.
They are important for a safe and warranted installation and operation of the Linear Motor.

1.1. Important notice

Before installing and using the Linear Motor, read this instruction manual carefully. The manufacturer declines all responsibility in case of accident or damage due to negligence or lack of observance of the instructions described in this manual. The manufacturer also declines all responsibility in case of accident or damage in conditions that differ from those indicated in the manual; Tecnotion also declines all responsibility for damage caused by improper use of the Linear Motor.

Handle the components of the Linear Motor with care, packed as well as unpacked. Especially the magnet yokes are sensitive to mechanical shocks. Never drop a magnet yoke or release it in an uncontrolled way.
Do not expose the magnets to temperatures higher than 70° C. The magnets may be demagnetized at higher temperatures.

Unpack the Linear Motor and check its integrity. If there is any irregularity. If there is any irregularity contact the dealer or manufacturer, signalling the nature of the defects.
Make a note of the serial number. This facilitates the correspondence with the supplier.

Safety and information symbols:

The lightbulb describes a 'Tip'.

The exclamation mark is a, non safety related, important notice that the user should be aware of.

The warning signs inform about safety information that the user should respect.

1.2 Safety warnings

The Linear Motor is used as a part of a machine. The machine manufacturer or representative has to take care that the machine as a whole fulfils all CE requirements.

The magnet yokes show large attraction forces on all soft magnetic objects such as iron. These forces cannot be controlled by hand. They may cause serious jamming danger. Do not bring any soft magnetic objects (iron) nearer than 25 cm of the magnetic side of the magnet yoke.

Magnetic sensitive objects like banking cards, pacemakers or other magnetic information carriers may be damaged if they are brought within 1m of the magnet yokes.

The magnet yoke and coil unit can be damaged when cleaned with a non-prescribed cleaning agent.
Use only isopropanol as a cleaning agent.

UV Blacklight can cause irreversible damage to the eyes and other tissue when exposed. When using a UV Blacklight installation wear appropriate protective clothing and glasses.

The magnet yokes do attract each other while mounting. Take care that the closing plates of one yoke do not damage the magnets of the neighbour magnet yoke while mounting.

If at any time and in any situation there is any doubt about the safety of the Linear Motor, do not use it and contact your supplier.

The Linear Motor is powered by a servo amplifier. In case of a power disruption or fatal error this may automatically result in a free run out of the motor. Make mechanical precautions to prevent damage on the motor or your machine in the case of such an event.

Before installing the motor, make sure that the supply mains are grounded and operate in conformity with the regulations in force.

Make sure that there is an effective protective earth. Make sure that there is no voltage at the wire terminals before connecting.

An earth connection does not work on non-conducting mounting surfaces like granite. In these cases the protective earth must be established by an earthing wire

Before carrying out checks or doing any maintenance, clear the system by disconnecting the voltage. Be sure that there is no possibility of accidental connections.

1.3 Certification

All information about certifications can be found in this chapter. The declaration of comformity can be found in APPENDIX E.

1.3.1 CE certification

Tecnotion B.V. declares that the UM, UL, UX,UXA and UXX linear motors mentioned in this Installation manual are manufactured in accordance with European directive 2006/95/EC and in conformity with the following standards, see table 1.1.

Tecnotion B.V. declares that the UC and UF linear motors mentioned in this Installation manual are destined to be incorporated in other machines or to be combined with other machines, and is not (entirely) in compliance with the Machine Directive (98/37/EC). The UC and UF linear motors are in conformity with the following standards, see table 1.1.

Standard	Name of standard
EN 60034-1: 2010	Rotating Electrical Machines, Part 1: Rating and performance
EN 60204-1: 2010	Safety of machinery - Electrical equipment of machines, Part 1: General requirements

Table 1.1: Applicable standards

1.3.2 UL / CSA certification

Tecnotion B.V. Ironless motors currently do not have UL / CSA certification. Please contact your local Tecnotion representative for more information.

1.3.3 Restriction of Hazardous Substance (RoHS)

Tecnotion B.V. declares to be compliant with the RoHS-guideline. Therefore Tecnotion ensures that all products are free from lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls or probrominated diphenyl ethers.

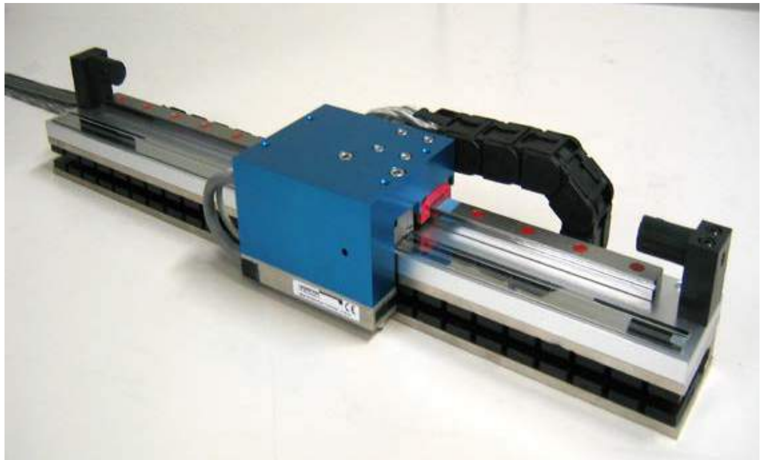
Series	CE	UL / CSA	RoHS
UC3	Yes	No	Yes
UC6	Yes	No	Yes
UF3	Yes	No	Yes
UF6	Yes	No	Yes
UM3	Yes	No	Yes
UM6	Yes	No	Yes
UM9	Yes	No	Yes
UM12	Yes	No	Yes
UMV12	Yes	No	Yes
UL3	Yes	No	Yes
UL6	Yes	No	Yes
UL9	Yes	No	Yes
ULV9	Yes	No	Yes
UL12	Yes	No	Yes
UL15	Yes	No	Yes
UXA3	Yes	No	Yes
UXA6	Yes	No	Yes
UXA9	Yes	No	Yes
UXA12	Yes	No	Yes
UXA18	Yes	No	Yes
UXX3	Yes	No	Yes
UXX6	Yes	No	Yes
UXX9	Yes	No	Yes
UXX12	Yes	No	Yes
UXX18	Yes	No	Yes

Table 1.2: Overview of applicable standards per motortype

2. [MOTOR COMPONENTS]

An ironless linear motor of Tecnotion is not a system on itself. It contains several components, such as a coil unit and magnet yokes. The components should be build within a total machine concept or a working unit. The size and the shape of the mounting frame, the design of the slide, the type bearings or the kind of dampers depend of the required application. For instance the mounting frame and the slide should be designed in such a way that a correct air gap between coil unit and magnet yokes will be obtained.

Tecnotion provides standard and special components which are suitable for numerous linear motor applications. These components can easily be applied in your system.



Picture 2.1: A complete ironless linear motor system

2.1 Basic components

The basic Linear Motor components supplied by Tecnotion are:

- The coil unit (the N and S version differing in voltage and current requirements)
- The magnet yoke (in different lengths, varying in outer dimensions)

Picture 2.2: A coil unit and magnet yoke

2.2 Additional features

For a proper installation of your linear motor system you also need:

- fixing components, like bolts and dowel pins;
- additional devices, like a servo controller and a linear encoder;
- the right tools.

These features are no part of Tecnotion's standard delivery.

2.2.1 Bolts and dowel pins

The following bolts and dowel pins are required for positioning and fixing the coil unit to the slide as well as connecting the magnet yokes to the mounting frame:

Features	UM	UL	UXA	UXX
Bolts for coil unit (steel)	M3x16, DIN912	M4x20, DIN912	M5x20, DIN912	M5x20, DIN912
Tightening torque	1.0 - 2.0 Nm	2.0 - 3.0 Nm	3.0 - 5.0 Nm	3.0 - 5.0 Nm
Bolts for magnet yoke (steel)	M4x25, DIN912	M5x35, DIN912	M6x40, DIN912	M6x50, DIN912
Dowel pins for magnet yoke (optional)	3h8, DIN7			

Table 2.3: Bolts for coil unit and yoke UM,UL,UXA and UXX series

Features	UC	UF
Bolts for coil unit (steel)	M3, DIN912, Class 12.9	M3, DIN912, Class 12.9
Tightening torque	1.0 - 2.0 Nm	1.0 - 2.0 Nm
Dept bolt in threat hole	Top: through coil unit Side: 1.5 - 2.8mm	Top: through coil unit Side: 1.5 - 2.8mm
Bolts for magnet yoke (steel)	M4x20, DIN912	M4x25, DIN912
Dowel pins for magnet yoke (optional)	3h8, DIN7	

Table 2.4: Bolts for coil unit and yoke UC and UF series

2.2.2 Controller and measurement unit

Required is:

- An appropriate servo controller/amplifier
- A ruler and a linear encoder or an Hall module
- Power supply, cabling and connectors

For more information please contact Tecnotion.

2.2.3 Tools

Necessary for the installation is:

- Allen Key set

Occasionally useful are:

- Heat sink compound (optional)
- Isopropanolwipes to clean mounting surfaces

3. [INSTALLATION]

3.1 Cleaning

The magnet yokes show large attraction forces on all soft magnetic objects such as iron. These forces cannot be controlled by hand. They may cause serious jamming danger.

Do not bring any soft magnetic objects (iron) nearer than 1m of the magnetic side of the magnet yoke.

Magnetic sensitive objects like banking cards, pacemakers or other magnetic information carriers may be damaged if they are brought within 25cm of the magnet yokes.

The magnet yoke and coil unit can be damaged when cleaned with a non-prescribed cleaning agent.

Use only Isopropanol as a cleaning agent.

For general, non-cleanroom applications, the magnet yokes and coil units do not need to be cleaned intensively.

For cleaning purposes Tecnotions prescribes Isopropanol as cleaning agent for the magnet yoke and coil.

3.2 Cleanroom cleaning

For cleanroom applications Tecnotion products need to be cleaned additi-onally to remove dust particles.

3.2.1 Tools

- Isopropanol cleaning wipes
- Filtered pressed air installation
- Blacklight installation
- UV Glasses
- Cleanroom compatible vacuum cleaner
- Cotton swap

step 1/5

step 2

step 3

step 4/11

step 7/8

step 9

3.2.2 Cleaning instructions

Only the cleaning of the yokes is described. The same method can be used to clean the coils and the cables.

Initial cleaning

1. Clean the workstation with Isopropanol cleaning wipes (IPA). Make sure the workstation is clean.

2. Blow filtered pressed air in to the gap between each pair of magnets.

UV Blacklight can cause irreversible damage to the eyes and other tissue when exposed. When using a UV Blacklight installation wear appropriate protective clothing and glasses.

Verification of surface pollution

4. Inspect the yoke with the blacklight installation for dust particles.

Intensive cleaning

5. Clean the workstation with IPA cleaning wipes.

6. Place the magnet yoke on the cleaned workstation.

3. Blow filtered pressed air in to the side of the yoke. Repeat for the other side.

7. Clean the yoke with a cleanroom compatible vacuum cleaner.

8. Repeat the process for the other side of the yoke.

9. Clean all sides of the magnet yoke with IPA cleaning wipes.

Only move the IPA cleaning wipe in one direction, do not move back and forward. This will enhance the cleaning action.

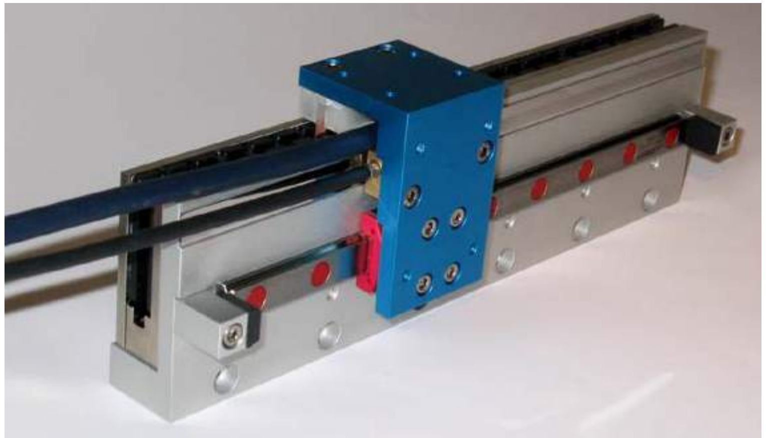
10. Clean the inside of the magnet yoke with an IPA cleaning wipe and a cotton swab.

Verification of cleaning

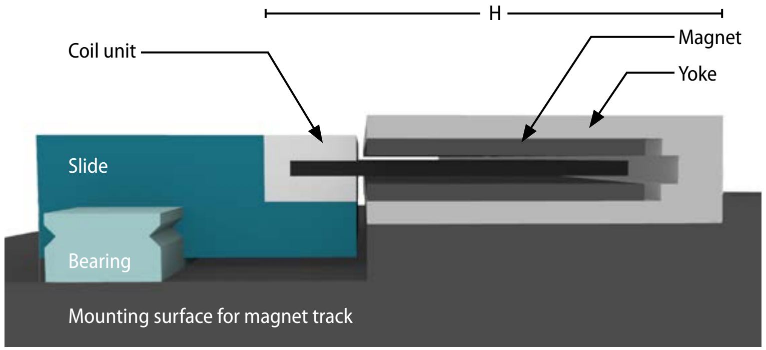
11. Inspect the magnet yoke with the blacklight installation for remaining dust particles.

Especially check the areas between the magnets and the gab between the magnets and the bottom of the yoke.

12. If dust particles are visible: Remove them with an IPA cleaning wipe and cotton swab until the surface is cleaned to an acceptable level.



Picture 3.1: A ironless linear motor system



Picture 3.2: Coil unit, slide, magnet yoke and mounting surface

Before starting the installation, check the presence of the right number and type of the delivered components. In case of doubt, please contact Tecnotion immediately.

3.3 Installation

Vacuum installation

! For installation of vacuum motors special instructions are required, these instructions can be found in the vacuum appendix.

Before installing the Linear Motor components, the installation of the mounting frame should be completed. The slide should be provided with bearings, dampers, linear probe and required cabling in such a way that a smooth, save and well positioned transport of the slide over the stroke is established. The ruler should be properly positioned and fixed to the frame. The operation of bearings and dampers should be tested as well as the guidance of the moving cables.

The correct installation order is for electrical safety reasons:

1. Mount the magnet yokes to the mounting surface of the machine.
2. Mount the coil unit to the involved machine parts
3. Connect the wiring to the coil unit.

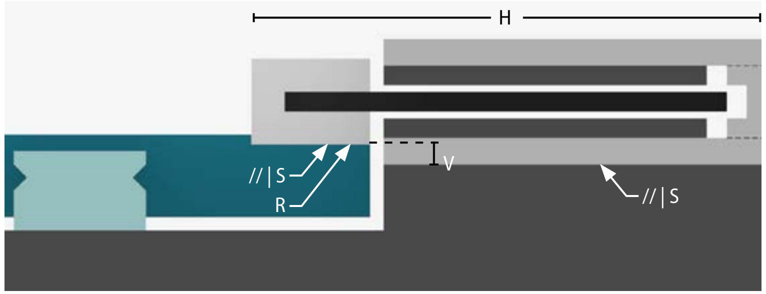
From a magnetic point of view the installation order of the mechanics is not critical, because no attraction is present between the coil unit and magnet yokes.

The de-installation order is:

1. Disconnect the wiring from the coil unit.
2. Dismount the coil unit from the machine parts.
3. Dismount the magnet yokes from the machine's mounting surface

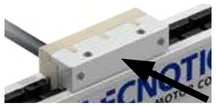
Before mounting the Linear Motor, special attention must be paid tot the mounting surface of the motor.

3.4 Requirements for the mounting surface



Picture 3.3: Flatness and parallelism of mounting surfaces

! Only use the aluminium side of the UC and UF series housing as mounting surface (see picture 3.4). The epoxy/power cable side is not suited for alignment.



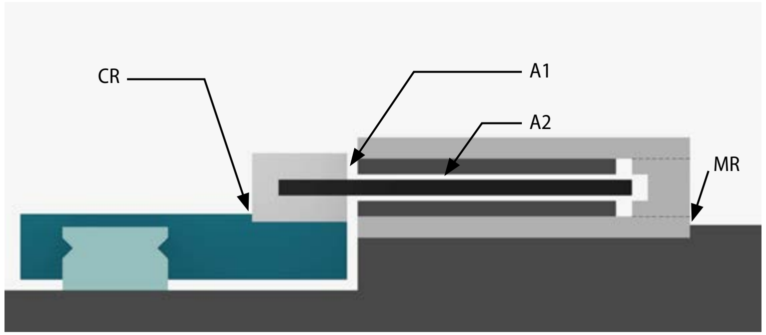
Picture 3.4: UC-UF coil

The mounting surfaces of both magnet yokes and coil units have to be flat to prevent them from being submitted to bending forces (see picture 3.3 and table 3.5).

