Technical Information
Linear Systems

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Franke aluminium Linear Systems have base bodies made of high-strength anodized aluminium. Depending on their type, the rollers are mounted on needle or ball bearings and are made of roller bearing steel. Face plates made of plastic house the felt wipers that keep the guide system clean.

1 Type FD – Franke Dynamic

1.1 Designs and system description

Aluminium roller guides by Franke are available as double rails with cassette or as a pair of single rails with a pair of roller shoes:

Double rail with cassette

By standard, the design with double rail and cassette is a fully calibrated linear guide. The cassette and rail come with standard market connection bores.

Pair of single rails with pair of roller shoes (Diagram 1)

The single rails with roller shoes are integral elements of the design, offering the benefit of variable guide width. The customer specifies the connecting plate.
The cassette or the pair of roller shoes in standard type

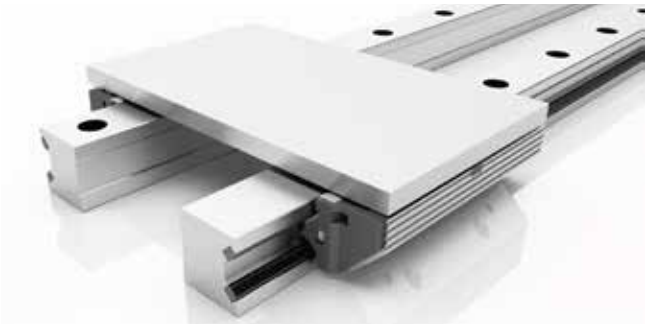


Diagram 1: Pair of single rails and pair of roller shoes

FDA each run over four rollers mounted on needle bearings and arranged crosswise, fitted on raceways made of tough-but-flexible spring steel. Other types are available for special applications, among them non-corrosive raceways or individual customized versions.

The aluminium roller guides are lifetime lubricated. Travel speeds of 10 m/s and acceleration of 40 m/s² can be achieved. The operating temperature of the guides is between –20 °C and +100 °C. Franke is pleased to provide advice if you require solutions suitable for temperatures outside of the range specified above.

Cassettes are mounted on rails and factory set free from clearance. An integrated clearance adjuster can be used downstream to align the aluminium roller guides to their respective load situation. The clearance setting is best determined by measuring the slide resistance in an unloaded state (see Diagram 2).

Diagram 2: Measure slide resistance

The screw connection on the cassette plate is loosened slightly to make the setting. After this the threaded pin integrated in the longer cassette side is reset. Turning the threaded pin displaces the roller shoe and hence increases or reduces preload

The setting values for the individual type are listed in Table 3.6 Slide resistances. Please find more precise instructions on fitting and setting the guides in the assembly instructions for the aluminium roller guides.

1.2 Design of the guides

The following parameters are required to correctly design the guides:

- Selection of arrangement
- All prevalent forces/moments (dynamic/static), (see Diagram 3)
- Load type (resting, expanding, alternating)
- Ambient influences (e.g. temperature, moisture) or special operating conditions (e.g. clean room, vacuum)
- Travel speed and acceleration
- Stroke length
- Target service life in km

All prevailing forces and moments must be within the specified limits. The relevant data are found on the type pages.

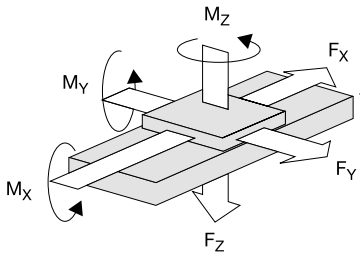
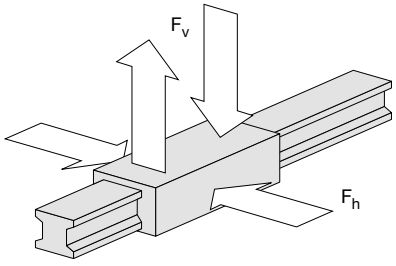


Diagram 3: Arrangement of forces and moments

Recommended safeties (given Screw quality 8.8):
- Pressure load: S > 1.2
- Tensile load: S > 2.5
- Moment load: S > 4.0

