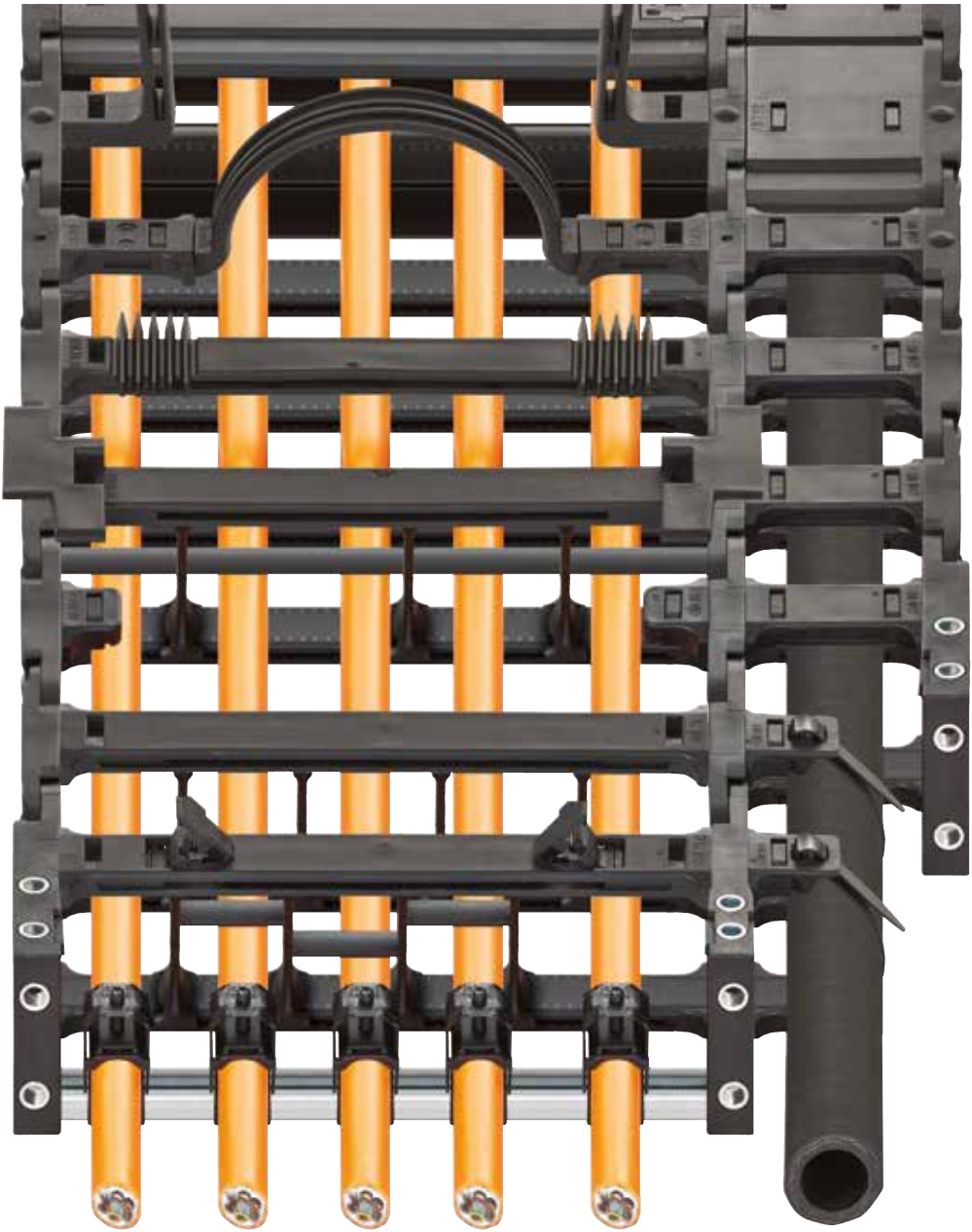
Selection, assembly and installation guide for

e-chainsystems® from igus®



www.igus.eu/designing

Foreword

With this manual for the**e-chain** igus® has designed a guide for the selection, assembly and installation of energy supply systems

It is intended to provide all the necessary basic information to allow the quick and easy use of our products.

All of our experience has gone into the preparation of this manual as well as the online configurator for the**e-chain**. The details about our products are accompanied by clear images.

We hope that, by providing this manual for the**e-chain**, we give you a clear guide for your application.
We are, of course, always grateful for comments and suggestions for improvements, which can be included in the next edition.

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Legend

a	Acceleration
Ba	e-chain® outer width
Bi	e-chain® inner width
B_{Ra}	Outer trough width
B_{Ri}	Inner trough width
D	Diameter
D_2	Over length - long travels, gliding
FL_B	Unsupported length e-chain® with permitted sag
FL_G	Unsupported length e-chain® "straight"
Fl_U	Unsupported length of e-chain®, without support of the lower run
F_{PPF}	Push-pull force calculation
F_Z	Tensile strength
H	Nominal clearance height
H2	Installation height (with lowered moving end)
ha	e-chain® outer height
H_F	Required clearance height
hi	e-chains® inner height
H_{Ra}	Trough outer height
H_{Ri}	Trough inner height
K	Addition for bending radius (please refer to the individual igus® series for K)
K_2	Addition (with lowered moving end)
KMA	Plastic-metal mounting bracket
L_K	Length e-chain®
PPF	Push-pull force (calculation)
R	Bending radius e-chain®
RBR	Reverse bending radius (for circular movements)
S	Length of travel
v	Speed

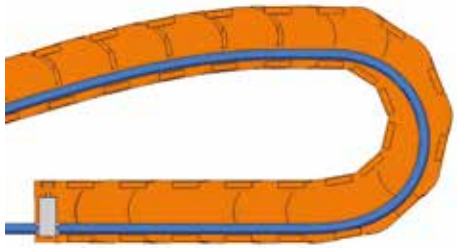
$L_K = S/2 + K_2$ | $H_{Ri} \geq 2 \times ha$ | $B_{Ri} \geq Ba + 4$