Type	Coil unit flatness	Parallelism	H	Seperation of mounting faces
	R (mm)	S (mm)	(mm)	V (mm)
UC	0.02	0.02	51	0.375 +/- 0.05
UF	0.05	0.02	53	0.625 +/- 0.05
UM	0.05	0.05	68	5.5 +/- 0.1
UMX	0.05	0.05	68	6.5 +/- 0.1
UL	0.1	0.05	105	8.2 +/- 0.1
ULX	0.1	0.05	105	12.0 +/- 0.1
UXA	0.1	0.05	124.8	11.5 +/- 0.1
UXX	0.1	0.05	124.8	16.5 +/- 0.1

Table 3.5: Installation tolerances U-series

The track of the magnet yokes – from now on to be called the magnet track – and the coil unit have to be aligned with respect to each other. Note that this has to be accomplished by the machine's construction.



Picture 3.6: Air gaps and axial references, schematically

Axial reference for the magnet track (MR, see picture 3.6) can be obtained by the use of:

- Dowel pins in the middle yoke of a short track
- Dowel pins along the complete side of a long track
- Milled reference along complete side of a long track (inner radius < 0.2mm), or
- Alignment by hand during mounting

Axial reference for the coil unit (CR, see picture 3.6) is obtained by:

- Two dowel pins beside the first and last bolt of the coil unit
- Milled reference along complete side (inner radius < 0.2mm), or
- Alignment by hand during mounting

! Note that only when the right references and dimensions as listed in table 3.5 are applied the right dimensioned air gaps (A1 and A2, see picture 3.6) will be obtained. The dimensions of the coil units and magnet yokes can be found in APPENDIX A.

3.5 Magnet yoke mounting

Especially the magnet yokes must be handled with care. They are sensitive to mechanical shocks. Never drop a magnet yoke or release it in an uncontrolled way!

Be sure that the mounting surfaces are free of contamination. Particles > 0.1mm can cause inaccurate placement and consequently damage to your Linear Motor.

The magnet yokes contain a strong magnetic field. Lose iron objects that are brought within 5cm of the yokes, can be drawn into the yokes and cause damage.

Magnetic sensitive objects like banking cards or other magnetic information carriers may be damaged if they are brought within 1m of the magnet yokes.

The magnet yokes do attract each other while mounting. Take care that the closing plates of one yoke do not damage the magnets of the neighbour magnet yoke while mounting.

It is recommended to start the mounting of the magnet track with the middle – and preferably the longest – magnet yoke. This middle yoke can be aligned using the 3mm dowel pins or a milled reference.

Fix the magnet yoke on the mounting surface with bolts using the prescripted tightening torque.

The following yokes can be mounted with mechanical contact using the mutual attraction force of the magnet yokes.

Take care: apply the principle of controlled rotational mounting. A straight forward directing and placing of the yokes implies the risk of striking due to magnetic forces. Uncontrolled approach may cause damage to the magnets (see picture 3.7)

Picture 3.7: Principle of controlled rotational mounting of the magnet yokes

The next magnet yokes should not be aligned on dowel pins. Using a track of pins has two disadvantages:

1. In that situation rotational mounting is difficult.
2. Mounting can be impossible because of tolerances. The yokes are designed for a contact mounting without guaranteed gap between them.

Using a milled axial reference is advised for placement of the next tracks.

Placement of just one yoke on each side of the middle yoke can be done by simply aligning the yokes with respect to each other.

There is no danger of mounting the magnet yokes with an incorrect orientation, the standard yokes are "Murphy-safe". A 180° rotated yoke does not have any effect on the motor function.

3.6 Coil unit mounting instructions

Be sure that the mounting surfaces are free of contamination. Particles > 0.1mm can cause inaccurate placement and consequently damage to your Linear Motor.

The mounting of the coil unit on appropriate and clean mounting surfaces is very straightforward because no attraction forces are present between coil unit and magnet yokes. Please review chapter 3.1 Cleaning on page 9.

The coil unit can be placed into the machine by hand carefully, pushed to the axial reference and fixed with bolts. Tightening torque of the bolts as prescribed in chapter 2.1 Basic components on page 7.

For applications which are susceptible to vibrations, the bolts have to be secured against loosening by means of rings or (Loctite) thread lock.

In case of high continous forces, apply a heatsink compound to obtain optimal thermal contact between the coil unit and the mounting surface.

3.7 Electrical connections

Before starting any activity on the wiring, make sure that the mains are disconnected. Work carefully according the instructions belonging to the applied servo controller. Be sure your machine as a whole meets the requirements of all applicable electrical standards, such as the EN 60204 standard.

3.7.1 General remarks

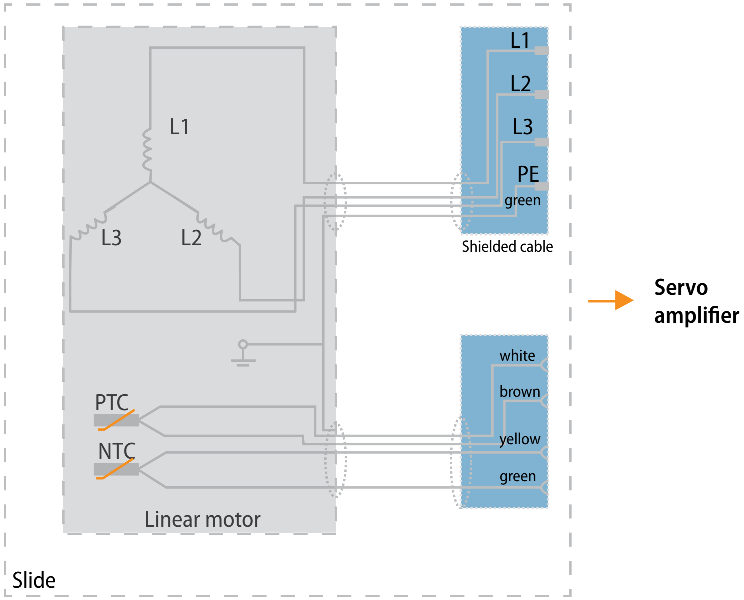
The linear motor's electrical wiring is externally configured with two 1.0 meter cables: a power cable and a temperature cable. If desired you can shorten these cables and provide them with appropriate connectors.

The UXA/UXX3S is delivered with a FLEX cable of 3m. Suitable for cable chains.

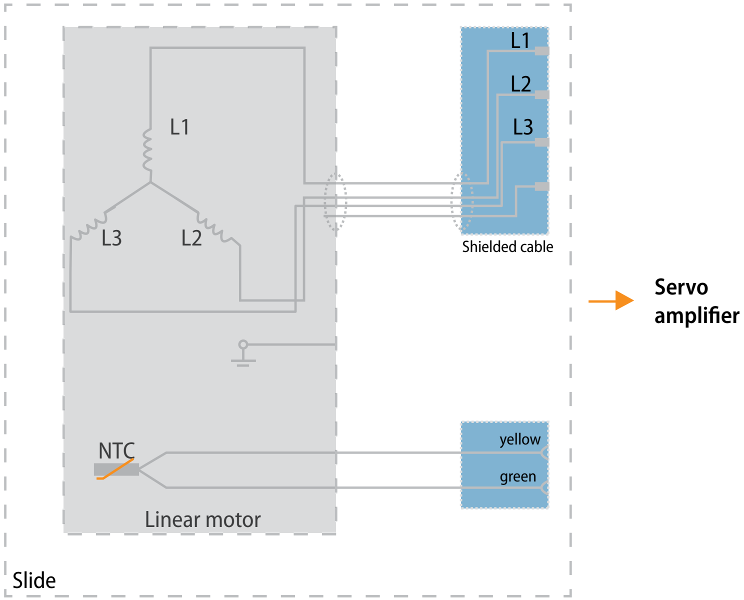
Both power cable and temperature cable are shielded with a braided metal cable shield for electromagnetic immunity. The shield is galvanically connected inside the coil unit housing.
Besides this manual you should follow carefully the installation instructions of your servo amplifier supplier. Make sure that the linear motor system as a whole meets all the applicable electrical directives.

For wiring scheme of the UM, UL,UXA and UXX series see figure 3.8.
The wiring scheme of the UF type is shown in figure 3.9.
The wiring scheme of the UC type is shown in figure 3.10.

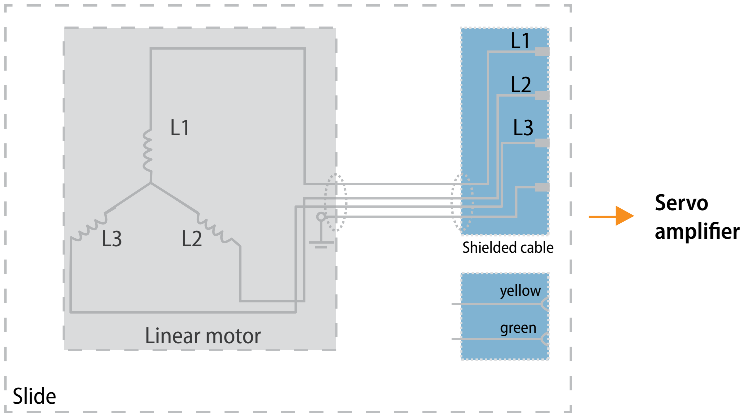
! The UC coil is supplied with a five wire cable. The green and the yellow wire do not have a function.



Picture 3.8: Wiring scheme UM, UL, UXA and UXX series ironless



Picture 3.9: Wiring scheme UF series ironless



Picture 3.10: Wiring scheme UC series ironless, green and yellow wires are unused

3.7.2 Power lines

The three phases of the motor's power cable have to be connected to the servo amplifier in such a way that the positive three phase direction of the motor conforms the positive direction of the linear encoder. This polarization has to be tested, it cannot be seen at first sight.

Testing the polarization is very important, because a wrong polarization will result in an uncontrolled run out of the slide.

The power cable can be confectioned by the user to fit on the servo drive. The power cables are not suited for use in cable chains.

Powercable		Color code	Connection to servo controller
3-phases	L1	black	3-phases
	L2	red	
	L3	white	
Protective Earth		green/yellow	Protective Earth
Shield			(Protective) Earth

Table 3.11: Powercables wire identification

Sensor cable (color)	Connection to servo controller
PTC (white)	PTC
PTC (brown)	PTC
NTC (green)	NTC
NTC (yellow)	NTC
Shield	Protective Earth

Table 3.12: Sensor cable wire identification

3.7.3 Protective earth

Be sure that the earth shield of the cable is well connected – also through the connecting devices – to the PE connector or the housing of the amplifier. Most linear motors are driven on the principle of pulse width modulation. This involves large electrical impulses and causes a significant risk of electromagnetical interference.

Internally the motor's PE wire (green/yellow) is galvanic connected to the motor housing. This wire must be connected to the PE connector of the servo amplifier. Provide the motor system with PE lines to the amplifier that are as short as possible.

3.7.4 Temperature Sensor

The coil unit of the UM,UL,UXA and UXX Linear Motors come equipped with two temperature sensors, one PTC-1k-type and one NTC-sensor. The UF series has only a NTC-sensor. The UC series has no temperature sensors. For more details about both sensor see the next three paragraphs.

The temperature cable consists of four wires. For wire color and function, see table 3.12.

3.7.5 Temperature protection

The temperature sensors are normally used for overheating protection of the coil unit. The NTC-sensor can be used for monitoring temperature, the PTC can be used as cut off sensor when the maximal temperature is exceeded. For specifications and characteristics see the next two paragraphs.

In cases where long peak currents are demanded, the thermal response time of the coil unit is too long to ensure a proper overheating protection by the sensors. The temperature sensors can ensure a proper protection up to an Irms of 25% of the peak current of the motor. This corresponds to a temperature increase of 4,5°C/s.
These long peak current conditions can occur for example during an accidental run or by taking a new axis in control.

In this case I^2t protection is essential to prevent the coil unit from overheating. In almost all controllers an I^2t-protention can be set in the software.

For more information contact Tecnotion's Application support team.

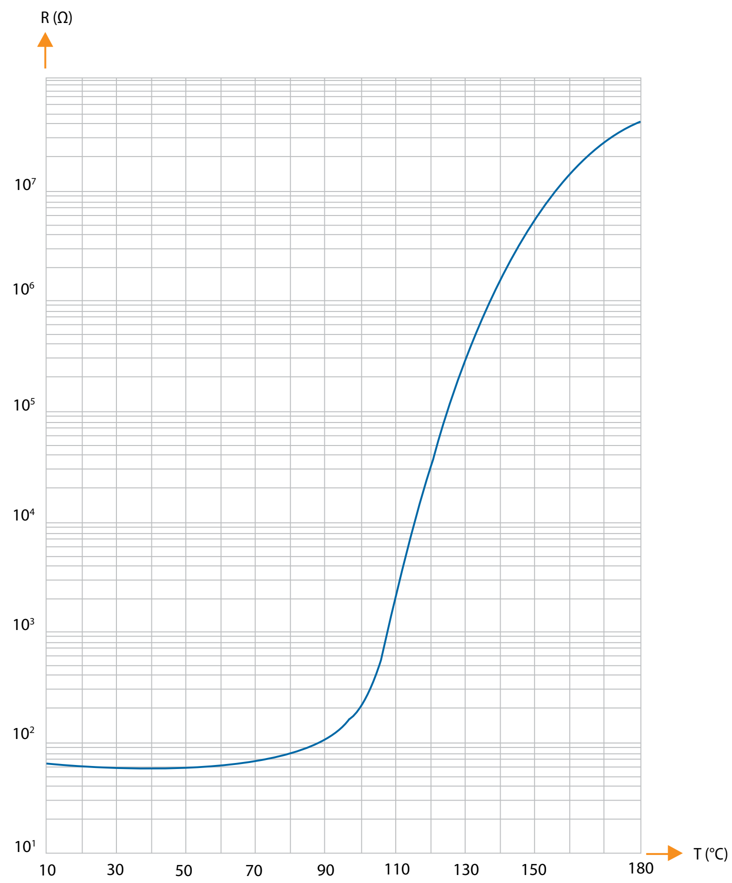
3.7.6 PTC specification

The PTC-1k type is a sensor which has a very sudden resistance rise near the critical temperature of the coils. It is almost a digital indicator: temperature below vs. over critical temperature. Therefore it is very useful for signalizing over temperature without requiring sensitive electronics. Disadvantage is that it is not possible to obtain a temperate signal.

At room temperature the PTC has an electrical resistance <100 Ω. When the temperature raises to the critical temperature the resistance will increase rather uniformly up to 1000 Ω. Above this temperature the resistance increases exponentially. Now, 1000 Ω is the switching resistance. The amplifier should immediately stop the power supply when this resistance is exceeded. In this way overheating and motor damage can be prevented. No need to say that the PTC cable must be connected properly to the amplifier.

Temperature	Resistance
Up to 20°C below critical temperature	< 250 Ω
Up to 5°C below critical temperature	< 550 Ω
Nominal switching resistance	1000 Ω
Above critical temperature	> 1330 Ω

Table 3.13: Resistance range of the PTC-1K sensor



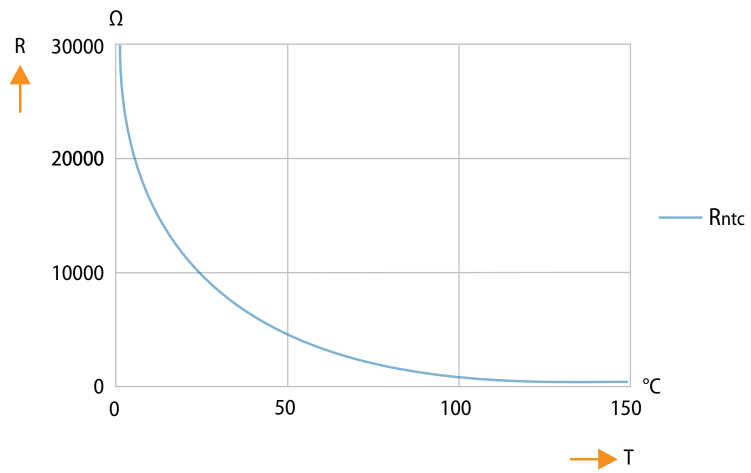
Graph 3.14: Temperature dependence of the PTC-1k sensor. The sensor follows the 110°C characteristic

3.7.7 Maximum operating temperature

Series	Maximum operating temperature
UC	80ºC
UF, UM, UL, UXA, UXX	110ºC

3.7.8 NTC Characteristic

The Coil has a NTC temperature sensor for monitoring the temperature.