1.3 Calculation of Linear Systems



1.3.1 Terms, dimensions

C	= dynamic rated load	(N)
C_0	= static rated load	(N)
D_a	= diameter of rollers	(mm)
F	= dynamic equivalent load	(N)
F_a	= off-center load	(N)
F_0	= static equivalent load	(N)
F_1, F_2, F_n	= individual loads	(N)
F_h, F_v	= horizontal force/vertical force	(N)
L	= service life	(km)
$M_{0cx,\ 0cy,\ 0cz}$	= per. stat. moment rated load	(Nm)
$M_{cx,\ cy,\ cz}$	= per. stat. or dyn. torsion moment	(Nm)
q_1, q_2	= time quotient for F1, F2	(%)
S	= safety	

1.3.2 Static calculation

A static calculation is sufficient with load at rest or in minimal linear motion up to v ≤ 0.1m/s. A linear guide with sufficient load capacity would be chosen once the recommended static safety S is reached.

Static safety $$S = \frac{C_0}{F_0}$$

The equivalent load is the product of adding the individual external loads F_v and F_h.

Stat. equivalent load $$F_0 = F_v + F_h$$

An off-center load F_a with a torsion moment M_0 produces the following correlation:

$$F_0 = F_0 + C_0 \cdot \frac{M_x}{M_{0cx}} + C_0 \cdot \frac{M_{yz}}{M_{0cy,0cz}}$$

1.3.2.1 Recommended safeties

Condition	Recommended safety Screw qual. 8.8
Pressure load	S > 1.3
Tensile load	S > 2.5
Moment load	S > 4.0

1.3.3 Dynamic calculation

We recommend a dynamic calculation of the load circumstances if there is linear movement with v > 0.1 m/s.

Service life $$L = \left(\frac{C}{F}\right)^p \cdot \prod \cdot D_a$$

(with P = 10/3 for the types FDA, FDC, FDD and FDE, and P = 3 for the types FDB, FDG, FDH)

The calculation is based on the following roller diameters D_a:

Size	Diameter of rollers D_a (mm)
12	11.0
15	12.5
20	15.5
25	19.0
35	27.5
45	34.5

The equivalent load is the product of adding the individual external loads F_v and F_h.

Dyn. equivalent load $$F = F_v + F_h$$

An off-center load F_a with a torsion moment M produces the following correlation:

$$F = F_a + C \cdot \frac{M}{M_{dyn.}}$$

These calculations are based on a single one-rail arrangement of linear guides. We would be pleased to perform the calculation for you when dealing with multi-rail arrangements or complicated load circumstances.

1.3.4 Calculation example

For your application you determined the load values F_v and F_h and would like to know whether an aluminium roller guide Franke Dynamic type FDA in size 25 will provide sufficient safety and service life.

Your values (examples):

F_v = 2000 N
F_h = 400N
$F = F_v + F_h$ = 2400 N

Franke Dynamic FDA size 25:

C = 9000 N
C_0 = 10100 N
D_a = 19 mm

1.3.4.1 Static safety

In your application there will be an overhead load. Please find a recommended safety of > 2.5 in Table 2.1.

$$S = \frac{C_0}{F_0} = \frac{10100\ N}{2400\ N} = 4.2$$

The calculation confirms adequate safety.

1.3.4.2 Service life

$$L = \left(\frac{C}{F}\right)^p \cdot \prod \cdot D_a = \left(\frac{9000}{2400}\right)^{\frac{10}{3}} \cdot 3{,}14 \cdot 19 = 4890$$

The service life is 4890 kilometers.

1.4 Instructions for the connecting construction

1.4.1 Connecting plate for type FD

When using single rails and roller shoes please also use a connecting plate (additional design). The roller shoes and the connecting plate form the runner.

Instruction on designing the connecting plate for the runner:
The roller shoes come with centering grooves to facilitate adjustment during assembly. To do this you attach a centering web to the connecting plate (Diagram 4). The dimensions for producing the centering web are listed in Table 1.
All other dimensions, tolerances and accuracies of the guides are listed on the respective pages.