Courtesy of IMA Klessmann GmbH

Content

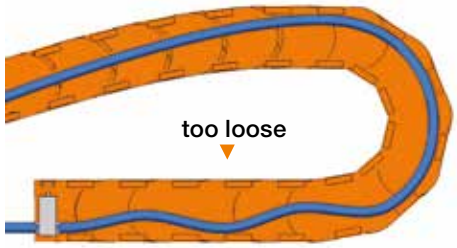
Visual inspection of cables and hoses

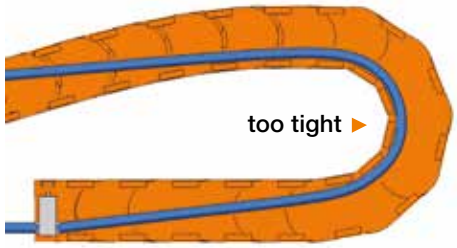
correct



igus® chainflex®-cables can have strain relief fixed directly to the mounting bracket

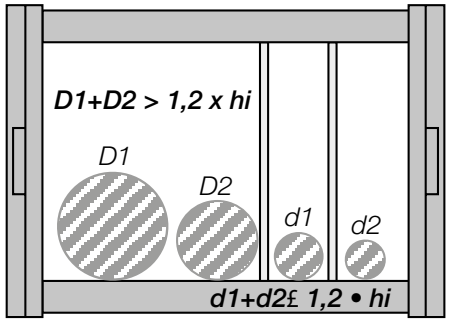
wrong

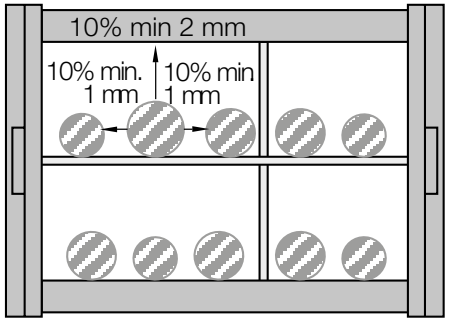


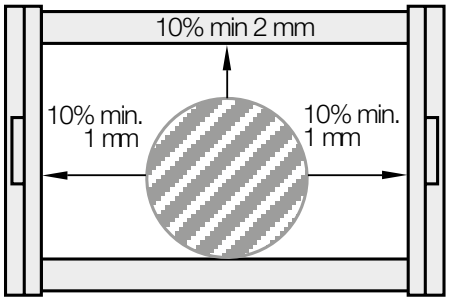


Layout rules

The layout rules ensure sufficient space around the cables and hoses







Content | Laying guidelines for cables and hoses

General rules for cables and hoses in e-chains®

The great advantage of igus® e-chains® is that you can safely guide different types of electrical cables and hoses together in one system. Also, you can separate and subdivide the various media in anyway you want. Besides the quality of the cables used, the arrangement of cables within the e-chain® play a crucial role in the service life of the system. With many separation options, it is easy to customise the e-chains® to the specific requirements of each application. In this section we offer detailed advice and tips in this area. We are happy to support you with our free project planning service, just ask us.

Electrical cables, round

For electrical cables, the round cable is a safe, simple and cost-effective solution for e-chainsystems®. When purchasing, we recommend that you pay attention to the following criteria:

- Minimum bend radii and mounting heights
- Service life at minimum bend radius
- Service life required for your application
- Possibility for strain relief of cables on the mounting bracket
- Bend-resistant shielding for shielded cables
- Abrasion-resistant outer jackets
- For bus cables and fibre optic cables, how well the transmission rates and the shielding effects are preserved after millions of cycles at the minimum bend radius.

Round cables are the best option; flat cables are only conditionally suitable for e-chains® due to their shape and construction.

igus® GmbH has a wide range of cables which are optimally matched to the material of the e-chains® offering very low wear. igus® chainflex® cables in combination with e-chains® also offer a tested and proven long service life, even for millions of strokes! For information on our chainflex® product range, please see our current chainflex® cable catalogue or visit our website (www.igus.eu/cf)

Flat cables

Flat cables must be able to move freely at the bend radius. Two flat cables next to each other should be partitioned by separators. If two flat cables should be laid one above the other, we strongly recommend the use of igus® horizontal interior separation options. Flat and round cables should be routed separately in the e-chain®. Strain relief should be used at both ends. Flat cables are only considered conditionally suitable for use in e-chains®, because of their shape and the outer material (usually rubber) meaning higher abrasion in e-chains®. **But the outer material which is mostly made of rubber means high abrasion in the e-chain®.** The use of round cables improves the service life of the application.

Hydraulic hoses

When designing hydraulic hoses in e-chains®, special attention should be paid to the **expansion of the hoses** when pressurised. It is necessary to provide enough space (20% clearance all around). When selecting hoses, make sure that they are sufficiently flexible so that they can be **bent to a predetermined radius**. Also important is a **low friction, abrasion-resistant surface**. Usually hoses with textile braiding are more flexible than those with steel wire. As lateral movements of the hydraulic hoses within the e-chain® can lead to increased abrasion of the hose material, they should be **secured in position with vertical separators**, but not forced. Special locking separators which grip the crossbars of the chain very firmly, prevent lateral shifting of the separators - they also ensure the hoses stay put in cases of strong vibration and impact on the e-chain®. In most cases hydraulic hoses exhibit a linear extension in use. This must be taken into account when strain relieving by providing more hose length or a floating strain relief. Generally, a strain relief only on the moving end is recommended.

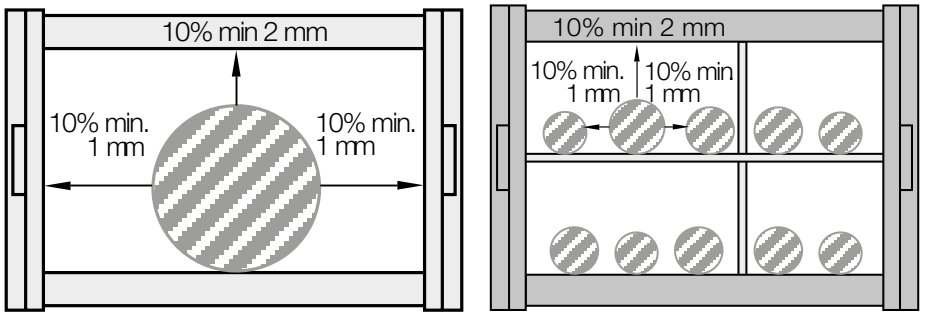
Pneumatic hoses

In principle, the **same rules for round cables** apply to pneumatic hoses. Practical experience, however, shows that pneumatic hoses are less prone to faults. Generally, they can also be laid together more closely than using the the “10% clearance” rule. Strain relief at both ends is recommended. In pneumatic hoses made from rubber, we recommend sticking closely to the “10% clearance” rule, because they can stick together or to other cables.