Graph 3.15: Temperature dependency of the NTC

Sensor specification of NTC-sensor	
Tolerance $\Delta R_R / \Delta R_R$	5%
Max power	60mW

T (ºC)	0	10	20	30	40	50	60
RNTC (Ω)	32650	19900	12490	8057	5327	3603	2488

T (ºC)	70	80	90	100	110	120	130
RNTC (Ω)	1752	1258	918	680	511	389	301

Table 3.16: Scheme for obtaining a linear voltage signal from the NTC-sensor

3.7.9 Polarization test

Before testing, make sure that the electrical and mechanical protection of the linear motor system is well configured!

Make sure that there is an effective protective earth. Make sure that there is no voltage at the wire terminals before connecting.

There is one regular way of testing the polarization. Some servo amplifiers can operate in an in moment service mode. By means of regulating an external resolver manually, it can be determined whether the motor's direction of running conforms the resolver's sense of rotation. If so, the motor is well connected. If not, two phases of the power cable – phase 1 and 3 – must be changed.

Internally all ironless linear motors are equally wired and connected, so one test satisfies to find out the polarization of a motor ruler combination. If more axes are constructed in exactly the same way the polarization will be equal.

For more information, please contact Tecnotion.

3.8 Transportation

For transport, additional transport packacking is neccesary.

3.9 Storage

The Storage area for linear motor components needs to be clearly delimited with a warning sign: "Caution! Powerful magnets"

To ensure the product quality Tecnotion advises the folowing storage conditions:

! Only store motors and magnetyokes in their original packaging.

Stacking height	4 cartons
Storage temperature	-25°C to +55°C and a maximum rate of change of 20°C/hour
Storage humidity	5 to 95%, relative humidity with no condensation
Storage duration	No limitation.

4. [OPERATION]

4.1 Pre-commissioning

When you are convinced that your application's linear motor system is assembled in a proper way, both mechanically and electrically, you can proceed to the next step. You can put your motor system into operation.
But before powering the system, please do have a final check:

1. Does the slide have a free run over the whole magnet track, without touching small mechanical parts like bolts or contamination?
2. Are the mechanical end stops, end switches and the dampers well dimensioned and properly configured?
3. Does your system have an emergency stop?
4. When used, is the temperature cable properly connected?
5. Does the motor ruler combination have the right polarization?
6. Has the power cable been connected properly?
7. Does the physical earth has been connected properly?

4.2 Configuring

After the amplifier is powered up some input and output signals need to be examined.

1. Check the end switches by pushing the slide manually to the switch position. Simultaneously check whether the signal is detected by the amplifier.

2. Check the presence of the PTC signal.

3. The following motor items should be configured as parameter settings of the servo amplifier:

- Maximum continuous current.
- Maximum peak current.
- Amount of coils.
- Maximum speed.
- Presence/absence of an electromechanical motor brake.
- Magnet interval (North-South distance) and/or pole pitch (North-North distance).
- Switching resistance of PTC.

4. The following settings for the ruler system should be configured as parameters of the servo amplifier:

- Type of interface of the ruler system.
- Resolution or period of the linear encoder.

5. These are the I/O parameters to be configured:

- Settings of the available digital inputs and outputs. For instance,
- pay attention to the type of end switches.
- Settings of the available analog inputs and outputs.

6. Finally the controlling parameters must be configured.

- Current control settings. These settings depend on both motor and amplifier.
- Speed control settings.
- Position control settings.

For configuring several types of servo amplifiers Tecnotion can offer parameter files. With these files motor specific settings can be configured. Nevertheless, application specific settings should be configured by yourself. Please contact Tecnotion for information.

4.3 Testing

Before handing over the control of the linear motor to the closed loop feedback controllers, it is wise to perform some tests. Most important issue for testing are the end switches.

Before testing, make sure that the electrical and mechanical protection of the linear motor system is well configured!

4.3.1 End switches

Check proper functioning of the end switches.

4.4 Starting up

- Start the tuning with very low speeds.
- Increase maximum speed if everything operates properly.

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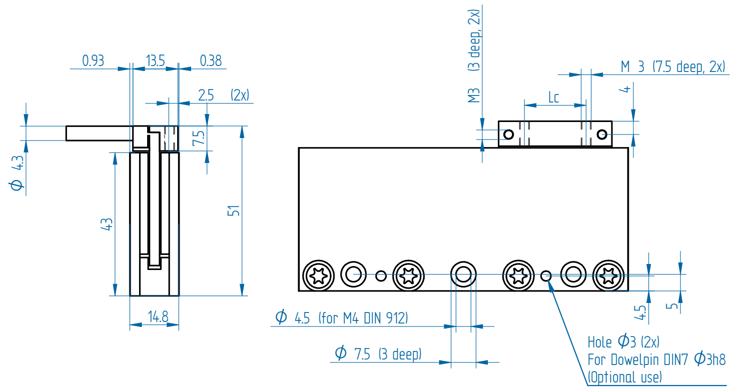
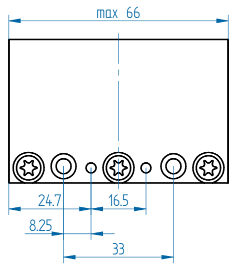
TECNOTION
THE LINEAR MOTOR COMPANY

APPENDIX A | Dimensions - UC

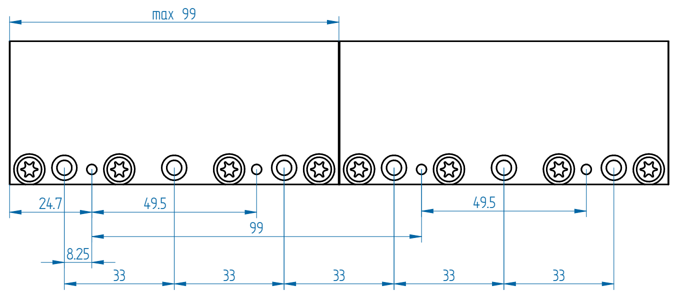


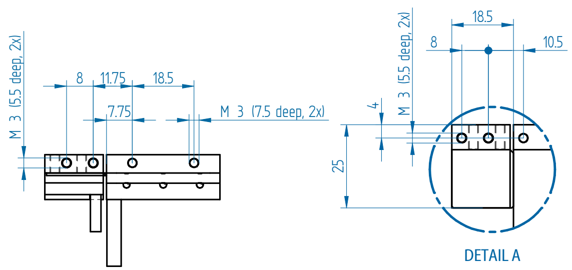
	Dig. Hall cable (mm)	Lc (mm)
UC3	Ø3.2	18.5
UC6	Ø3.2	51.5

UC 66mm

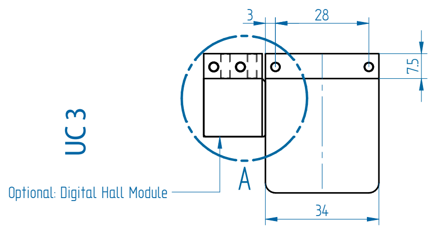


2x UC 99mm

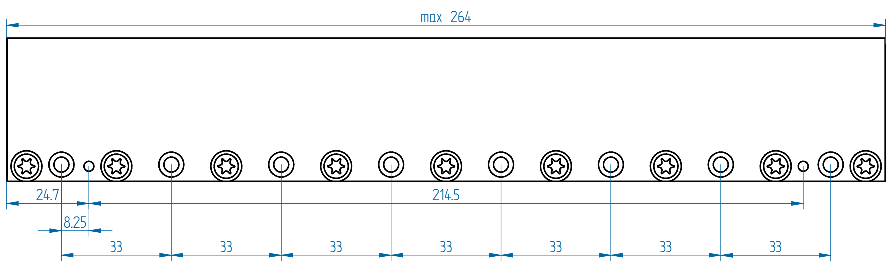




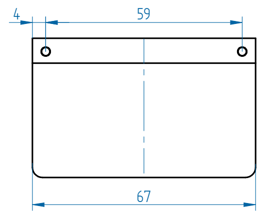
UC 3



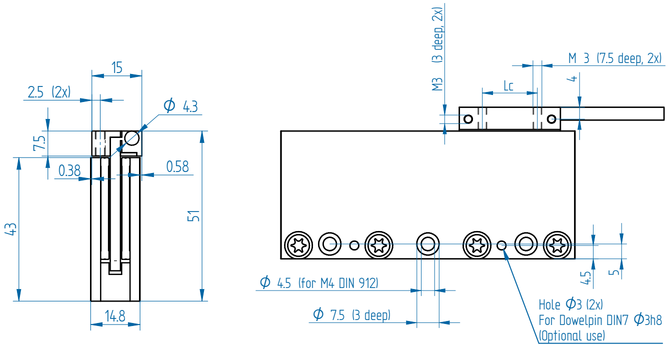
UC 264mm



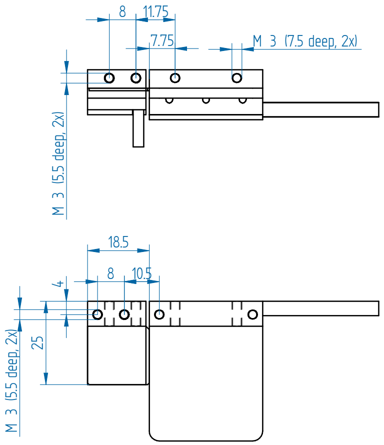
UC 6



TECNOTION THE LINEAR MOTOR COMPANY | APPENDIX A | Dimensions - UC 3 Inline



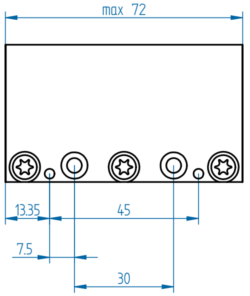
	Dig. Hall cable (mm)	Lc (mm)
UC3 Inline	Ø3.2	18.5

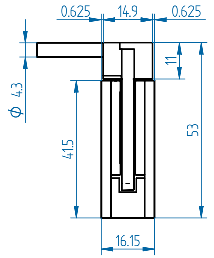


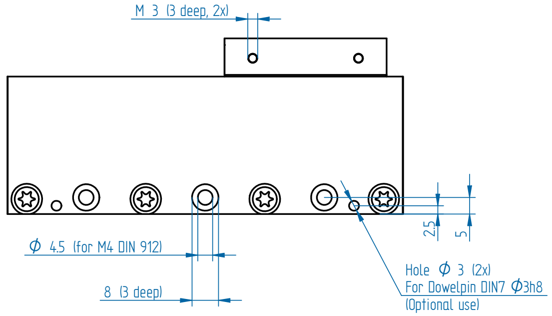
TECNOTION
THE LINEAR MOTOR COMPANY

APPENDIX A | Dimensions - UF

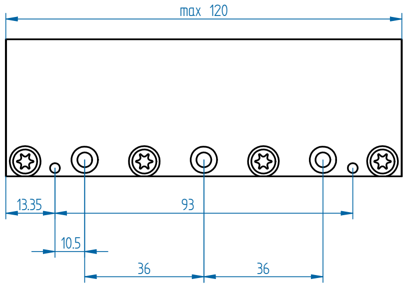
UF 72mm



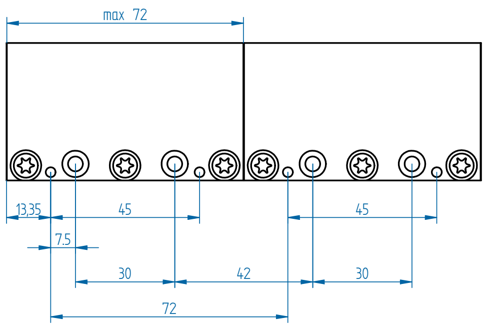


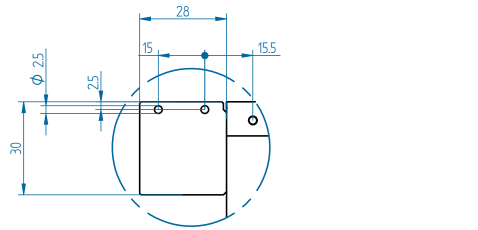


UF 120mm



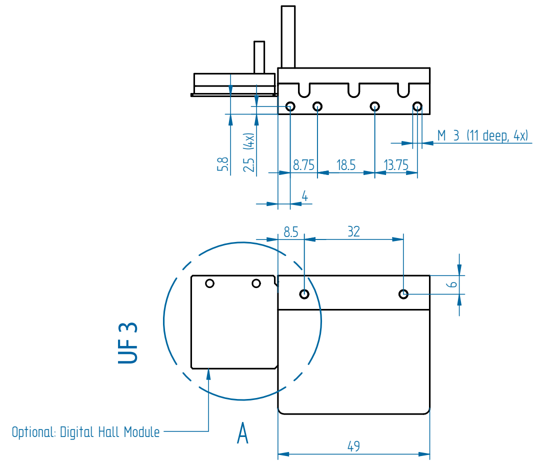
2x UF 72mm



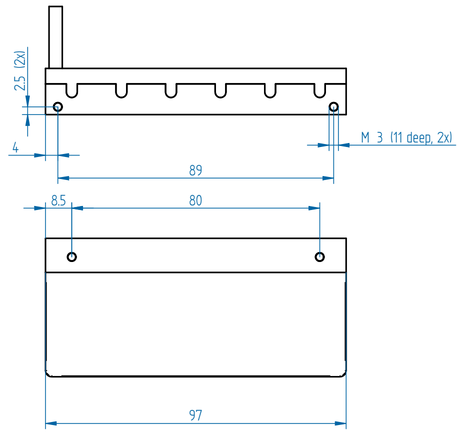


DETAIL A

UF 3

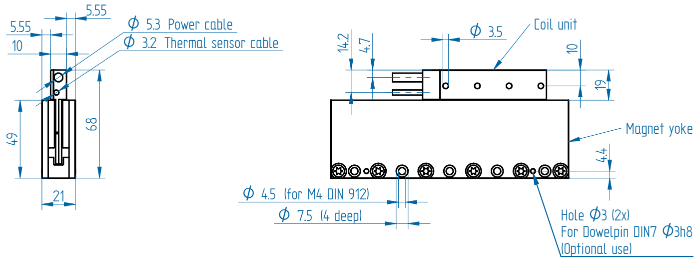


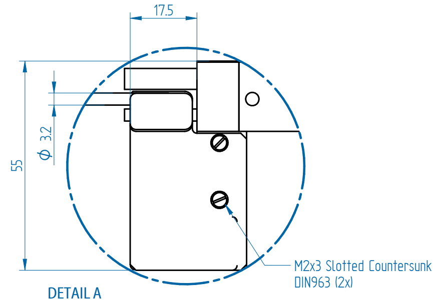
UF 6



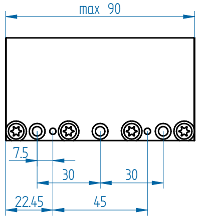
TECNOTION THE LINEAR MOTOR COMPANY

APPENDIX A | Dimensions - UM

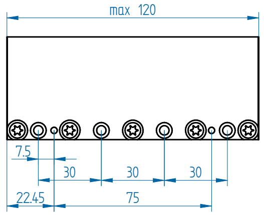




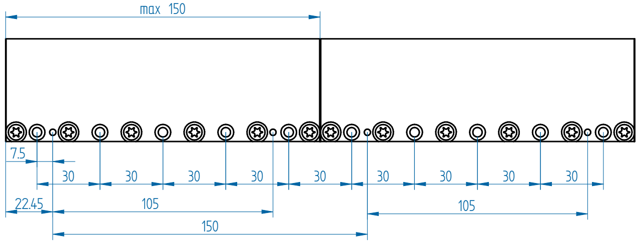
UM 90mm



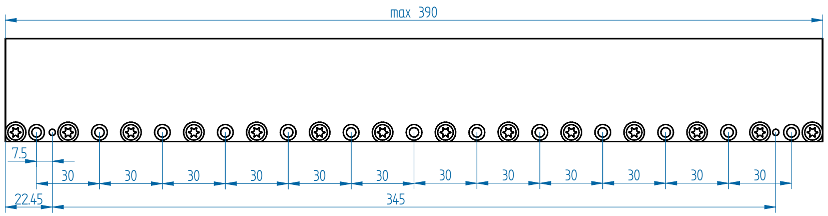
UM 120mm



2x UM 150mm



UM 390mm



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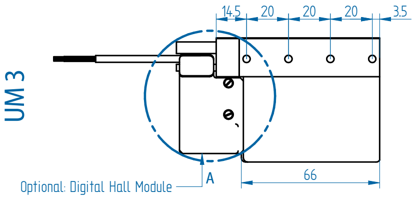