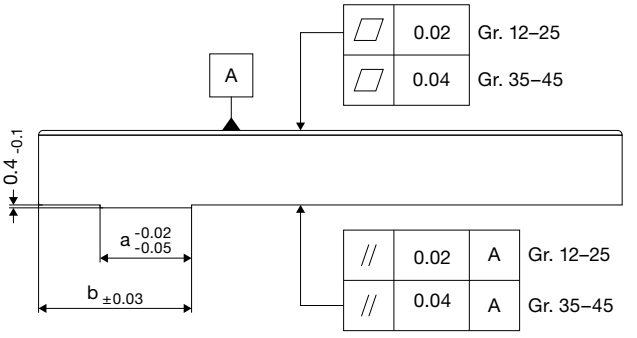


Diagram 4: Centering web

Size	a mm	b mm
12	4.5	9.6
15	5.0	12.6
20	7.5	16.1
25	10.5	17.6
35	12.5	26.1
45	15.5	31.1

Table 1: Dimensions of centering web

1.4.2 Multi-rail arrangements

If there is a multi-rail arrangement it is recommended to define a fixed and a loose bearing side on the runner plate. This is the best method to compensate tolerances between the rails.

For instance the loose bearing side can be designed with a catch and a stay rod. The fixed bearing side assumes the guide function, while the loose bearing side compensates parallel adjustment and height tolerances. It is recommended to design the drive in the immediate proximity of the guide side, as it is what absorbs the drive moments.

1.4.3 Assembly space

The input and connecting surfaces have substantial influence on the function and accuracy of the guide. Inaccuracies may accumulate on top of the running accuracy of the guide system. An exact parallel and height adjustment is necessary if there is a double-track arrangement, for instance. The accuracy of the screw-on and connection surfaces for the rails as specified in Table 2 must be adhered to in order to guarantee running accuracy of the guide:

Size	12-20 mm	25-45 mm
Max. tolerance for parallel run	0.03/m	0.05/m
Max. evenness of screw-on surface	0.05/m	0.10/m

Table 2: Accuracy of input and connecting surfaces

1.4.4 Attaching the rails

Use a ruler or a locating shoulder to align of the rails.
Depending on the type of load, the guide rails should be

1. screwed on or
2. screwed on and dowelled or
3. applied against a locating shoulder and screwed on (Table 5).

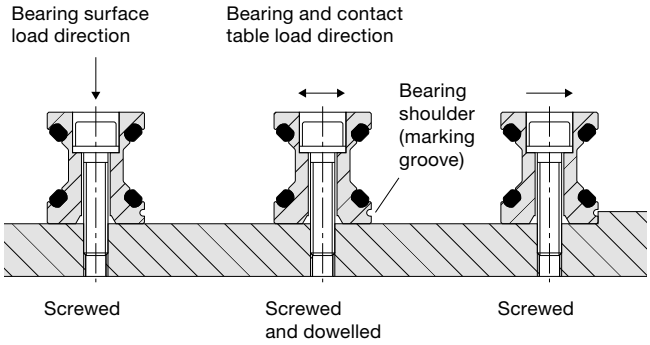


Diagram 5: Attaching the rails

The connections between the guide elements and the connecting construction influence the load capacity of the guide. Screws in quality 8.8 with washers DIN 433 are used to make the attachment to the connecting construction.

1.4.5 Assembly instruction for coupled rails

Rails above a length of 4000 mm are coupled according to the Franke standard. Separation according to the Franke standard guarantees a constant, even drilling pattern and an ideal use of the rail length. Separations according to customer specifications are also possible.

Coupled rails are specifically matched.
This is why the rails have a sequential product number (e.g. A/1-1/1-2/2-2/E) to ensure correct assembly.