This must not happen!

For igus® e-chainsystems®, corkscrewing cables are a thing of the past

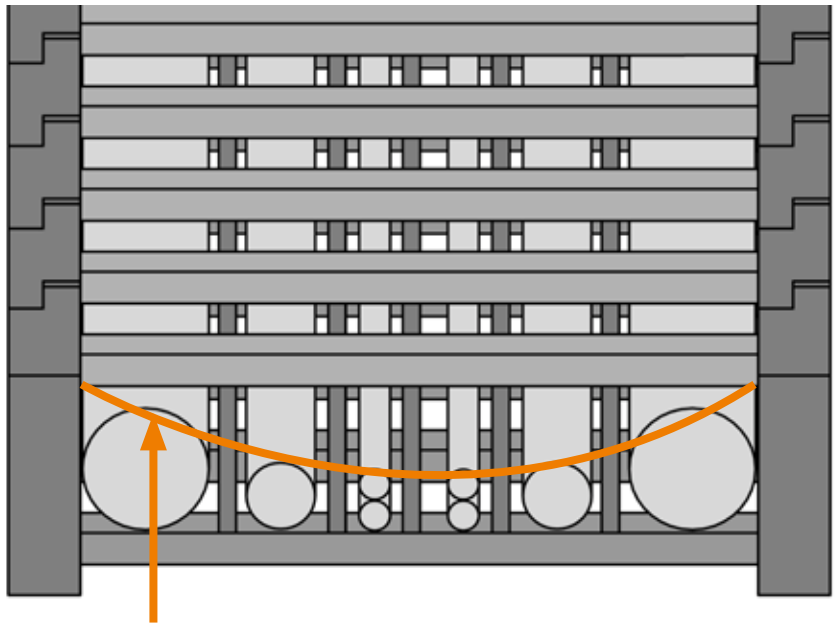
The maximum cable diameter corresponds to the clearance height (hi) of the selected e-chain® or e-tube minus a clearance. This is, for example, 10% for round electrical cables. An e-chain® is ideally filled, when a minimum lateral distance is allowed to the next cable or wall. The minimum distance is always 1 mm! More clearance needs to be provided according to the nature of the cables, the dynamics and the service life. In exceptional cases, the filling can be laid out more closely. You may talk to us about this.



Clearance space

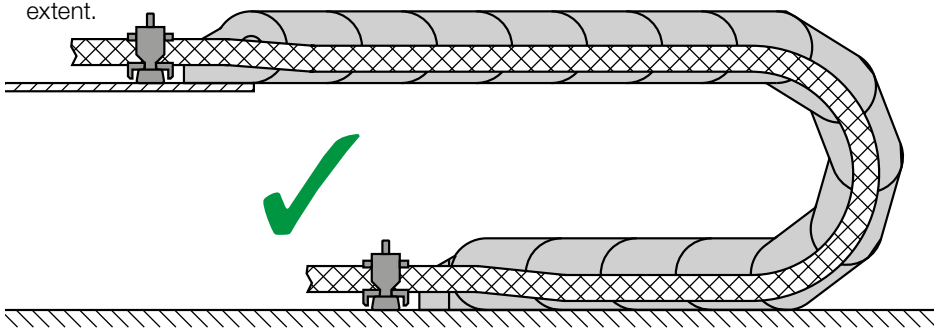
Round electrical cables:	10 %
Flat electrical cables:	10 %
Pneumatic:	5-10 % (rubber: 10 %!)
Hydraulic:	20 %
Media hoses:	15-20 %

Consideration of weight distribution is strongly recommended. Otherwise, one side of the chain wears out more and that leads to more clearance between pin and hole. It thereby leads to a deterioration in the service life of the application. The cable weight should be distributed **symmetrically along the width of the e-chain®, with the heaviest cables laying on the outside**. This ensures that the **outer links** which bear the fill weight are not over stressed. Generally speaking, the faster and the more often the e-chains® move, the more important is the layout of the cables in the e-chain®. Because of the large number of options, we are happy to support you with your specific application.



Optimum weight distribution in an e-chain®

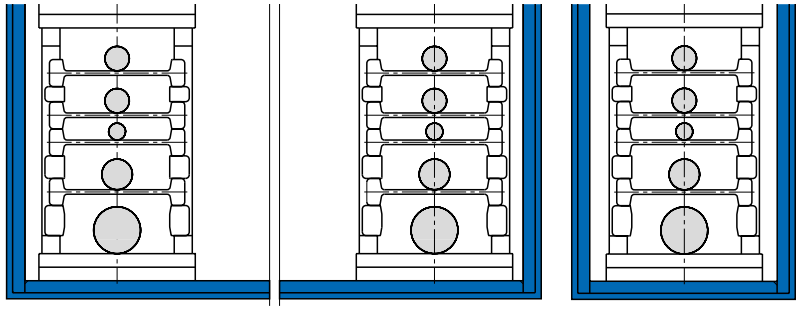
- The cables must be routed in such a way that each individual cable can move freely in the longitudinal direction.
- The cables must be able to move freely at the bend radius. This must be checked when the upper run is at either extent. This must be checked when the upper run is at either extent.



- The division of the interior by separators is necessary when multiple cables with different diameters are fitted. It is important that the cables do not tangle. It is important that the cables do not tangle.
- For cables with different outer jacket materials, it must be ensured that they do not stick together, and ideally separated. If necessary, they must be separated.
- Strain relief should be used at both ends of round electrical cables. In exceptional cases (for example, in circular motion) the cables must be attached with strain relief just at the moving end of the e-chain® . A distance of no more than 10-30 times the cable diameter between the end of the bending motion and fixing is recommended for most cables. For igus® chainflex® cables, however, the strain relief may be directly integrated to the mounting bracket, which have have been proven to be very effective.

Filling of side mounted applications

- Use locking separators (E4 family) or spacers (E2 family), so as not to pinch the cables (see interior separation)
- Max. two cables side by side in case of linear movements For rotary movements we recommend one cable in each chamber.