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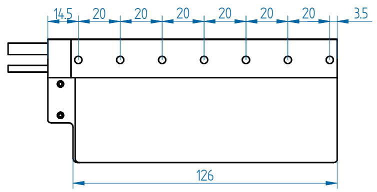

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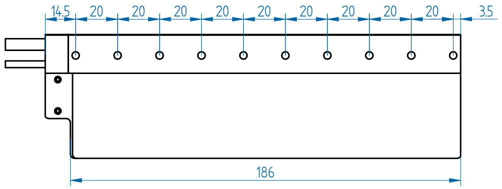
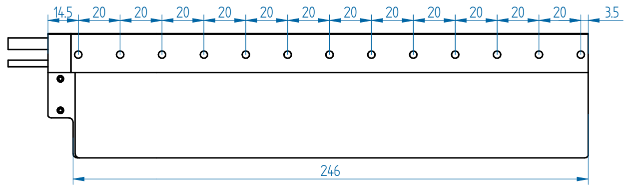
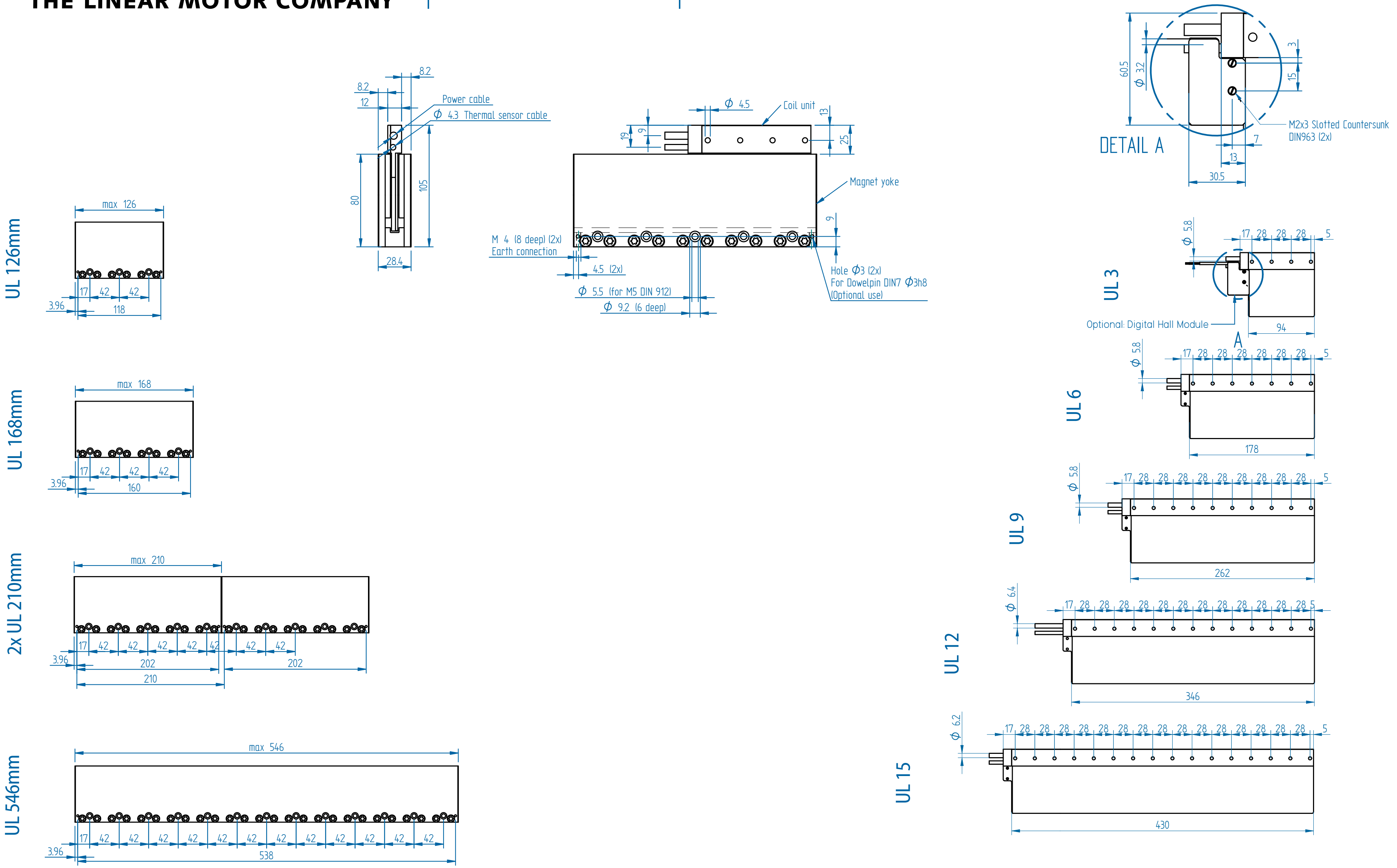


UM 12

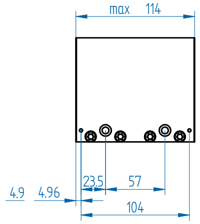


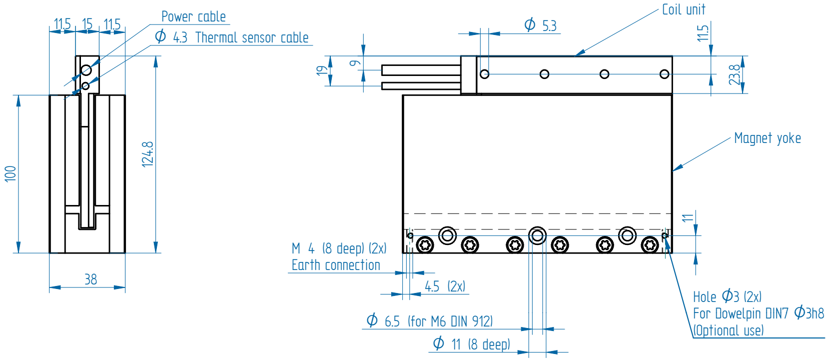
TECNOTION THE LINEAR MOTOR COMPANY | APPENDIX A | Dimensions - UL

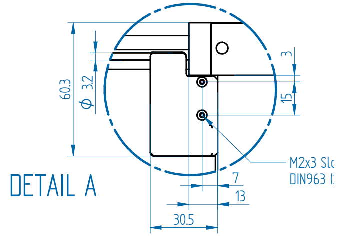


APPENDIX A | Dimensions - UXA

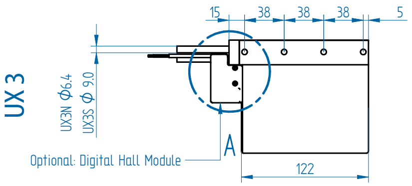
UXA 114mm



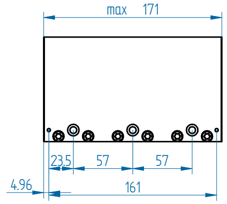




UX 3



UXA 171mm



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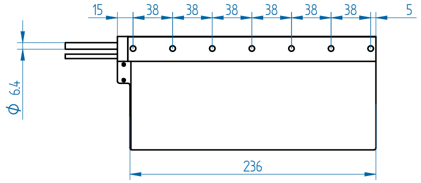

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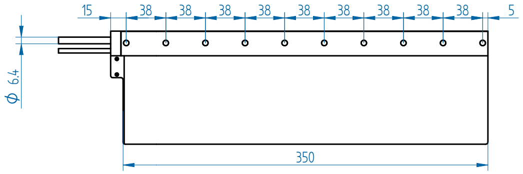
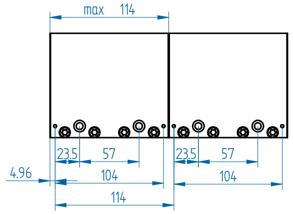


2x UXA 114mm



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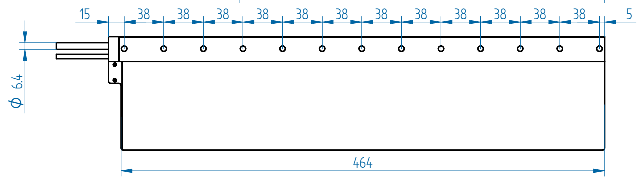
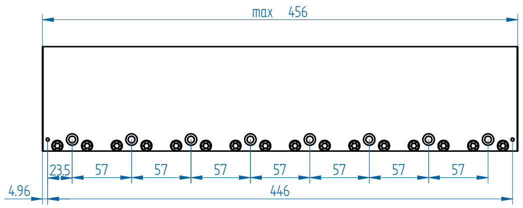
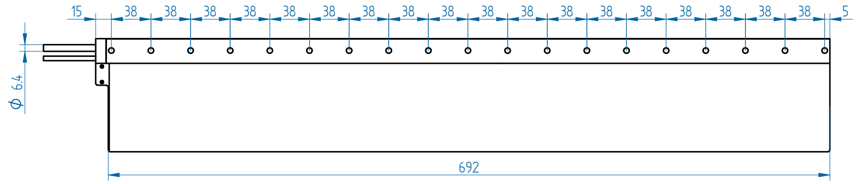


UXA 456mm



UX 18



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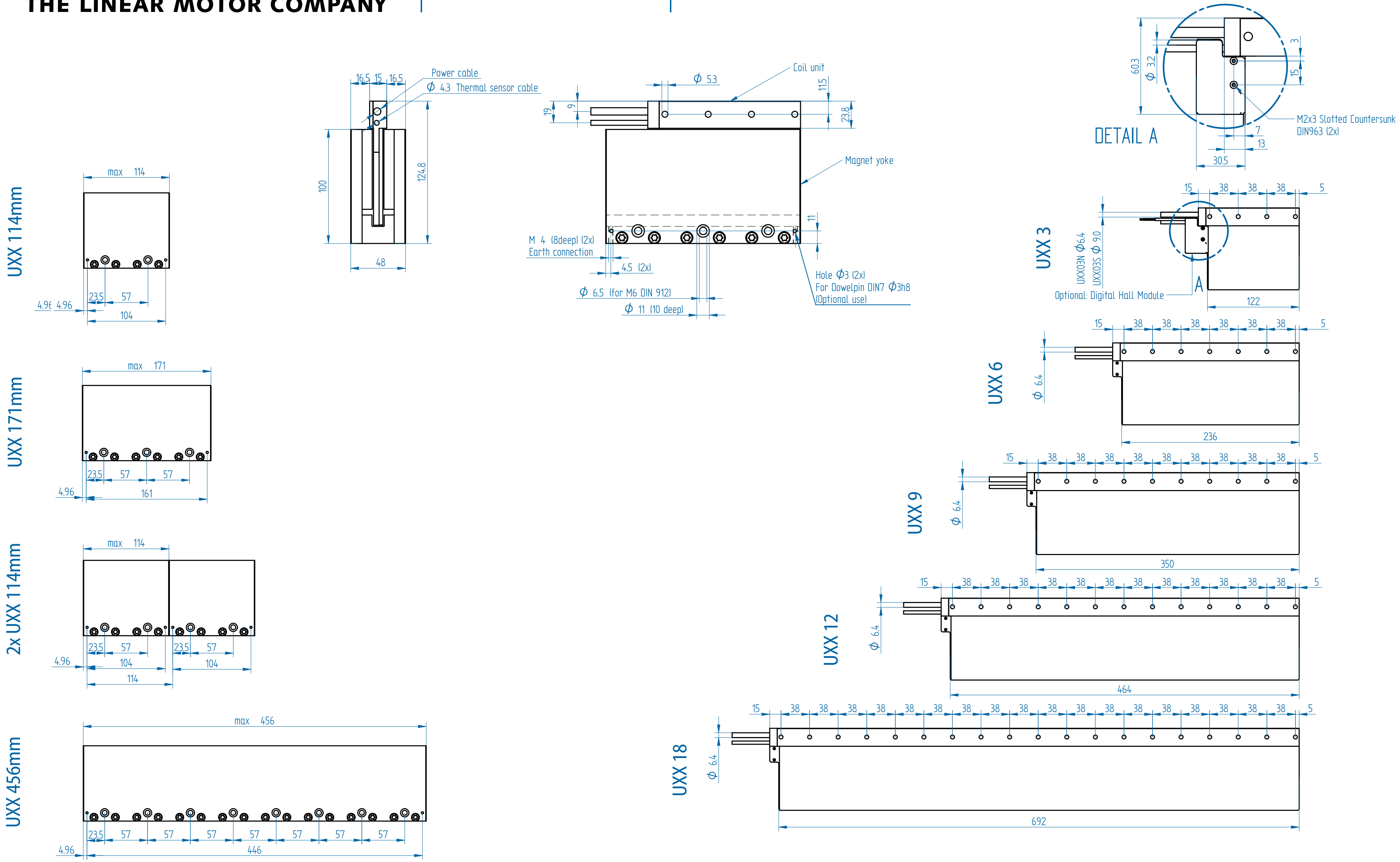
APPENDIX A | Dimensions - UXX



TECNOTION THE LINEAR MOTOR COMPANY

APPENDIX B | Motor cable configuration

		Power cable				Sensor Cable			
Coil unit	Lenght	Outside diameter	Configuration	Static	Dynamic	Outside diameter	Configuration	Static	Dynamic
UC 03	1m	4,3 mm	3 x 0,24 mm² + 2 x 0,05 mm² (AWG 24 + 30)	5x diam.	8x diam.	n/a	n/a	n/a	n/a
UC 06	1m	4,3 mm	3 x 0,24 mm² + 2 x 0,05 mm² (AWG 24 + 30)	5x diam.	8x diam.	n/a	n/a	n/a	n/a
UF 03	1m	4,3 mm	3 x 0,24 mm² + 2 x 0,05 mm² (AWG 24 + 30)	5x diam.	8x diam.	n/a	n/a	n/a	n/a
UF 06	1m	4,3 mm	3 x 0,24 mm² + 2 x 0,05 mm² (AWG 24 + 30)	5x diam.	8x diam.	n/a	n/a	n/a	n/a
UM 3N	1m	5,3 mm	4 x 0,36 mm² (AWG 22)	10x diam.	*	3,2 mm	4 x 0,14 mm² (AWG 26)	13x diam.	*
UM 3S	1m	5,3 mm	4 x 0,36 mm² (AWG 22)	10x diam.	*	3,2 mm	4 x 0,14 mm² (AWG 26)	13x diam.	*
UM 6N	1m	5,3 mm	4 x 0,36 mm² (AWG 22)	10x diam.	*	3,2 mm	4 x 0,14 mm² (AWG 26)	13x diam.	*
UM 6S	1m	5,3 mm	4 x 0,36 mm² (AWG 22)	10x diam.	*	3,2 mm	4 x 0,14 mm² (AWG 26)	13x diam.	*
UM 9N	1m	5,3 mm	4 x 0,36 mm² (AWG 22)	10x diam.	*	3,2 mm	4 x 0,14 mm² (AWG 26)	13x diam.	*
UM 9S	1m	5,3 mm	4 x 0,36 mm² (AWG 22)	10x diam.	*	3,2 mm	4 x 0,14 mm² (AWG 26)	13x diam.	*
UM 12N	1m	5,3 mm	4 x 0,36 mm² (AWG 22)	10x diam.	*	3,2 mm	4 x 0,14 mm² (AWG 26)	13x diam.	*
UM 12S	1m	5,3 mm	4 x 0,36 mm² (AWG 22)	10x diam.	*	3,2 mm	4 x 0,14 mm² (AWG 26)	13x diam.	*
UL 3N	1m	5,8 mm	4 x 0,56 mm² (AWG 20)	10x diam.	*	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	*
UL 3S	1m	5,8 mm	4 x 0,56 mm² (AWG 20)	10x diam.	*	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	*
UL 6N	1m	5,8 mm	4 x 0,56 mm² (AWG 20)	10x diam.	*	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	*
UL 6S	1m	5,8 mm	4 x 0,56 mm² (AWG 20)	10x diam.	*	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	*
UL 9N	1m	5,8 mm	4 x 0,56 mm² (AWG 20)	10x diam.	*	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	*
UL 9S	1m	5,8 mm	4 x 0,56 mm² (AWG 20)	10x diam.	*	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	*
UL 12N	1m	6,4 mm	4 x 0,82 mm² (AWG 18)	10x diam.	*	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	*
UL 12S	1m	6,4 mm	4 x 0,82 mm² (AWG 18)	10x diam.	*	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	*