Diagram 6: Coupled rails/auxiliary cylinder

The rails are labelled additionally with a marking groove below the lower edge of the rail; it must always be on the same side. The rails must be aligned without a gap. To do this please use the suitable auxiliary cylinder (Diagram 6). Dimensions for aligning the auxiliary cylinder are found in Table 3. The cylinders are inserted into the raceways at the separating point of the rails and loaded using a suitable device.
The matching tightening torques for the screw connections in question are listed in Table 4.

Size	Auxiliary cylinder mm
12	11
15	11
20	14
25	16
35	27
45	35

Table 3: Dimensions of auxiliary cylinder

Screw	Tightening torque
M 3	1.1
M 4	2.5
M 5	5.0
M 6	8.5
M 8	21.0
M 10	41.0
M 12	71.0

Table 4: Tightening torques for screw connections

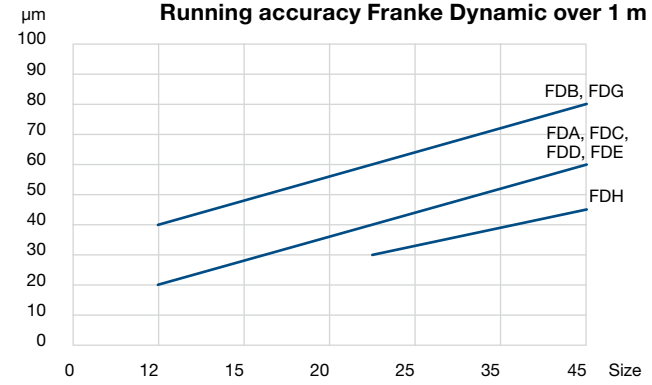
1.4.6 Slide resistances*

Size		Slide resistance N						
		FDA	FDB	FDG	FDC	FDD	FDE	FDH
12	Min.	1.0	0.15	0.2	1.0	–	0.5	–
	Max.	1.5	0.30	0.3	2.0	–	2.0	–
15	Min.	0.5	0.20	0.2	0.5	–	0.8	–
	Max.	2.0	0.40	0.3	2.0	–	2.0	–
20	Min.	1.5	0.50	0.5	1.5	–	1.0	–
	Max.	2.5	0.90	0.9	2.5	–	2.5	–
25	Min.	1.5	0.40	1.0	1.5	1.5	1.5	2.5
	Max.	3.0	0.80	1.5	3.0	3.0	3.0	5.0
35	Min.	2.0	1.00	3.0	2.0	–	2.0	4.0
	Max.	4.0	1.50	4.0	4.0	–	4.0	6.0
45	Min.	5.0	2.00	3.0	5.0	–	5.0	5.0
	Max.	8.0	3.00	4.0	8.0	–	8.0	8.0

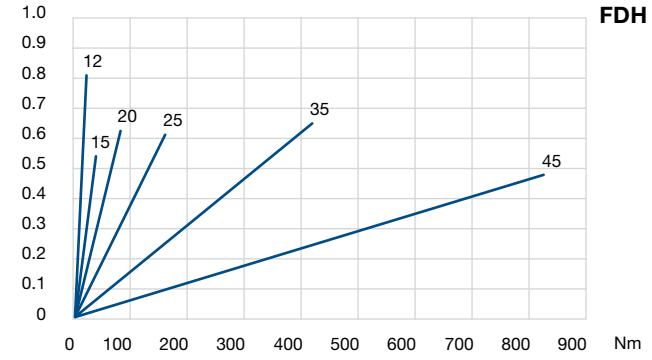
* Without wipers

1.4.7 Running accuracy and rigidity

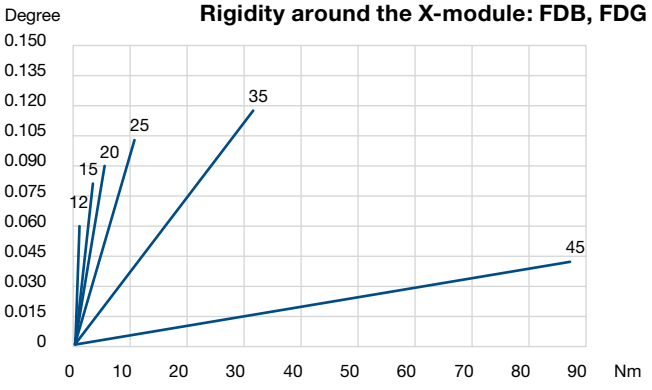
Running accuracy Franke Dynamic over 1 m