Interior separation

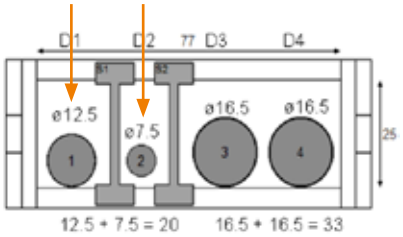
Cables and hoses with very different diameters should be laid separately. The separation is achieved using modular separators. The cables must never have the opportunity to slide over each other. The igus® interior separation ensures low abrasion by having large, smooth areas. The clearance height of a compartment with several equally thick cables next to each other should never be more than the cable diameter plus 50%.

Rules

- A separator is required when the sum of the diameters (D) of the cables laid side by side falls below 1.2 x the chain inner height (hi) or the chamber formed by horizontal shelves.

Formula: D1 + D2 < 1.2 x hi

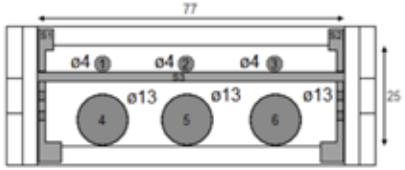
Example:



- If the inner width of the energy chain® is not sufficient to separate the cables from each other according to the rules above, it is also possible to run two cables with similar diameter stacked one above the other. It is important that the two cables are prevented from wrapping around each other by using separators. A horizontal sub-division using shelves is required when the diameter of the cables vary too much or when the number of cycles of the application exceeds 10,000 double strokes per year and speed is higher than 0.5 m/s.

Formula:
D1 ≤ 0.5 x D4
v > 0.5 m/s & cycles > 10,000/year

Example:



Laying guidelines for media carriers | Filling rules

Rules

igus® e-chains® are offered as **standard with internal separation fitted every other link**. This means that an **interior separation only appears every second chain link**. Upon request, or if a very demanding application is required, the e-chain® can also be supplied with an interior separation fitted every chain link.
e-chains® with interior separation fitted every other link provide the **same stability** as e-chains® with interior separation in every link, but are **cheaper**. A second advantage is **lower weight**, which in turn requires **less power for the movement**. Thirdly time savings during assembly and from the easier access to the interior separation and cables are an additional advantage. The mounting or necessary **maintenance work** can thus be carried out **much faster** because only **half as many interior separators** have to be installed.

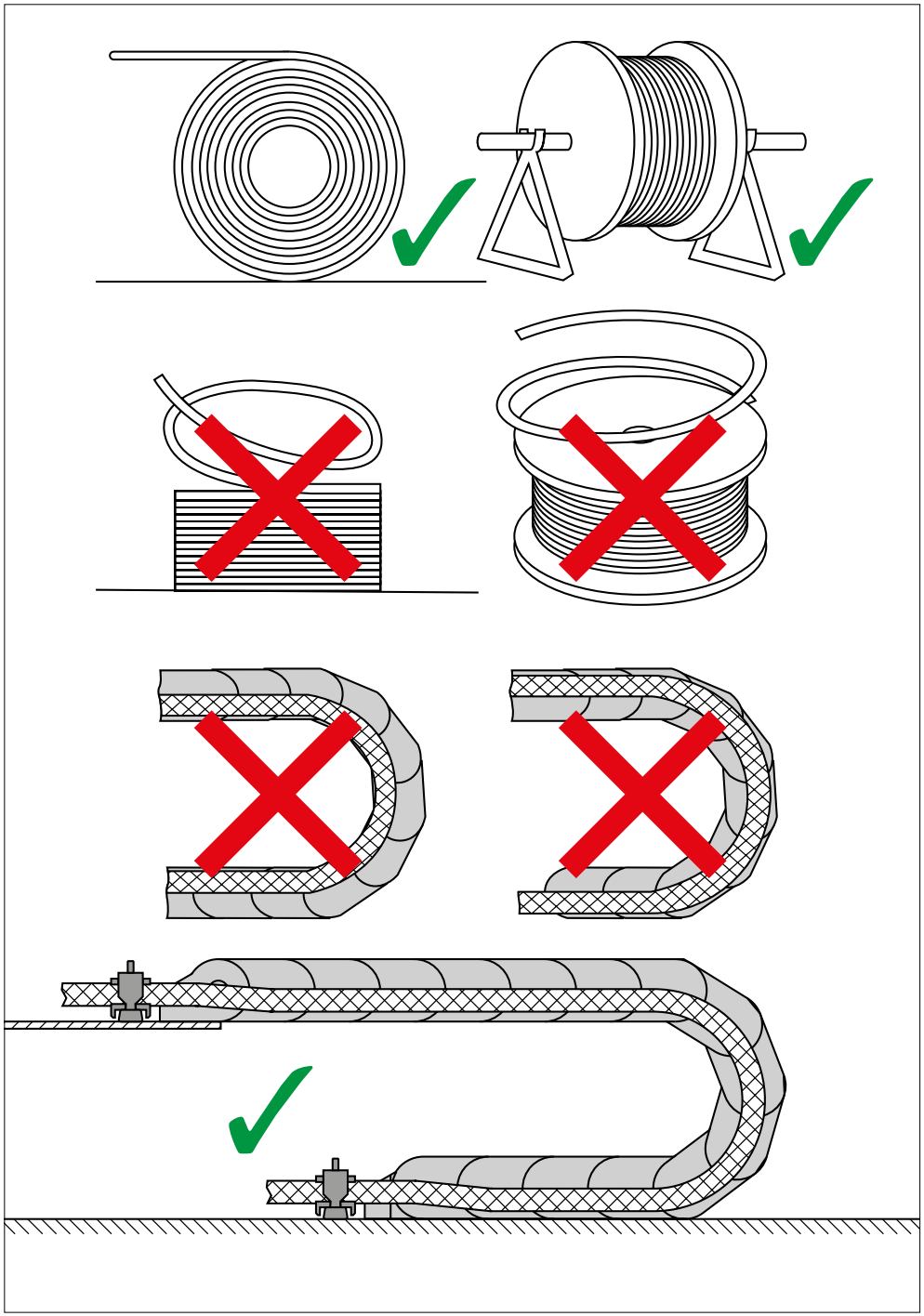
An application can be particularly challenging if a number of **very large or heavy cables** have to be laid in the chain (e.g. hydraulic hoses). Some other cables or hoses could get crushed, if they are under pressure from an adjacent hydraulic hose in an e-chain®. In applications with high speed, acceleration and cycles combined with high fill weights are also challenging. In such cases interior separation is **recommended to be fitted every link**.