** Not suitable for use in cable chains.*

Note: All cables are shielded (braided screen)

TECNOTION THE LINEAR MOTOR COMPANY

APPENDIX B | Motor cable configuration

		Power cable				Sensor Cable			
Coil unit	**Lenght**	Outside diameter	Power cable configuration	Static	Dynamic	Outside diameter	Configuration	Static	Dynamic
UXX 3N**	1m	6,4 mm	4 x 0,82 mm² (AWG 18)	10x diam.	*	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	15x diam.***
UXX 3S FLEX**	3m	9 mm	4 x 0,5 mm² (AWG 21)	4x diam	10x diam.	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	15x diam.
UXX 6N**	1m	6,4 mm	4 x 0,82 mm² (AWG 18)	10x diam	*	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	15x diam.***
UXX 6S**	1m	6,4 mm	4 x 0,82 mm² (AWG 18)	10x diam	*	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	15x diam.***
UXX 9N**	1m	6,4 mm	4 x 0,82 mm² (AWG 18)	10x diam	*	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	15x diam.***
UXX 9S**	1m	6,4 mm	4 x 0,82 mm² (AWG 18)	10x diam	*	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	15x diam.***
UXX 12N**	1m	6,4 mm	4 x 0,82 mm² (AWG 18)	10x diam	*	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	15x diam.***
UXX 12S**	1m	6,4 mm	4 x 0,82 mm² (AWG 18)	10x diam	*	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	15x diam.***
UXX 18N**	1m	6,4 mm	4 x 0,82 mm² (AWG 18)	10x diam	*	4,3 mm	4 x 0,14 mm² (AWG 26)	6x diam.	15x diam.***

** Not suitable for use in cable chains.*

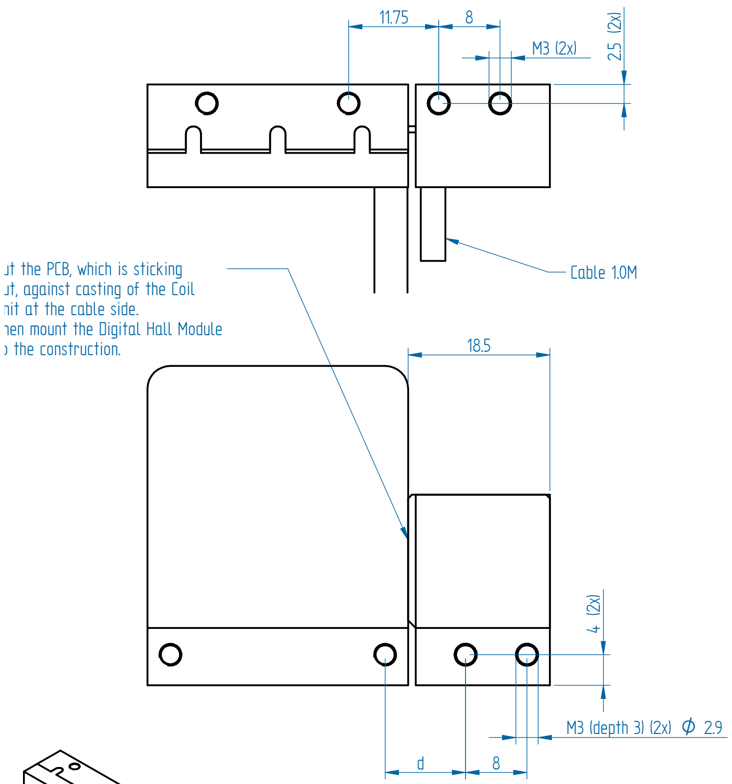
*** UXX and UXA coil are the same*

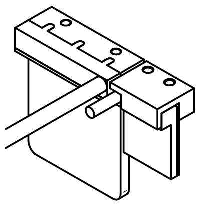
**** Carefull only the sensor cable is suitable for use in cable chains*

Note: All cables are shielded (braided screen)

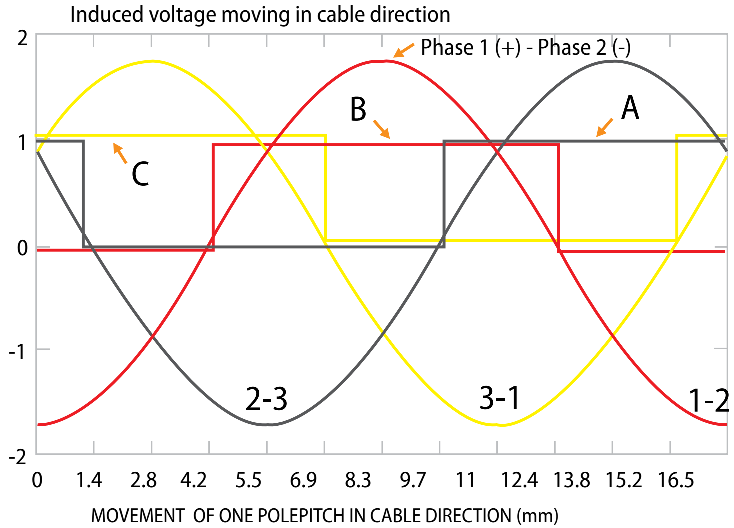
TECNOTION
THE LINEAR MOTOR COMPANY

APPENDIX C | Digital Hall Module - UC





Coilunit	Dimension d (mm)
UC3	10.5
UC6	11.5



3 DIGITAL OUTPUTS A,B,C:
- SINK-TYPE 20mA max.
- PERIOD 16.5mm (UC SERIES)
- SIGNAL DEFINITION ACCORDING TO FIGURE (HIGH=SINK)
- MAXIMUM VOLTAGE DROP 0.4V + 120 * Isink (in A)
- TYPICAL VOLTAGE DROP 0.1V + 120 * Isink (in A)
- SHORT CIRCUIT SAFE @5V SUPPLY

POWERSUPPLY
- +4.5 .. + 28V DC
- 40mA

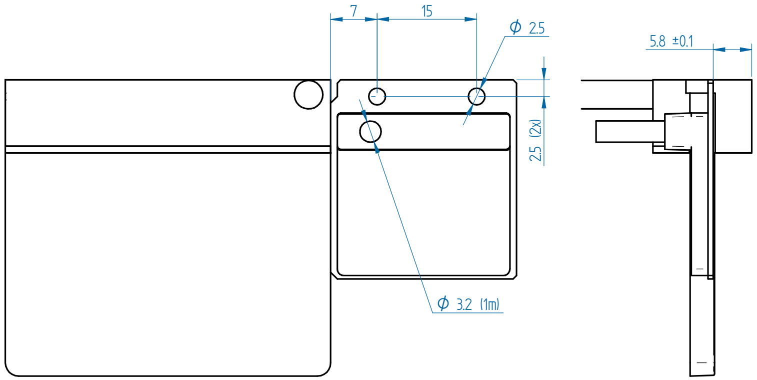
CABLE CONNECTIONS

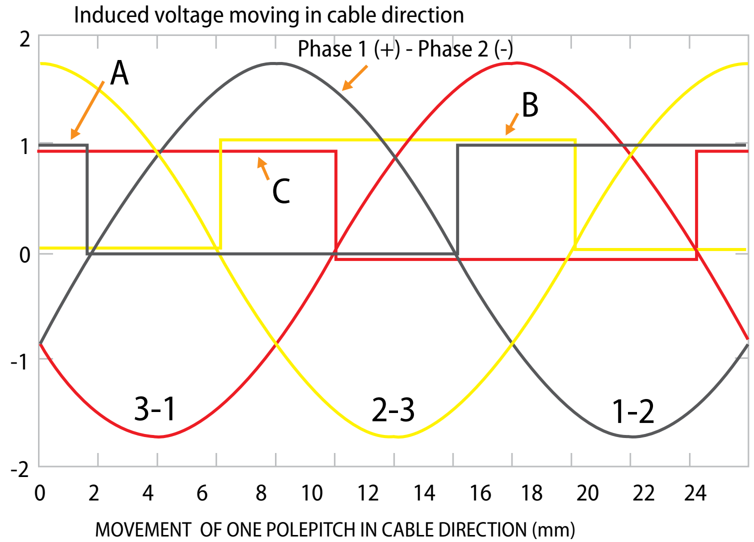
WHITE	BROWN	GREEN	YELLOW	GREY	PINK	BLUE	RED	SHIELD
0 V	+4.5 .. 28V	GND	HALL C	HALL A	GND	GND	HALL B	GND

Only one ground wire needs to be connected for proper grounding.

TECNOTION THE LINEAR MOTOR COMPANY

APPENDIX C | Digital Hall Module - UF





3 DIGITAL OUTPUTS A,B,C:

- SINK-TYPE 20mA max.
- PERIOD 24mm (UF SERIES)
- SIGNAL DEFINITION ACCORDING TO FIGURE (HIGH=SINK)
- MAXIMUM VOLTAGE DROP 0.4V + 120 * Isink (in A)
- TYPICAL VOLTAGE DROP 0.1V + 120 * Isink (in A)
- SHORT CIRCUIT SAFE @5V SUPPLY

POWERSUPPLY

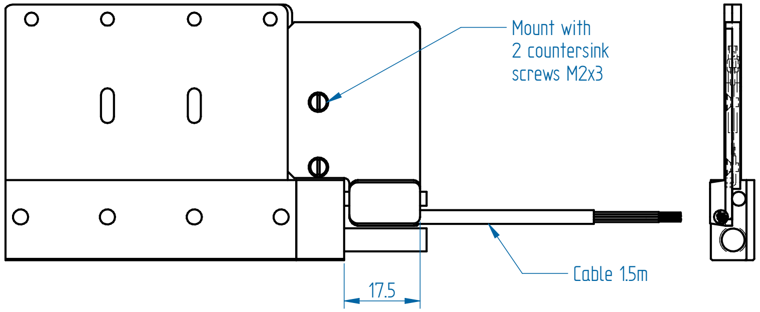
- +4.5 .. + 28V DC
- 40mA

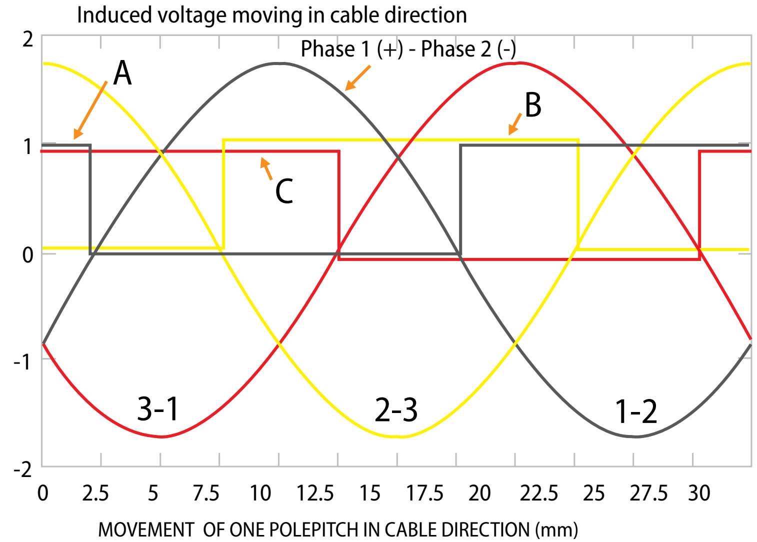
CABLE CONNECTIONS

WHITE	BROWN	GREEN	YELLOW	GREY	PINK	BLUE	RED	SHIELD
0 V	+4.5 .. 28V	GND	HALL B	HALL A	GND	GND	HALL C	GND

Only one ground wire needs to be connected for proper grounding.

TECNOTION THE LINEAR MOTOR COMPANY | APPENDIX C | Digital Hall Module - UM





3 DIGITAL OUTPUTS A,B,C:

- SINK-TYPE 20mA max.
- PERIOD 30mm (UM SERIES)
- SIGNAL DEFINITION ACCORDING TO FIGURE (HIGH=SINK)
- MAXIMUM VOLTAGE DROP 0.4V + 120 * Isink (in A)
- TYPICAL VOLTAGE DROP 0.1V + 120 * Isink (in A)
- SHORT CIRCUIT SAFE @5V SUPPLY

POWERSUPPLY

- +4.5 .. + 28V DC
- 40mA

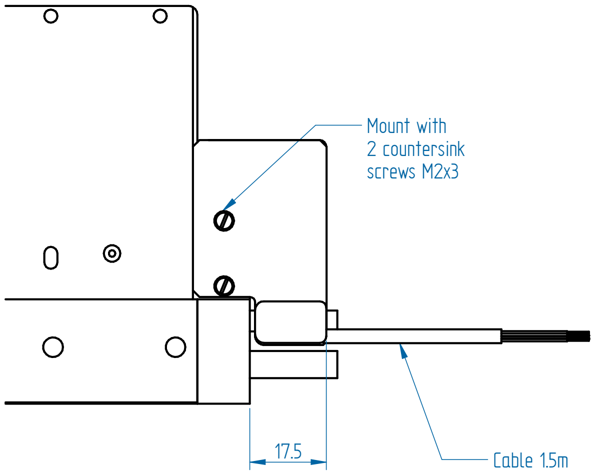
CABLE CONNECTIONS

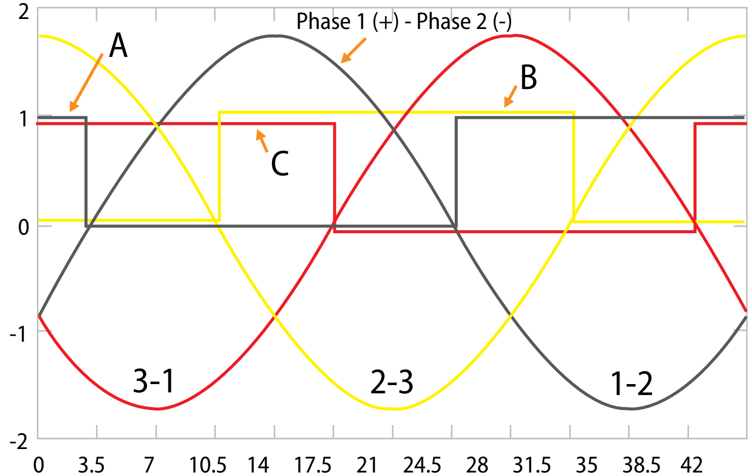
WHITE	BROWN	GREEN	YELLOW	GREY	PINK	BLUE	RED	SHIELD
0 V	+4.5 .. 28V	GND	HALL B	HALL A	GND	GND	HALL C	GND

Only one ground wire needs to be connected for proper grounding.