Rigidity around the X-module: FDA, FDC, FDD, FDE, FDH



Rigidity around the X-module: FDB, FDG



2 Linear tables/modules

2.1 Design

Uses of Franke linear tables include automation tasks in measurement and testing or to rationalize handling and assembly. The selection ranges from strokes larger than 100 mm to 7000 mm; there are spindle and belt drives. The lightweight aluminium construction, in connection with the integrated Franke guide system, permits high load ratings and moment loads. Please find precise technical data on this in the respective catalogue pages.

2.2 Area of use

We recommend using Franke Linear Systems with the safety S ≥ 3 for simple loads without acceleration and moment loads. A safety of S ≥ 6 should be used for dynamic moments. The mounting position is infinitely variable; we recommend an end stop or a brake for vertical operation.

The positioning accuracy of the Linear Systems type FTB is ±0.052/300 mm (IT7) as defined in the spindle pitch accuracy. Other accuracies are available on request. Repeatability is ≤ 0.01 mm. Running accuracy of the linear tables FTB is 0.03/300 mm.
Franke rotary tables can be used in operating temperatures from –20 °C to +80 °C. The Linear Systems FTD 15–35 are suitable for continuous operation in temperatures of –30 °C to +80 °C. Please contact us if you wish to operate in a different temperature range.

2.3 Limit switch and reference switch

- Reference switch: Franke Linear Systems in series FTB are fitted with inductive proximity switches that are set to stroke end position. On request another proximity switch can be fitted as a reference switch. The linear modules FTC and FTD have the option of attaching infinitely adjustable limit switches to the outside. By standard, Franke Linear Systems are fitted with inductive limit and reference switches PNP-nc 10-30VDC. PNP-no, NPN-no and NPN-nc switches are available on request. Fitting or installing a length measurement system with sinus or square-wave signal is possible on request. Rotary encoders can be fitted to the motor.
- Multi-module units: Franke Linear Systems can be combined to produce multi-module units. The required angle and adapter plates are selected to meet your requirements. We deliver fully fitted units, wired and aligned, with additional accessories on request.
- Motorization: A large variety of stepper or servo motors can be fitted to the Linear Systems. Connecting flanges and

couplings are modified accordingly. We can also accommodate customer motors.
- Motor deflection, transmission: By standard, the motor is mounted in the extension of the stroke module. Motor deflection via toothed belt or angled gears can be fitted to suit special uses, e.g. in cramped spaces.

We are pleased to advise you here, also.

2.4 Maintenance and lubrication
Franke Linear Systems are low-maintenance and have factory-fitted lifetime lubrication. Relubrication is not necessary, apart from the ball screw. Relubrication may be necessary – depending on the use – resulting from leakage of grease via the spindle shaft. We recommend relubrication with approx. 1–2 g grease in intervals of approx. 700 operating hours. If necessary you should clean the insides and the guide tracks and coat them with grease.

Fully synthetic lubricants are best suited for long.term lubrication, In its factory Franke uses the fully synthetic, special grease ISOFLEX TOPAS NCA52 (made by Klüber). We recommend high-quality lithium soap grease on mineral oil basis as an alternative lubricant. If you intend to mix lubricants you must make sure that the types are compatible in terms of base oil type, thickener, base oil viscosity and NLGI class. Please consult with the lubricant manufacturer for extreme conditions and extraordinary operating circumstances (vacuum, radiation, high temperature).

2.5 Definitions
- Running accuracy describes the greatest possible deviation between any given point on the moved table surface from the ideal lines when travelling the entire stroke distance (provided the substructure is even).
- Positioning accuracy is the greatest possible deviation from reaching a predefined point traveled to from a previously defined zero point.
- Repeatability is the greatest possible deviation from reaching a previously defined point on multiple instances. The measurement system used defines the degree of accuracy.
- Discrimination is the smallest possible travel distance. It is dependent on the spindle pitch, the transmission, the step angle and the classification within the measurement system. Discrimination is used to neutralize faults in positioning or repetition. It must therefore always be higher than the permissible positioning accuracy.