Bend radius

The bend radius of your e-chain® is always determined by the **largest or stiffest cable** or hose to be fitted. The bend radii of e-chains® should be chosen to reflect the recommendations of the cable manufacturer. The choice of a **bend radius larger than the minimum** will have a positive effect on the expected service life. The minimum bending radii specified for cables refers to the use at normal ambient temperatures. Other bending radii may also be prescribed.

Correct unreeling

Cables must be **laid straight, without any twisting**. Cables must not be uncoiled from the top of the spool. igus® chainflex® cables are immediately ready for placement directly into the e-chain®. They need not be disconnected or laid out before installation. This may not be the case for other cable manufacturers.



Definition

The strain relief is a mechanical protection mechanism for affixing the cables and hoses used and securing them in position within the energy chain.

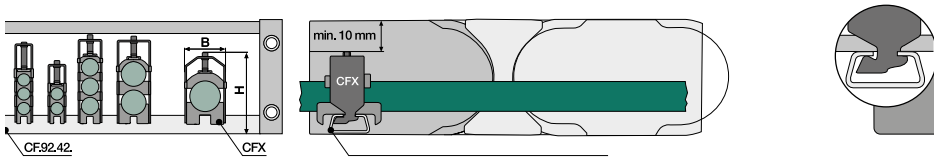
Application

By using strain relief, the connection between a flexible cable and the end of the e-chain® is protected against mechanical stress. To achieve this, cables are fixed using clamps.
The cable is clamped so that the length of the cable within the e-chain® remains constant, the cable also cannot be pulled in or out.
Strain relief can be custom made or consist of standard parts. For most applications, our standard range of C profiles in the mounting bracket and slim “chainfix” clamp can be used, or a simple strain relief using tie wrap plates and cable ties. Cables should be ideally fixed with strain relief at both ends of the e-chain®.

chainfix-clamp solutions

When using chainfix clamps, a C-profile is always required. This is guaranteed when using our KMA mounting brackets with C-profile. If another “C” rail is used, pay attention to the dimensions required: an 11mm opening is needed for the foot and the retaining elements of the clamp. The maximum rail width of 35mm is also determined by the clamp. The height of the C rail can be 12mm or more.

chainfix clamps have more than 3 times the tensile strength of standard clamps. This is due both to the material and the design. Ribs ensure that the cable is secured to prevent slipping.



Features of the igus® chainfix (CFX) strain relief clamps

- Optimal igus® chainfix housing with reduced height
- High tensile strength
- Long service life for dynamic applications thanks to our clamping elements
- Space- and time-saving assembly
- Polyamide compression elements means the rigidity, hardness and toughness are higher than those of polypropylene,with significantly increased reliability.
- Long service life for dynamic applications due to optimised saddles and clamps, captive within the housing.
- Can be fitted directly into the KMA mounting bracket
- Simple assembly with hex head set screw
- Good readability of part number and marking of the correct fitting direction
- Additional mounting options with universal double and mating troughs
- Optional CFXL clamps with increased holding power for heavy-duty applications (CFXL clamps are always installed ahead of the e-chain® and CANNOT be integrated in KMA mounting brackets with “C” rail!)

Fitting

The cables should ideally be fixed at both ends of the e-chain®. The minimum should be to be fixed to the moving end of the e-chain®!
When the e-chain® glides on itself on long travels, the screw heads of the strain relief must have a minimum clearance of 10 mm to the upper edge of the e-chain® at the fixed end. As a consequence of this, many strain relief elements described here may not be suitable for use at the fixed end on long gliding e-chains®.
When fitting the chainfix clamp, just clip it into the C profile and screw it down; that’s it!

Tiewrap plate solutions

- The tiewrap clamp is located on the mounting bracket itself; cables and hoses can be attached using cable ties.
- Quick and easy to use (clip on)
- Longer service life for cables
- Space-saving design
- Direct mounting within the “C” profile of the KMA mounting brackets is possible

Detachable tiewrap plate for the “C” profile

- Space-saving design
- Direct mounting within the “C” profile of the KMA mounting brackets is possible

Fitting

The detachable tiewrap plate can be clipped directly into the C profile without screws or other parts. The tiewrap plates can be loosened and moved, just using a screwdriver as a lever. Tiewrap plates can be used as separate parts to a mounting bracket using a countersunk screw.
For both options you need to use cable ties for strain relief. These are simultaneously tightened around the teeth of the tiewrap plate and around the cable to be secured.

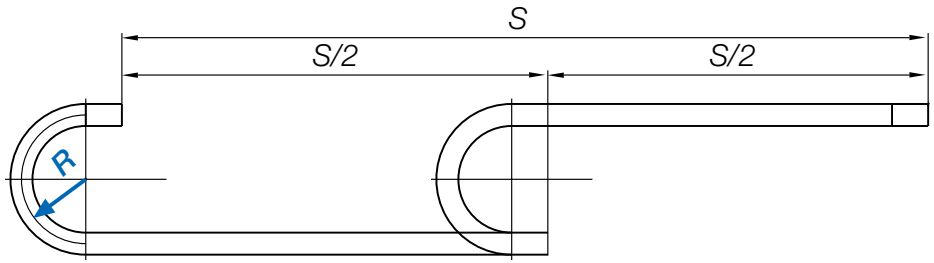
Example for unsupported straight FL_G

Example for unsupported use with sag FL_B

Unsupported application | Definition

Unsupported application:
An “unsupported application” is when the **upper run** of the e-chain® does not touch the **lower run over the entire travel length**.

Unsupported length:
The unsupported length is the **unsupported distance** between the moving end and the start of the radius arc of the e-chain®. The maximum unsupported length **varies depending on the chain type** (series) and **fill weight**.



Unsupported application:
The unsupported application is the most common of all operating modes. igus® e-chains® are also ideally suited for high **dynamics** and **long service-lives**.

Special features:
The unsupported application is only available for a **short travel distance**. **It depends on the chain type (series).** Please see the values for the maximum unsupported length in the concerned chain section in our catalogue.
An **e-chain® with pretension** (slightly curved upper run) should be used for unsupported applications to guarantee the unsupported length. If you are designing an application and the unsupported length is not enough, **please contact us for a custom solution**.