TECNOTION THE LINEAR MOTOR COMPANY

APPENDIX C | Digital Hall Module - UL





3 DIGITAL OUTPUTS A,B,C:
- SINK-TYPE 20mA max.
- PERIOD 42mm (UL SERIES)
- SIGNAL DEFINITION ACCORDING TO FIGURE (HIGH=SINK)
- MAXIMUM VOLTAGE DROP 0.4V + 120 * Isink (in A)
- TYPICAL VOLTAGE DROP 0.1V + 120 * Isink (in A)
- SHORT CIRCUIT SAFE @5V SUPPLY

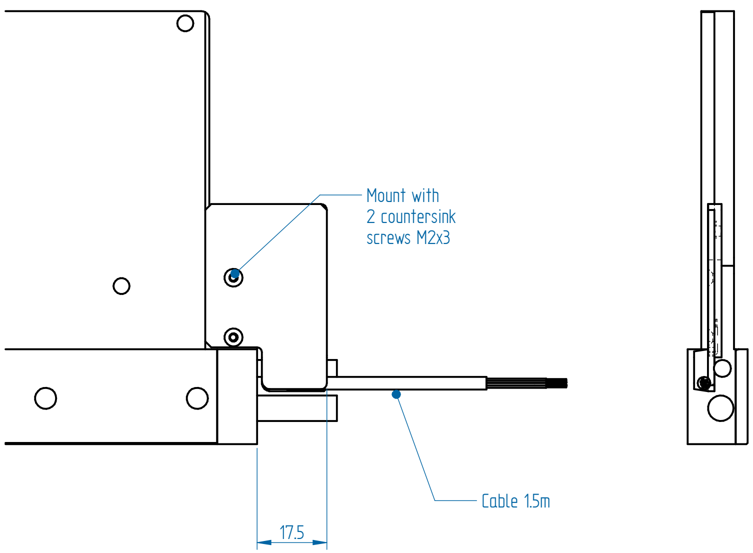
POWERSUPPLY
- +4.5 .. + 28V DC
- 40mA

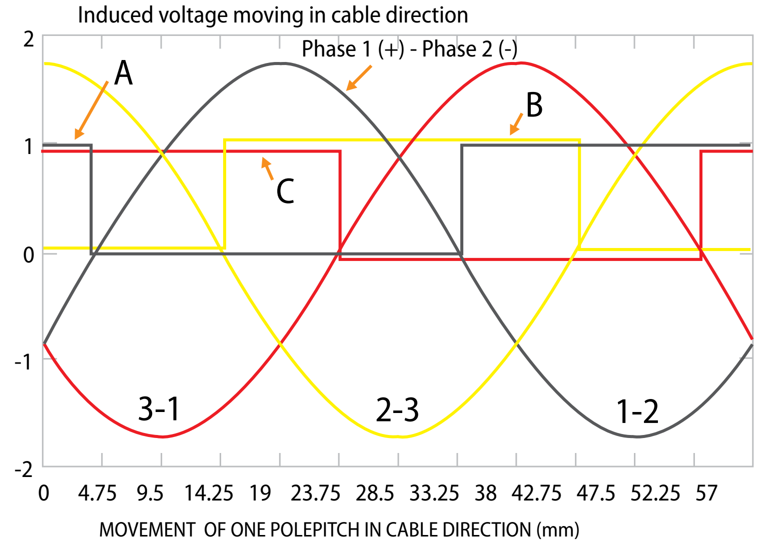
CABLE CONNECTIONS

WHITE	BROWN	GREEN	YELLOW	GREY	PINK	BLUE	RED	SHIELD
0 V	+4.5 .. 28V	GND	HALL B	HALL A	GND	GND	HALL C	GND

Only one ground wire needs to be connected for proper grounding.

TECNOTION THE LINEAR MOTOR COMPANY | APPENDIX C | Digital Hall Module - UXA/UXX





3 DIGITAL OUTPUTS A,B,C:

- SINK-TYPE 20mA max.
- PERIOD 57mm (UX SERIES)
- SIGNAL DEFINITION ACCORDING TO FIGURE (HIGH=SINK)
- MAXIMUM VOLTAGE DROP 0.4V + 120 * Isink (in A)
- TYPICAL VOLTAGE DROP 0.1V + 120 * Isink (in A)
- SHORT CIRCUIT SAFE @5V SUPPLY

POWERSUPPLY

- +4.5 .. + 28V DC
- 40mA

CABLE CONNECTIONS

WHITE	BROWN	GREEN	YELLOW	GREY	PINK	BLUE	RED	SHIELD
0 V	+4.5 .. 28V	GND	HALL B	HALL A	GND	GND	HALL C	GND

Only one ground wire needs to be connected for proper grounding.

TECNOTION THE LINEAR MOTOR COMPANY

APPENDIX D | Vacuum Installation

The Tecnotion vacuum motors come with stainless steel coil housing and PTFE flying lead wires to reduce outgassing. The magnet yokes are specifically designed for vacuum chamber compatibility e.g. by the application of nickel coated magnets.

All warnings and requirements as described in the ironless manual also apply to vacuum motors. This appendix only highlights the difference from standard ironless motors.

CE certification/Machine Directive for vacuum motors

Tecnotion B.V. declares that the UMV and ULV linear motors mentioned in this Installation manual are destined to be incorporated in or combined with other machines and are only in compliance with the Machine Directive (98/37/EC) for bus voltages below 75Vdc.

For higher bus voltages specific measures need to be taken to provide safe operation according to the Low voltage directive (2014/35/EU).
The extra measures needed to also comply for higher voltages are split in three different groups: <75Vdc, <250Vdc, <300Vdc

COMPLIANCE WITH MACHINE DIRECTIVE FOR <75VDC

Since all wires only have a single isolation and no shielding extra protection might be necessary for the application and is definitely advisable.
Because the vacuum motors normally operate in a (metal) vacuum chamber the chamber itself can be used as extra protective measurement. A grounded metal vacuum chamber will keep all EMC distortion inside the chamber and makes it impossible to touch the coil. This protection is only sufficient when it is combined with a fail save that when the chamber is opened all power to the coil is disconnected automatically.
The vacuum chamber wall is advised to be connected to a physical earth to prevent possible shock.

The UMV and ULV Vacuum motors are not supplied with an internal strain relief. Appropriate strain relief of the power and sensor wires need to be provided externally.

UMV and ULV power and sensor cables only have single isolation. Without further protective measures they may only be used below 75Vdc.

UMV and ULV coils do not have a PE wire. Appropriate grounding of the stainless steel housing with respect to the used bus voltage and application needs to be implemented by the customer.

TECNOTION THE LINEAR MOTOR COMPANY | APPENDIX D

Vacuum Installation

UMV and ULV coils flying leads power and sensor cable do not carry a (braided)shield. To comply with EMC regulation adequate shielding needs to be provided by the customer.

When all above safety warnings are respected the vacuum motors are in compliance with the Machine Directive (98/37/EC) for bus voltages below 75Vdc.

COMPLIANCE WITH MACHINE DIRECTIVE FOR 75VDC TILL 250VDC

All requirements as described in "Compliance with Machine Directive for <75Vdc" need to be implemented.

Since the cables only have single insulation for the use above 75Vdc extra isolation needs to be added.

Extra measurements with respect to grounding, shielding (EMC) and isolation need to be taken in to account depending on the application.

COMPLIANCE WITH MACHINE DIRECTIVE FOR <300VDC

All requirements as described in "Compliance with Machine Directive for <75Vdc" and "Compliance with Machine Directive for 75Vdc till 250Vdc" need to be implemented.

The temperature sensor cables are only rated till 250Vdc, they cannot be used above 250Vdc.

It is not allowed to use the vacuum motors above 300Vdc.

MECHANICAL

See 3.4 Requirements for the mounting surface for more details about the requirements for the mounting surface

Type	Coil unit flatness	Parallelism	Separation of mounting faces
	R(mm)	S(mm)	V(mm)
UMV	0.05	0.05	9.45 ±0.05
ULV	0.1	0.05	12.3 ±0.1

Table D1: Installation tolerances Vacuum U-series

ELECTRICAL

Features	UMV	ULV
Bolts for coil unit (steel DIN912)	M3x10	M4x12
Tightening torque	1.0 – 2.0 Nm	2.0 – 3.0 Nm
Bolts for magnet yoke (steel DIN912)	M4x25	M5x35

Table D2: Bolts for coil unit

Power Cable		Color code	Connection to servo controller
3-phases	L1	Black	3-phases
	L2	Red	
	L3	White	

Table D3: Powercables wire identification

Sensor Cable (color)	Connection to servo controller
Brown	PTC
White	PTC
Yellow	NTC
Green	NTC

Table D4: Sensor cable wire identification

For characteristics of PTC and NTC please see 3.7.6 PTC and 3.7.8 NTC.

TECNOTION THE LINEAR MOTOR COMPANY

APPENDIX E | Declarations

TECNOTION
THE LINEAR MOTOR COMPANY

Declaration of Conformity

(Directive 2011/65/EU)

Declaration of incorporation

(Directive 2006/42/EC, Annex II, sub B)
Ban on putting into service

We, the company

Tecnotion B.V.
Twentepoort West 15
7609 RD Almelo
Netherlands

Hereby declare under our sole responsibility that:

Our iron less linear motor series UC and UF

- Are in Conformity with the essential requirements of following EC Directive when installed according the installation manual

(2011/65/EU)	ROHS 2

- Is destined to be incorporated in other machines or to be combined with other machines and is not (entirely) in compliance with the Machinery Directive (2006/42/EC).
- The following harmonized standards have been applied

EN 60034-1: 2010	Rotating electrical machines
EN 60204-1: 2006 + AC 2010	Electrical equipment of machines

Issued by:
P. de Kok

Management:
B. Jonker

Almelo, Netherlands
2016-01-11
Legally binding Signature:

TECNOTION
THE LINEAR MOTOR COMPANY

Declaration of Conformity

We, the company

Tecnotion B.V.
Twentepoort West 15
7609 RD Almelo
Netherlands

Hereby declare that:

Our iron less linear motors series including UM, UL, UX

- Are in Conformity with the essential requirements of following EC Directive when installed according the installation manual

(2011/65/EU)	ROHS 2
(2014/35/EC)	Low voltage directive

-The following harmonized standards have been applied

EN 60034-1: 2010	Rotating electrical machines
EN 60204-1: 2006 + AC 2010	Electrical equipment of machines

Issued by:

P. de Kok

Management:

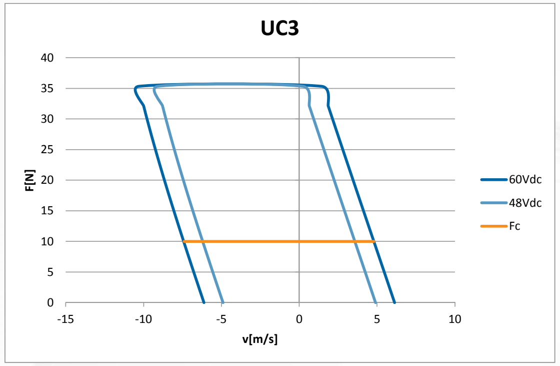
B. Jonker

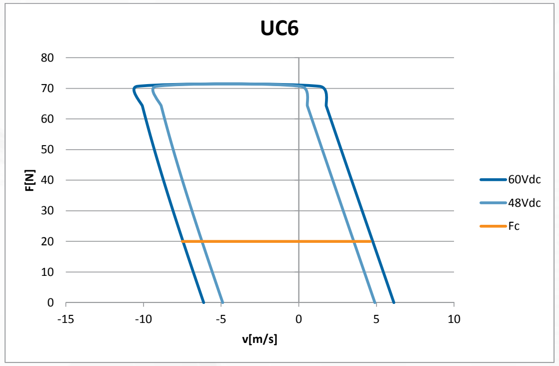
Almelo, Netherlands
2016-09-13

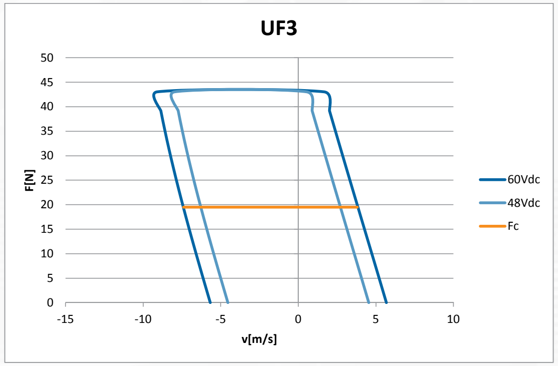
Legally binding Signature:

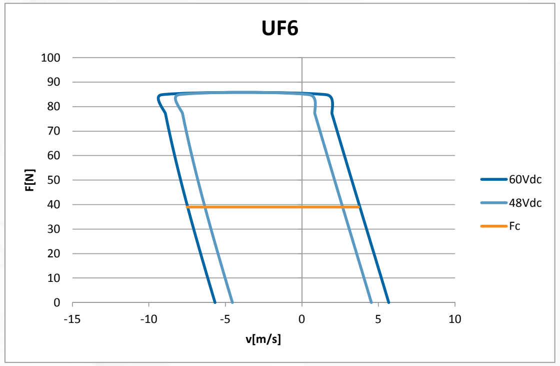
TECNOTION THE LINEAR MOTOR COMPANY

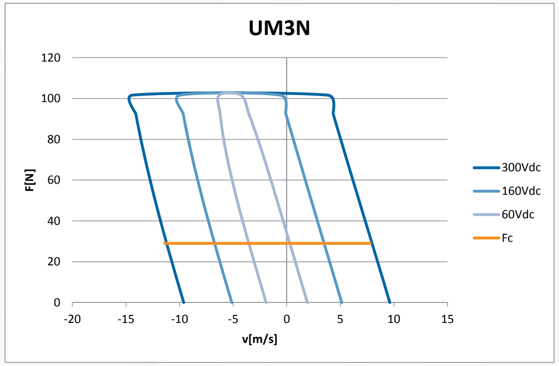
APPENDIX F | F / v Graphs

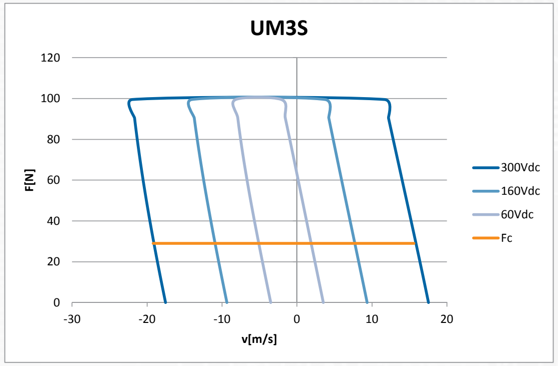


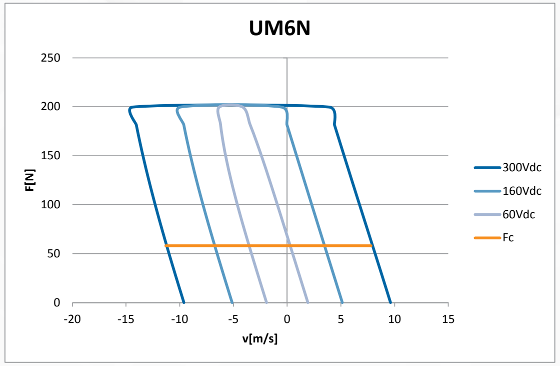


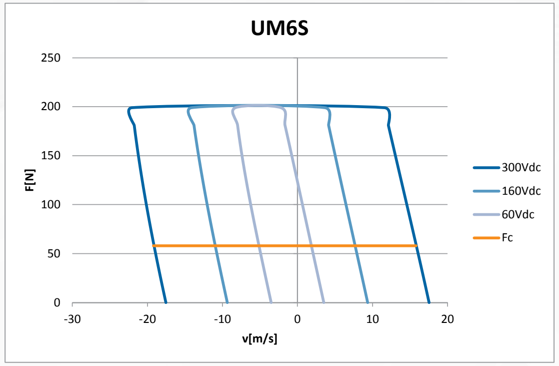


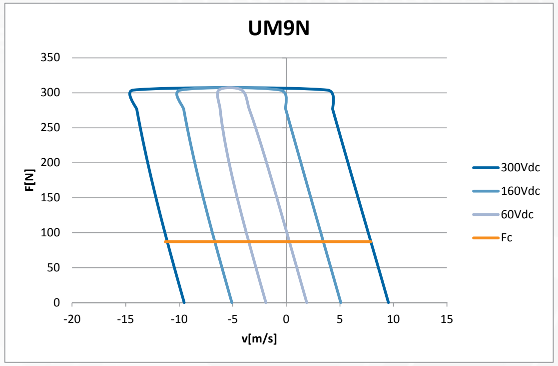




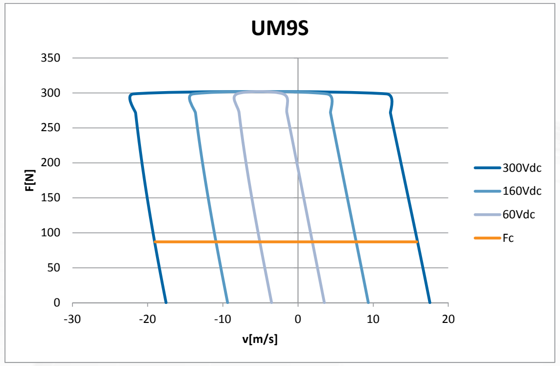


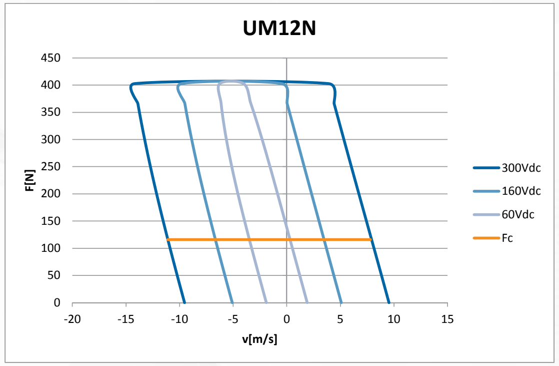


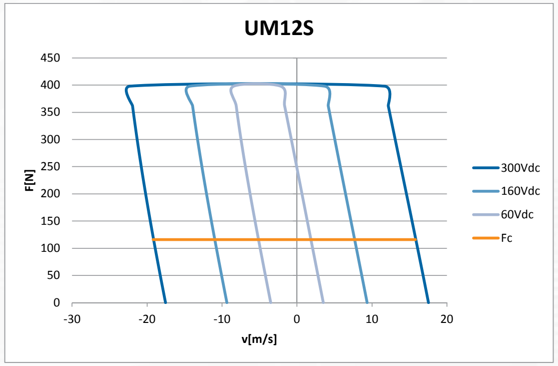


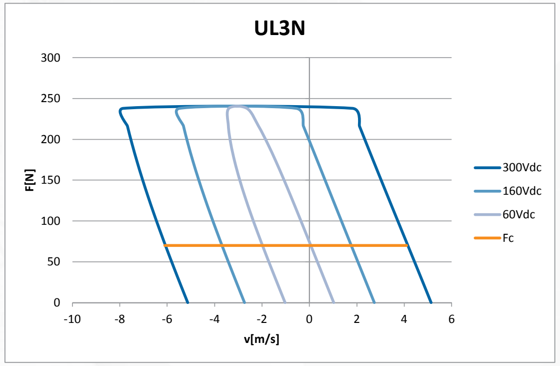


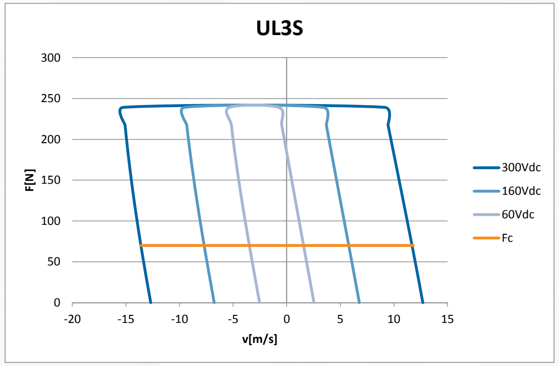
TECNOTION THE LINEAR MOTOR COMPANY | APPENDIX F | F / v Graphs

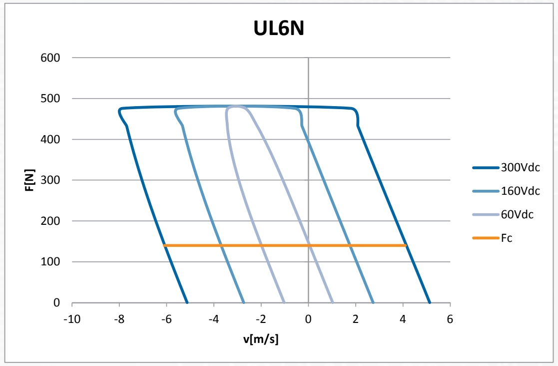


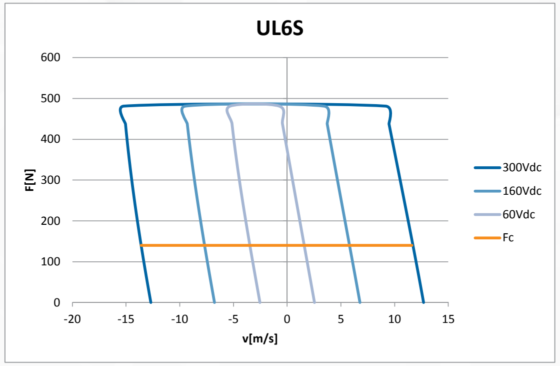


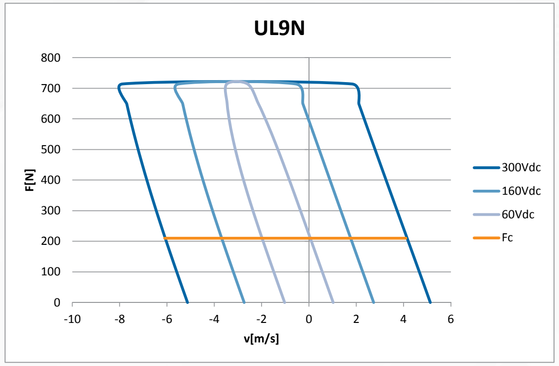


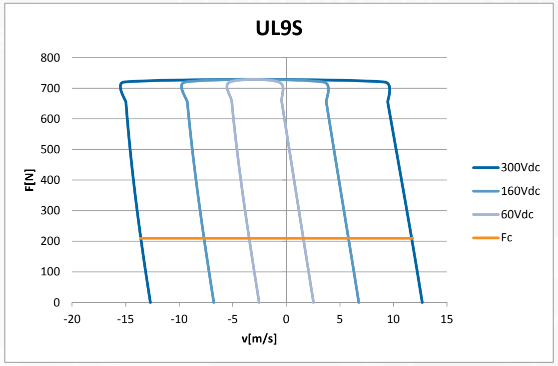




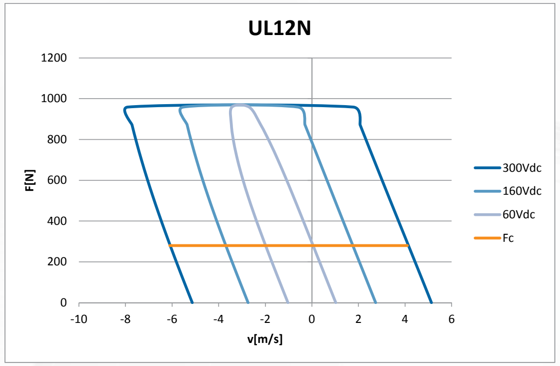


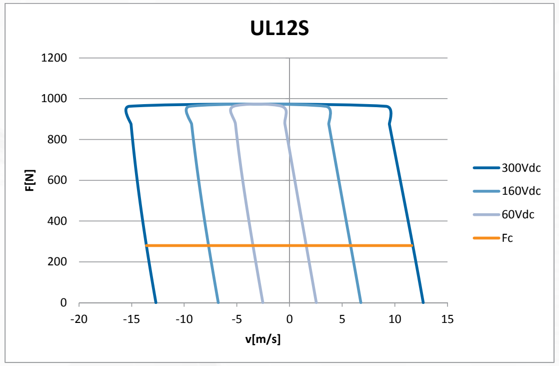


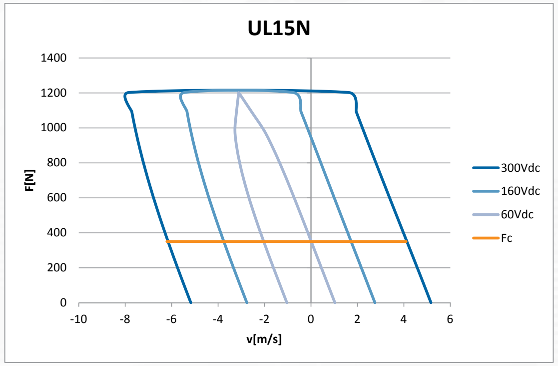


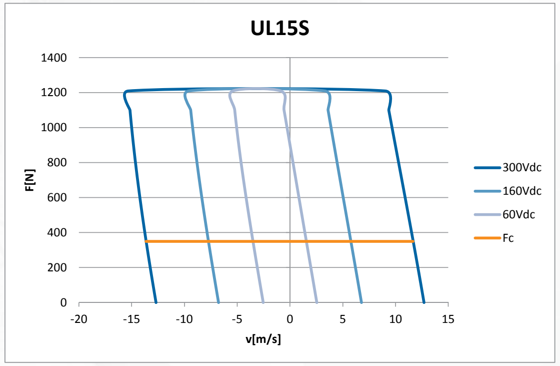


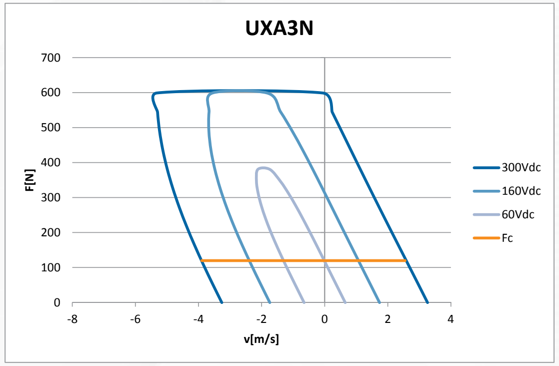
APPENDIX F | *F / v Graphs*

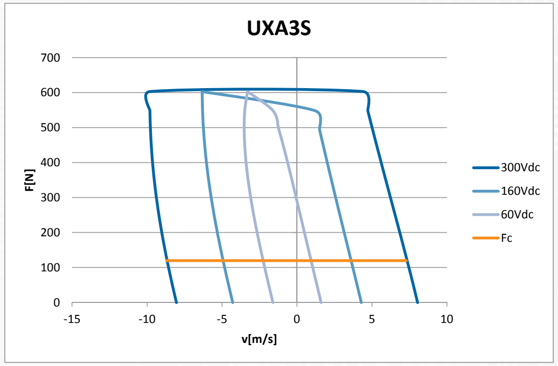


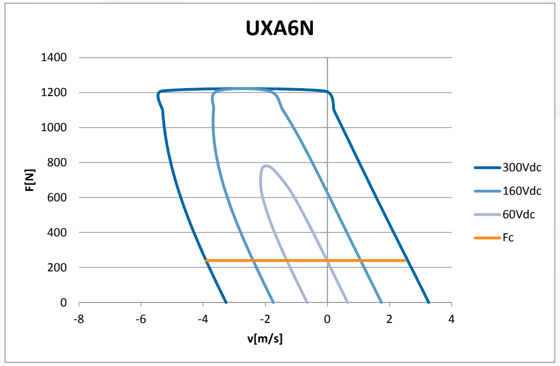


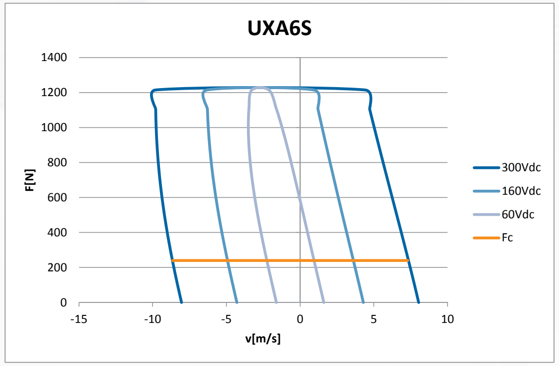


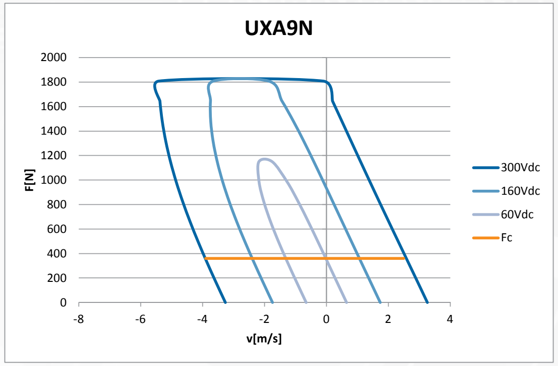




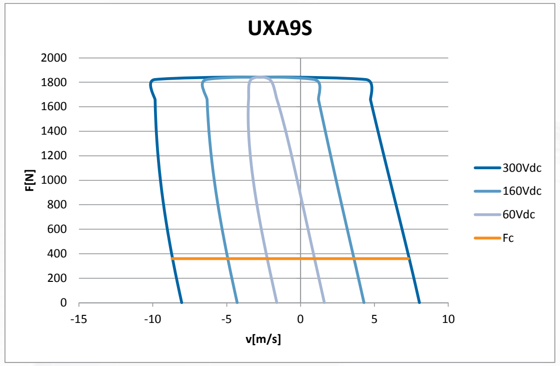


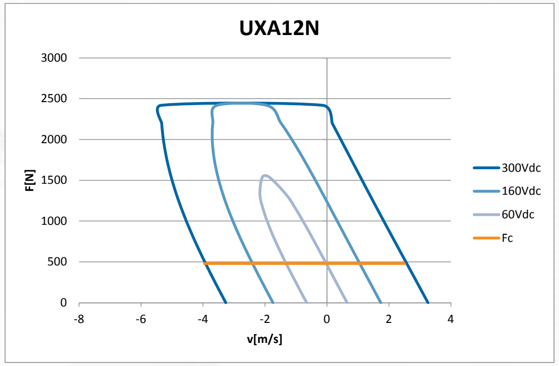


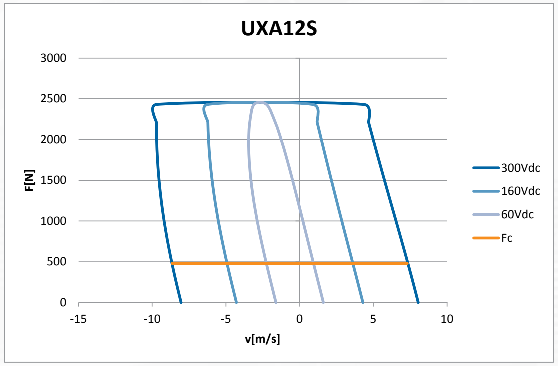


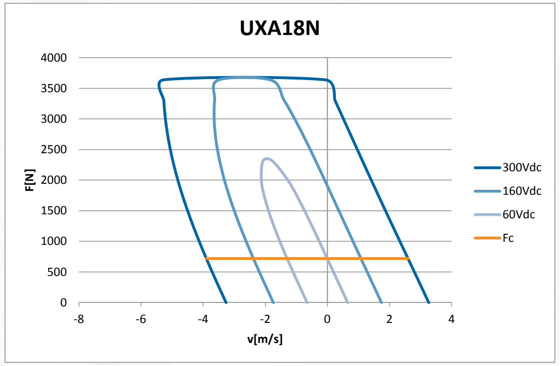


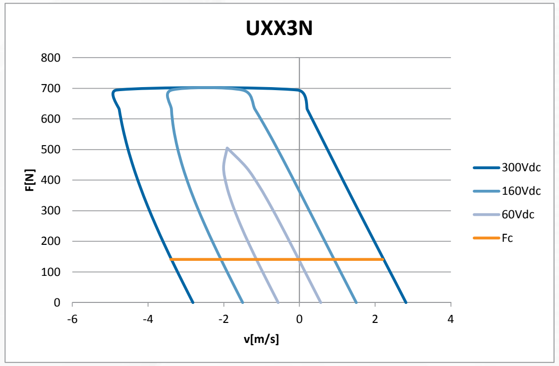
TECNOTION THE LINEAR MOTOR COMPANY | *APPENDIX F* | *F / v Graphs*