Please observe our assembly and maintenance instructions for each item.

3 Type FTH

3.1 Design
Franke linear motor modules FTH Drive are suitable for tasks in measurement and testing, also in handling and assembly. Strokes from 200 mm to 5300 mm are available. Integrated linear motors provide the drive. The lightweight aluminium construction, based on the Franke guide system, permits high load ratings and moment loads.

3.2 Area of use
We recommend using the safety S ≥ 3 for simple loads without acceleration and moment loads. A safety of S ≥ 6 should be achieved for dynamic moments. The mounting position is infinitely variable; we recommend an end stop or a brake for vertical operation.

Franke linear motor modules FTH Drive can be used in operating temperatures from –20 °C to +80 °C. Other temperature ranges on request.

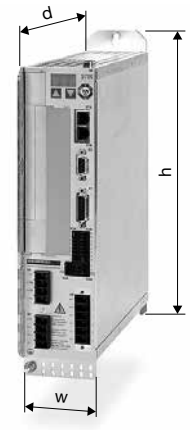
3.3 Accuracy
The positioning accuracy is ±0.01 mm/m and is dependent on the measurement system used. Other accuracies are available on request. The repeatability is ≤ 0.02 mm. The running accuracy is 0.04 mm/m.

3.4 Dynamism
Franke linear motor modules FTH Drive can achieve the values listed in the diagrams (page 131).
These are approximate values that are based on a horizontal feed movement in trapezoidal/delta operation. We are pleased to define the matching components for your application.

3.5 Motorization
The linear motor modules FTH Drive are driven by linear servo motors without mechanical drive components. The linear motor consists of a slide part and a guide part. The slide part houses the windings, the position recorder and the temperature gage. The drive magnets are found in the guide part.

The linear motors used are characterized by extremely high performance density (maximum dynamism with smallest possible space) and hence permit acceleration of up to 100 m/s^2 and travel speeds of up to 9 m/s.

3.6 Control



Dimensions mm		
H (incl. fan)	B	L (incl. plug)
345	70	243

We recommend a servo amplifier S700 by the provider Kollmorgen to operate the linear motor modules FTH Drive. The S700 offers numerous special features such as the free graphic Windows® software to commission the servo amplifier. The auto-tuning function additionally facilitates commissioning. A safe torque off (STO) is fitted as standard. The S700 can load many different return systems and can evaluate up to three positioning informations sets at once.

Our team of consultants will provide you with additional information, or access information on the Internet under www.kollmorgen.com.

3.7 Measurement system and limit, i.e. reference switch

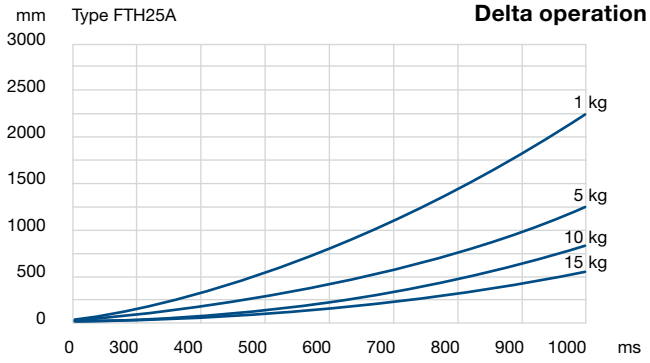
By standard, Franke linear motor modules are fitted with an integrated, magnetic length measurement system. The positioning accuracy is ± 10 µm with discrimination of ± 1 µm. Absolute measurement systems are available optionally.