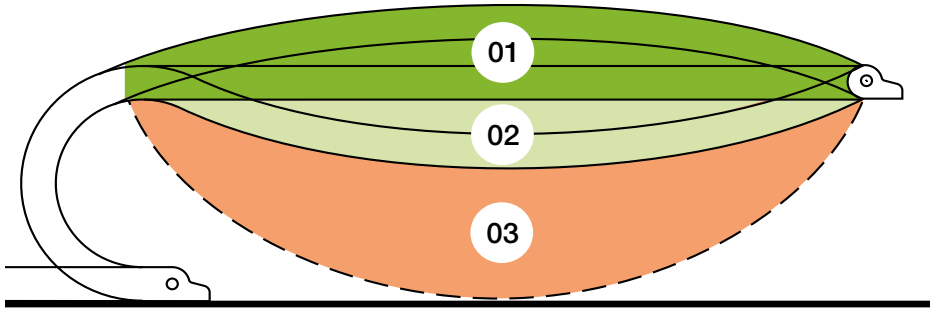
Unsupported applications | e-chain® application properties

Installation options:
- ▶ Unsupported with straight upper run **(FL_G)**
- ▶ Unsupported with permitted sag **(FL_B)**
- ▶ Unsupported with **critical sag**

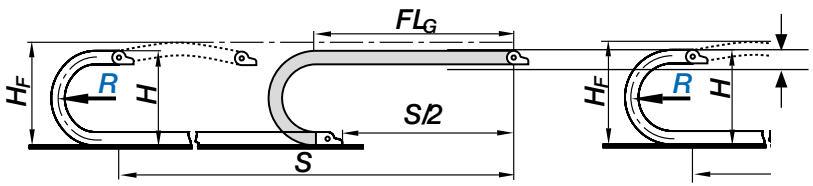
01 FL_G ▶ Pretension or straight upper run (max. ½ chain link height sagging). ▶ This design is ideal!

02 FL_B The sag is less than the minimum bend radius of the selected e-chain®. ▶ This **limits the speed and acceleration**.

03 Critical sag ▶ Not recommended. The service life and the speed and acceleration are significantly reduced. The **service life** and the **speed** and **acceleration** are **significantly reduced**.

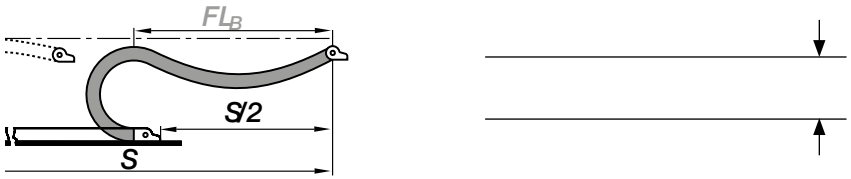


Unsupported length straight (FL_G):



Max sag: ½ chain link height

Unsupported length (FL_B):



Max sag: Minimum bending radius of the used e-chain®

Critical sag:

If the sag is greater than the allowable FLB, this is “critical sag”. **An application with critical sag must be avoided.**

Sag ► minimum bending radius of the used e-chain®.

Unsupported applications | e-chain® application properties

Unsupported length straight (FL_G):

The e-chain® is in the FL_G area, if its upper run either has pretension, is straight or reaches the maximum allowable sag.
The **unsupported length straight (FL_G) is always the first choice**, as it offers the greatest security and the longest service life.
The minimum expected service life is **10 million cycles**.

Unsupported length (FL_B):

An application with sag (FL_B) e.g. with longer travel distances or higher weights is possible but is always **dependent on the acceleration**.
If the velocity and acceleration are low, FL_B can be a good solution.
The best expected service life is between **5 to 7 million cycles**.

Critical sag:

Critical sag must be completely avoided! There are applications (FL_B), that reach critical sag after a very long period of use. The e-chain® should then be replaced.
In that situation, please contact us.

(Cycle = double stroke = 2 movements: travel out and back)

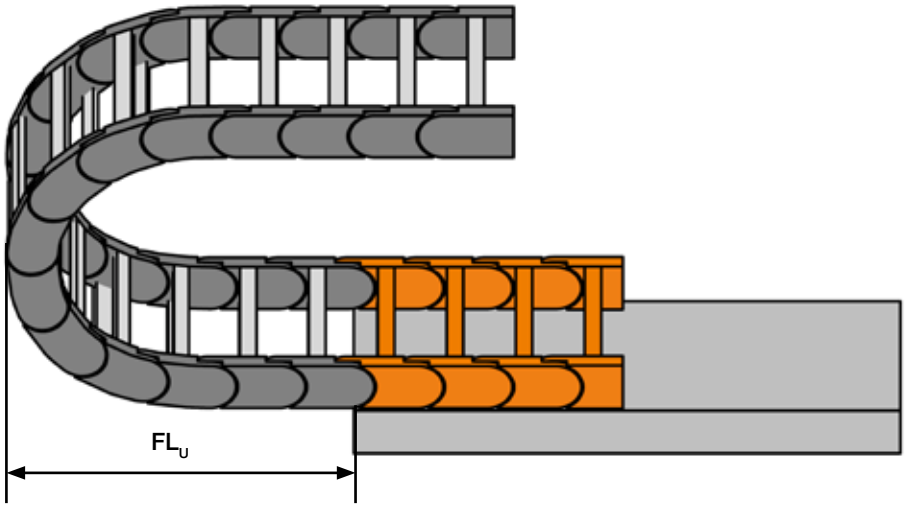
All data on the load rating of the individual chain types (series) can be found in our catalogue (1st section Designing with igus®), please see the required values for your e-chain® there.

Unsupported applications | Supporting surfaces

Unsupported e-chains® require a support surface on which the lower run can roll. This surface can be made from many different materials: metals, plastics, stone, wood, glass, etc. If you want to minimise the **rolling noise on the surface**, we have special solutions - just call us! In dirty environments it is important that the dirt cannot accumulate in the path of the e-chain®.

Unsupported without the support of the upper run

e-chains® **without lower run support** (FL_U) are **limited in length**. The allowable length depends on the chain type and the fill weight.