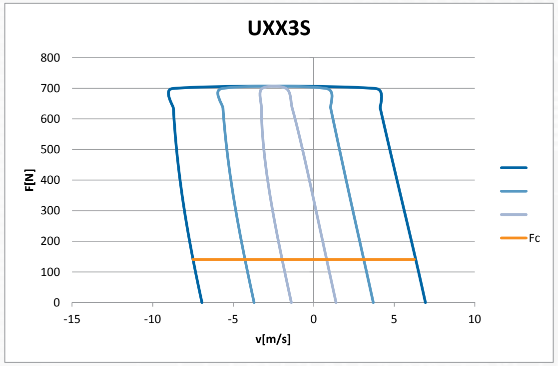


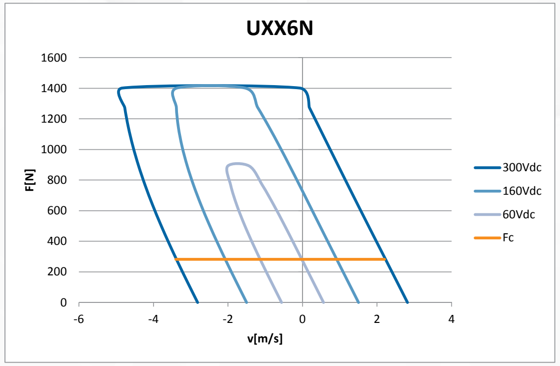


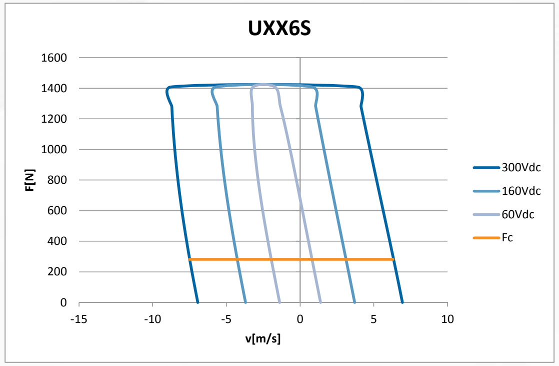


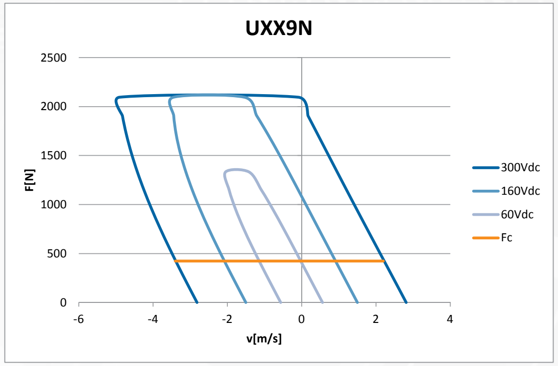






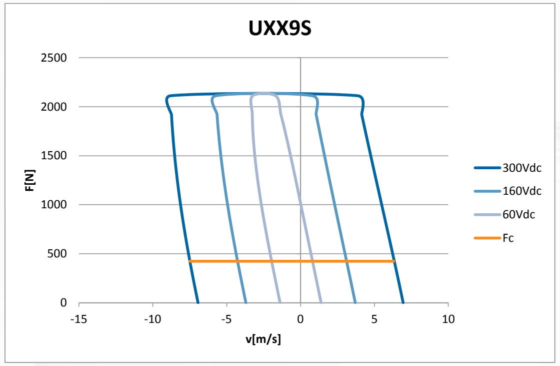


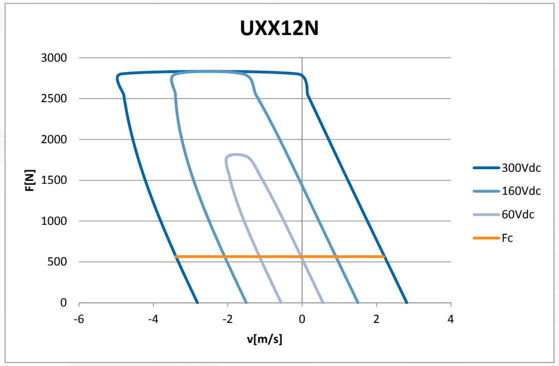


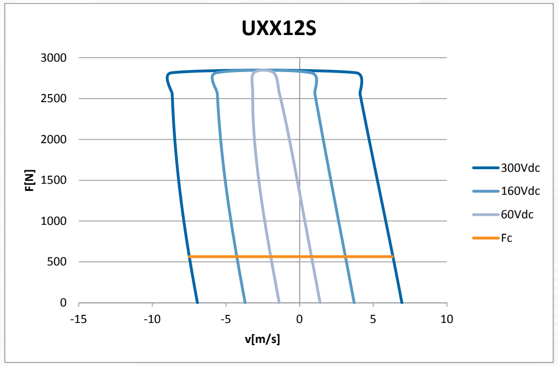


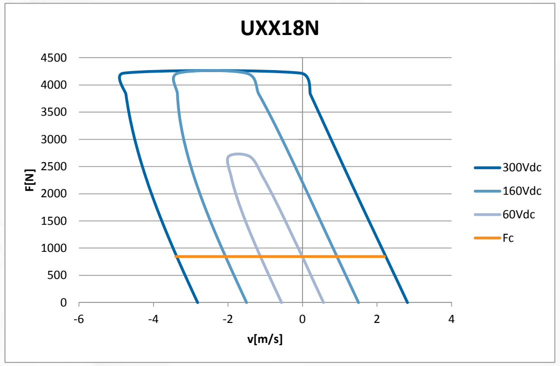
TECNOTION
THE LINEAR MOTOR COMPANY

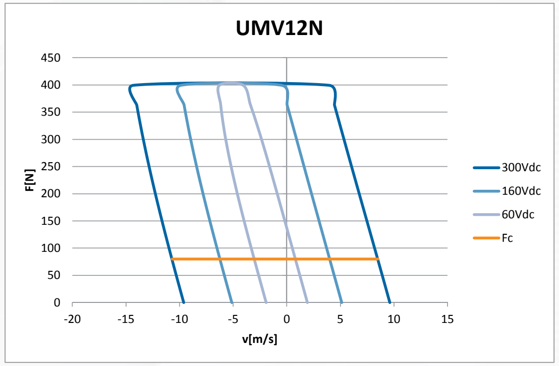
APPENDIX F | *F / v Graphs*

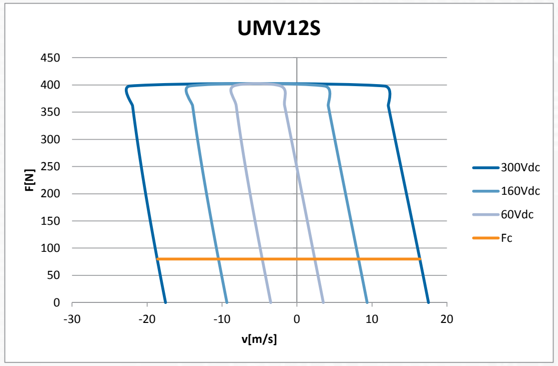


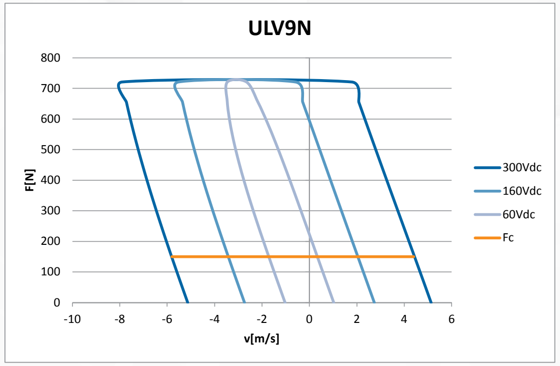


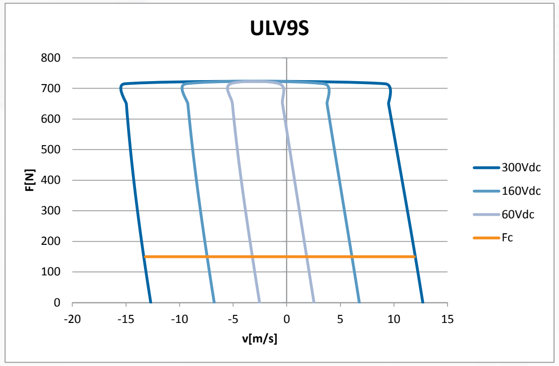


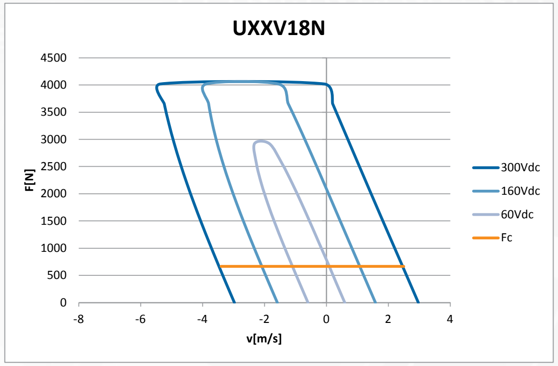












TECNOTION THE LINEAR MOTOR COMPANY | *Glossary*

Parameter	Remark	Sym	Unit	Definition
AWG				American Wire Gauge is a standard for wire thickness specification. The diameter "d" can be calculated with the AWG value "n". d[mm]= 0.127[mm] x 92 ^((36-n)/39).
Back EMF Phase-Phase_peak		B_{emf}	V/m/s	Back electromotive force. A linear motor, when operated, also acts as a generator. The Back EMF describes the coefficient between the generated voltage and the speed of the motor [V/m/s]. When the generated Voltage is nearly equal to the bus voltage of the system the motor can not run any faster.
Beding radius Static	minimum			Minimum bending radius for the cable when used in static configuration.
Bending radius Dynamic	minimum			Minimum bending radius for the cable when used in dynamic configuration.
Cable Life (Power FLEX)				Number of operating cycles for use in powerchains. Only applicable for coils with a FLEX cable. The specified value is for a temperature range of -5 to 90°C and with the cable configured with the minimum bending radius for flexible applications.
Cable mass	length 1m	m	kg/m	Mass of both cables.
Coil unit length	excluding cables	L	mm	Length of the coil unit.
Coil unit weight	excluding cables	W	Kg	Weight of the coil unit without the cable.
coils @ 100°C				The coil temperature where the specifications are rated at.
Continuous current air cooled	coils @ 100°C	I_c	Arms	The continuous current [A] the motor can be run at to achieve the continous force when cooled by means of radiation, convection and conduction through a 20°C aluminium reference surface and a thermal resistance of 0.05[K/W] .
Continuous current water cooled	coils @ 100°C	I_{cw}	Arms	The continuous current [A] the motor can be run at to achieve the continous force when water cooled.
Continuous force	coils @ 100°C	F_c	N	see Continuous force air cooled.
Continuous force air cooled	coils @ 100°C	F_c	N	The continuous force for a non water cooled coil. At continuous force the heat gain and dissipation in the coil are equal. Dissipation occurs purely via conduction, convection and radiation. Tecnotion' linear motors continous force is specified for a mounting surface at 20°C. The thermal resistance is 0.05K/W when mounted to a aluminium heatsink.
Continuous force water cooled	coils @ 100°C	F_{cw}	N	At continuous force the heat gain and dissipation in the coil is equal. For Tecnotion linear motors the mounting surface needs to be at 20°C. The thermal resistance for watercooling is 0.02K/W when combined with an aluminium heatsink.
Electrical time constant	coils @ 25°C	τ_e	ms	The time after which the current reaches 63%(1-(1/e)) of the desired magnitude. This metric gives an indication of the reaction time of the motor.
Induction per phase	I<0.6 Ip	L_{ph}	mH	The Induction value in [milli Henry] of one phase or winding of the coil. This value can be verified via the motor cables. The double value will be measured because of the star point configuration of the phases / windings.
KTY temperature sensor			Ohm/C	The temperature sensors for the Iron core series. Has a positive coefficient between temperature and resistance.

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Parameter	Remark	Sym	Unit	Definition
Magnetic pitch NN		τ	mm	The distance between two consecutive poles of the same polarity.
Magnets @ 25°C				Temperature at which the specified force is rated. Permanent magnets have a negative temperature coefficient. At higher magnet temperatures the achievable force will be lower. Permanent magnets will start to demagnetise at a specific temperature and applied external magnetic loads. For Tecnotion standard motors this will occur around 60°C. At the specified 25°C this demagnetisation will not occur.
Maximum continuous current				see Continuous current aircooled.
Maximum continuous power loss	all coils	P_c	W	The maximum amount of power in [Watt] that is dissipated when the motor is operated at continous force. The actual value can be lower as a result of variations in thermalresistance, coil temperature and winding resistance. The winding resistance Rph increases with the temperature according to Rph_ΔT= Rph*(1+α x ΔT). With α being the temperature coefficient for copper [1/K] and ΔT the temperature increase in [K].
Maximum speed	@560V	v_{max}	m/s	The maximum speed the linear motor can achieve at continous force. The actual value depends on the busvoltage and required force. Please check the Force/ Velocity diagrams in the Tecnotion Simulation tool.
Motor attraction force	RMS @ 0A	F_a	N	The motor attraction force for an unpowered Ironcore motors. The value increases when the motor is powered. At maximum current the attraction force increases by approximatly 10%.
Motor Constant	coils @25°C	S	N^2/W	Ratio between force in Newton and dissipated heat in Watts [N^2/W]. A higher value of the constant implies that the motor dissipates less heat for the generation of a certain amount of force. The value decreases at higher coil temperatures. This is caused by increased Rph-ph winding resistance. S=(K^2/(3*Rph-ph).
Motor Force constant	mounting surface @ 20°C	K	N/A_{rms}	[N/Arms] Ratio between generated force in Newton and applied RMS current in Ampere. This value is completely linear for Ironless linear motors. Ironcore linear motors express a linear characteristic untill a saturation point. Beyond this point the ratio is no longer constant.
NTC temperature sensor			Ohm/C	The temperature sensors for the Ironless series. This sensor has no ferromagnetic components to prevent any attraction forces within the magnet yoke. This sensor has a negative coefficient between temperature and resistance.
Peak current	magnet @ 25°C	L_p	A_{rms}	The peak current [A] the motor can be run at to achieve the specified peak force.
Peak force @ 20°C/s increase	magnet @ 25°C			Ironless motors lack a saturation point in the Motor Force Constant. The peak force is determined by the tolerated material expansion due to an increased temperature of the coil. For Ironless motors this increase is at 20°C/s.
Peak force @ 6°C/s increase	magnet @ 25°C	F_p	N	For Iron core motors the peak force is the force generated by the motor just beyond the saturation point of the Motor Force Constant. The actual value of the Motor Force Constant is 14% less then the linear value. The coils will heat up with 6°C/s.
Resistance per phase	coils @ 25°C excluding cables	R_{ph}	Ohm	The resistance value in [Ohm] of one phase or winding of the coil. This value cannot be verified via the motor cables. The double value will be measured because of the star point configuration of the phases / windings.

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Parameter	Remark	Sym	Unit	Definition
Synchronous motor				A motorsystem with a linear relation between the currentfrequency and the movement frequency.
Temperature Cut-off sensor				A cut-off sensor is used to protect the motor from damage due to overheating. The sensor has a positive coefficient between temperature and resistance. Near 110°C the resistance increases exponentially. The sensor output can be used as input for the controller to shut off the current to prevent damage to the coils.
Temperature Sensor			Ohm/C	A temperature sensor can be used for monitoring the coil temperature. Iron core motors are fitted with KTY sensors Ironless sensors are fitted with a NTC sensor.
Thermal resistance	coils to mounting surface	R_{th}	C/W	Defines how warm the coil unit will become as a result of the dissipation of power to the surface. Rtherm x dissipated power = [°C/W] x [Watt] = [C] Temperature of the coil unit.
Thermal time constant	to 63% of maximum temperature	τ_{th}	S	Time [Sec] required for the coilwindings to reach [(1-(1/e))=63%] of their maximum temperature during continuous force.
Ultimate current	magnet @ 25°C	I_u	A_{rms}	The ultimate current [A] the motor can be run at to achieve the specified ultimate force.
Ultimate force @ 10°C/s increase	magnet @ 25°C	F_u	N	The force generated by the motor beyond the saturation point in the non linear area of the Motor Force Constant. The actual value of the Motor Force Constant at Ultimate Force is 26% less then the linear value. This is only applicable for Iron core motors. Transfer efficiency of current to force is lower and causes the coils to heat up faster. For ultimate force the temperature increase is 10°C/s.
V ac RMS				The effective value of a Sine shaped alternating current voltage.
V dc				The direct current bus voltage can be calculated from the AC supply voltage by multiplication Vdc=Vac rms x (sqrt2).
Watercooling flow	for ΔT=3K	ΦW	L/min	Volume of water at 20°C per minute that will create a ΔT of 3K between entrance and exit of the coilunit. At a different flow rate the delta T will be different.
Watercooling pressure drop	order of magnitude	ΔPw	bar	Drop in pressure over the in and outlet of the coils caused by friction forces in the watercooling channels. The pressure drop over the hoses and nipples of the entire system are not included.
Winding type				The winding type determines the relation between maximum speed, force, required current and bus voltage of the coil. N type windings are optimised for normal currents and regular busvoltages. S type windings are optimised for higher speeds and / or lower busvoltages. The S type winding requires higher currents. The available forces are winding type independent.

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