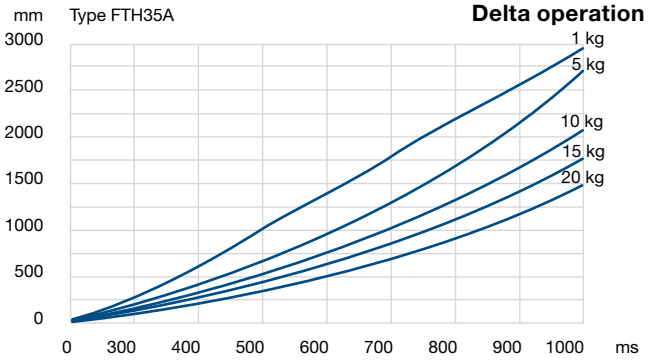
Inductive proximity switches, infinitely positionable in the guide profile, are available to record end positions or reference positions.

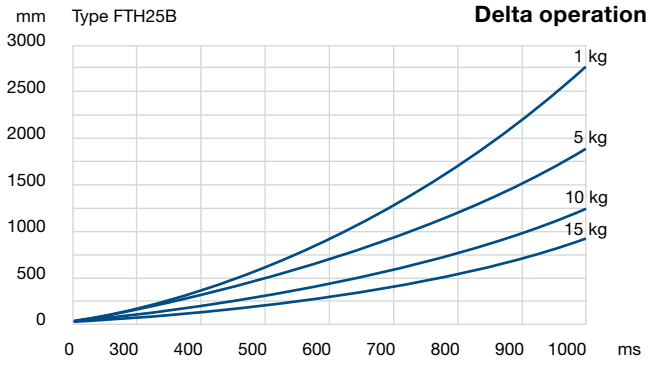
3.8 Multiple module units

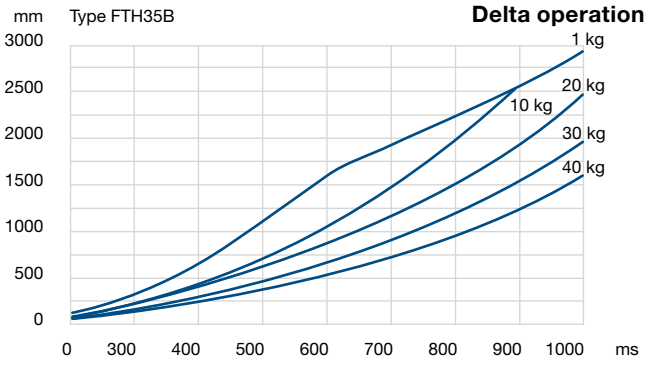
Linear motor modules type FTH Drive can be combined to form multi-module units. The required angle and adapter plates are selected to meet your requirements.
We deliver fully fitted units, wired and aligned, with additional accessories on request.

Please observe our assembly and maintenance instructions for each item.


mm
Type FTH25A
Delta operation
3000
2500
2000
1500
1000
500
0
1 kg
5 kg
10 kg
15 kg
0
300
400
500
600
700
800
900
1000
ms


mm
Type FTH35A
Delta operation
3000
2500
2000
1500
1000
500
0
1 kg
5 kg
10 kg
15 kg
20 kg
0
300
400
500
600
700
800
900
1000
ms