At least three chain links and the mounting bracket at the fixed end of the e-chain® must be supported.

Unsupported applications | Fitting

Mounting brackets

Mounting brackets are components that are attached to the ends of the e-chain®. They are ordered separately to the e-chain® **and are mandatory for assembly.**

We recommend pivoting mounting brackets as standard for unsupported applications. They compensate for the pretension and relieve the first chain link in operation.

Exception: if the acceleration is greater than 20 m/s² or the installation height is limited. In such cases, locking mounting brackets keep the e-chain® under the H_F measurement.

Installation height

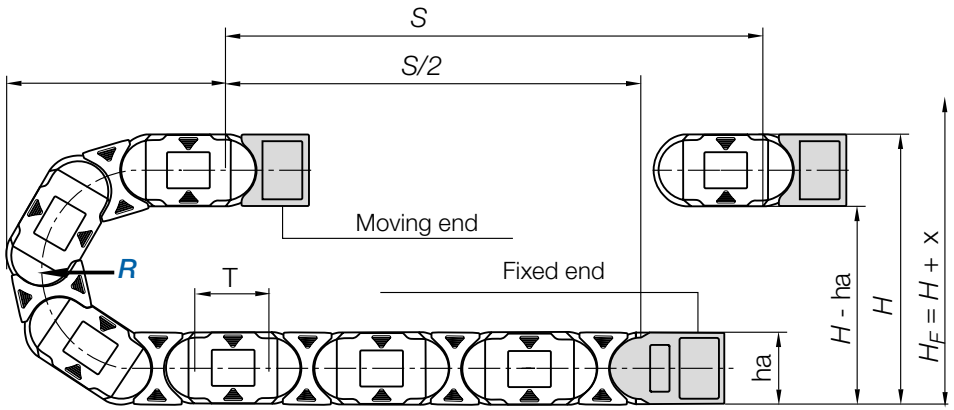
e-chain®:

When calculating the **installation space required** for an e-chain® with pretension, depending on the chain type (series), the **height** of the **curvature** created by pretensioning **must be taken into account**. This depends on chain series, and the value is given for any chain with any radius in our catalogue.

Moving end mounting bracket:

The installation height of the moving end is the **nominal installation height (H)** and corresponds to **double the chain radius and the chain link outer height**, with the upper run and the lower run parallel to each other. (The moving end is the end piece of the chain that is connected to the portable energy consumer)

*H-Value see catalog



T = Pitch ha = Outer height X = Camber clearance
HF = Clear installation height H = Nominal installation height

Definition

A “gliding” application is when the upper run of the e-chain® runs on the lower run.

Application

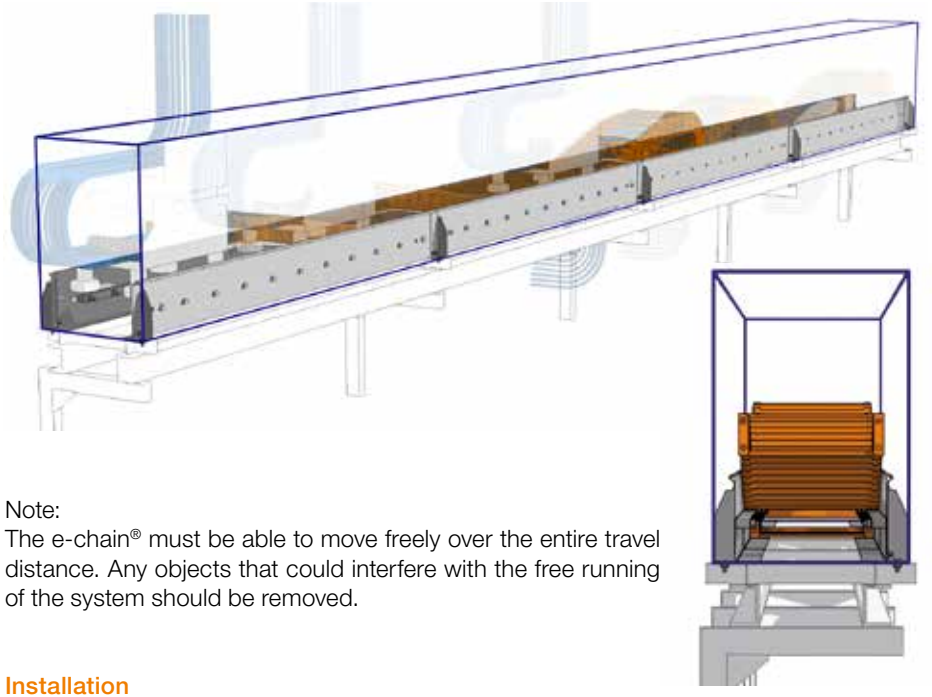
If the unsupported length is not sufficient, the **gliding application** is the best alternative for long travels.

Application parameters

Velocity:	v_{max}	10 m/s
Acceleration:	a_{max}	application-related, can be 50 m/s² +
Travel distance max.:		800 m
Fill weight max.:		application-related, can be 70 kg/m +

Special criteria

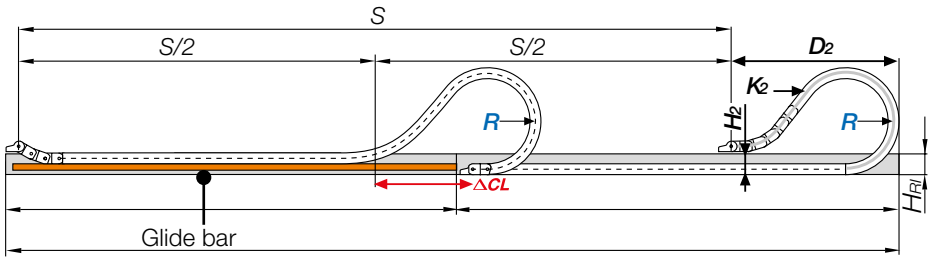
Gliding application is standard for **long travel** distances. Unlike unsupported applications, however, the maximum speed and acceleration are restricted. For a reliable gliding application, the moving end of the e-chain® must be lowered and the **first chain links rotated**. In general, the moving end of the e-chain® is set at an angle of 3-5°. If you are planning such an application, **please do not hesitate to contact us for project planning assistance or a custom solution**.
If the e-chain® is used in a gliding application, then it should run in a **guide trough**, so that the upper run glides squarely on the lower run without any offset.