mm
Type FTH25B
Delta operation
3000
2500
2000
1500
1000
500
0
1 kg
5 kg
10 kg
15 kg
0
300
400
500
600
700
800
900
1000
ms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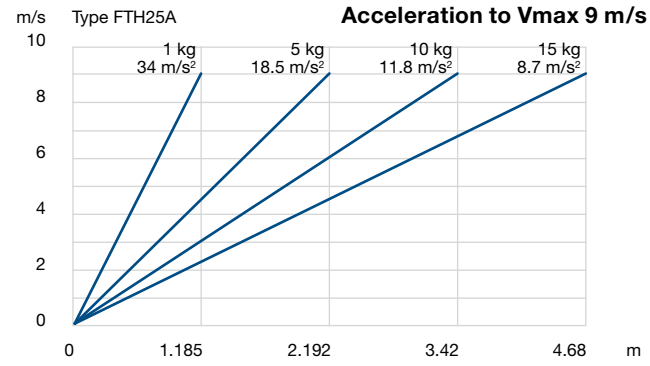
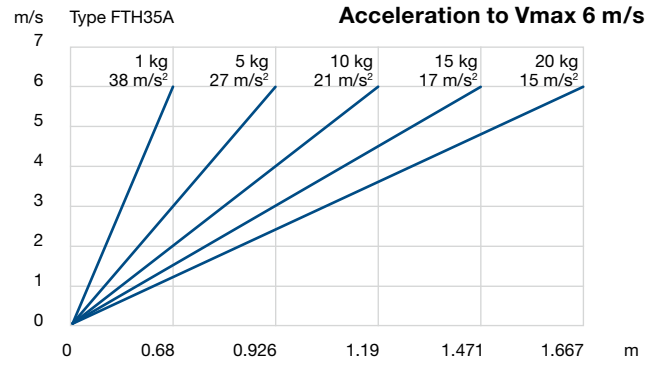
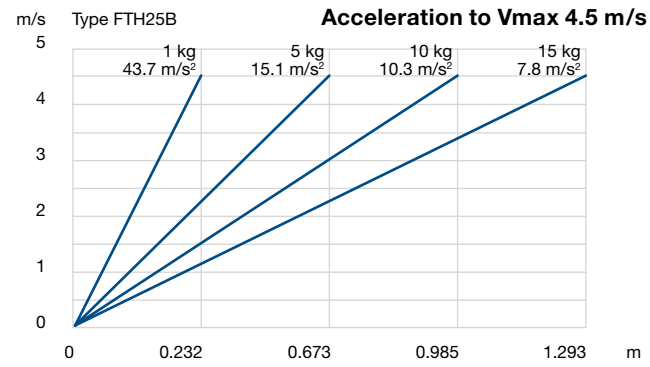
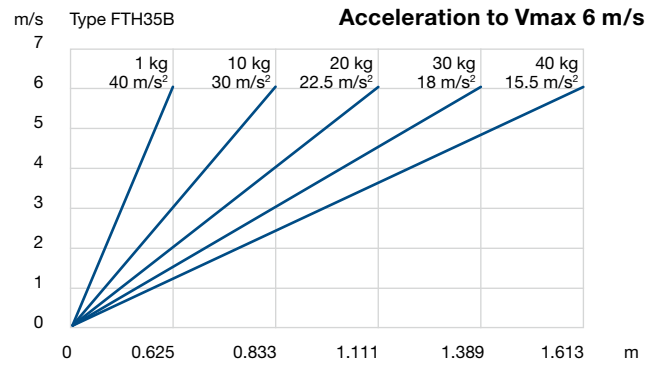
Delta operation
3000
2500
2000
1500
1000
500
0
1 kg
20 kg
10 kg
30 kg
40 kg
0
300
400
500
600
700
800
900
1000
ms


m/s
Type FTH25A
Acceleration to Vmax 9 m/s
10
8
6
4
2
0
1 kg
34 m/s²
5 kg
18.5 m/s²
10 kg
11.8 m/s²
15 kg
8.7 m/s²
0
1.185
2.192
3.42
4.68
m


m/s
Type FTH35A
Acceleration to Vmax 6 m/s
7
6
5
4
3
2
1
0
1 kg
38 m/s²
5 kg
27 m/s²
10 kg
21 m/s²
15 kg
17 m/s²
20 kg
15 m/s²
0
0.68
0.926
1.19
1.471
1.667
m


m/s
Type FTH25B
Acceleration to Vmax 4.5 m/s
5
4
3
2
1
0
1 kg
43.7 m/s²
5 kg
15.1 m/s²
10 kg
10.3 m/s²
15 kg
7.8 m/s²
0
0.232
0.673
0.985
1.293
m


m/s
Type FTH35B
Acceleration to Vmax 6 m/s
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6
5
4
3
2
1
0
1 kg
40 m/s²
10 kg
30 m/s²
20 kg
22.5 m/s²
30 kg
18 m/s²
40 kg
15.5 m/s²
0
0.625
0.833
1.111
1.389
1.613
m