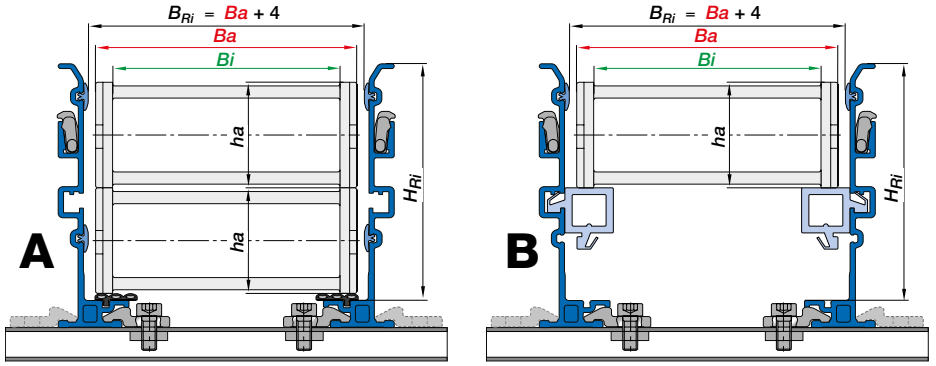


Note:
The e-chain® must be able to move freely over the entire travel distance. Any objects that could interfere with the free running of the system should be removed.

Installation

One or more e-chains® lying side by side or in opposite directions in a gliding application must always be fitted and guided in a separately procured guide trough.
For long travels, the upper run of the igus® e-chain® rests on the lower run. The upper run glides partly on the lower run of the echain and partly on a glide bar set at the same height.
A guide trough is required for lateral guiding.
To achieve the shortest chain length, the fixed end is placed at the middle of the travel.





(Details on guide troughs, installation and filling guidelines are given in the following sections)

Travel speeds and accelerations in a gliding application:

Travel speeds of up to 5m/s are possible in continuous operation. Even higher speeds are possible in special cases. In crash test facilities, for example, E4 system e-chains® reach speeds of 22 m/s and accelerations of 784 m/s². In these cases, however, only a few thousand cycles are required per year. **Acceleration plays a crucial role in the life calculation.** Sudden varying accelerations impact differently form normal continuous steady acceleration. Even in these situations, igus® e-chains® prove to be very durable. Prerequisite is the correct designing.

Service life calculator

Extensive tests enable us to understand the behaviour of our products. Typical tests carried out are: tensile and shear forces under temperature, humidity and dirt, friction coefficients of plastics in conjunction with various materials, behaviour of electric cables under tension/ compression, behaviour of hydraulic and fluidic hoses under tension/ compression.
We can **calculate the the service life for you**, and you can also **use our service life calculator online**: www.igus.eu/ECS-lifetime

Is the maximum fill weight indentical for all bend radii? – No!
The following applies: **The larger the bending radius the smaller is the additional load!**
Why?

A larger bend radius means a longer **unsupported length** until the upper run lies on the lower run and causes a higher **bending torque**. The acceleration now creates a higher load for the e-chain®**.**

The max. fill weight is dependent on the speed!

The higher the speed the lower the additional load!*

Speed [m/s]	Fill weight [%] max	Example: E4.32.Bi.150.0 [kg/m]
1 m/s	100 %	(5 kg/m)
2 m/s	50 %	(2.5 kg/m)
3 m/s	33 %	(1.65 kg/m)
4 m/s	25 %	(1.25 kg/m)

*For optimum use! If the this is exceeded, the wear increases disproportionately!

Ensuring stability of the e-chain®

To ensure stability of the e-chain®, the following rule of thumb applies when selecting the minimum width to bending ratio:

Stability formula: $\frac{\text{Bending radius}}{\text{Inner width}} < 4$

If the ratio is > 4, the energy chain must be widened.

Bending radius R (mm)	63	75	100	125	150	175	200	220	250	300	350	400	500
Minimum inner width (Bi) of the e-chain® is not less than:... in [mm]	16	19	25	32	38	44	50	55	63	75	88	100	125

Mounting brackets

Mounting brackets are components that are attached to the ends of the e-chain®. They are ordered separately to the e-chain® **and are mandatory for assembly.**

Pivoting mounting brackets are required for gliding applications, as it is necessary in every gliding application to lower the moving end height and to angle the mounting bracket. This prevents **the upper run from "rising up".**

Installation height

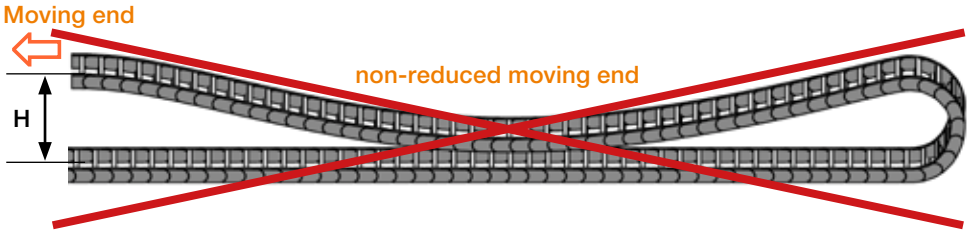
Moving end mounting bracket

For the moving end, the height H2 is dependant on the chain series, and can be found in our catalogue or data sheets.

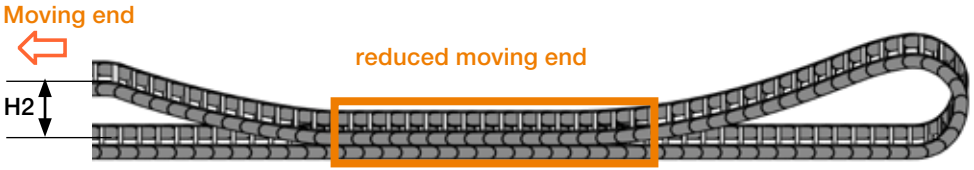
Lowered mounting height

A lowered mounting height is absolutely necessary for every gliding application:

- ▶ To prevent chain breakage through critical sag.
- ▶ To reduce wear (if the moving end is not lowered, there is more abrasion)



Example: If we move the e-chain® from right to left till the gap between upper run and the lower run is 1 mm, the chain would be at its maximum unsupported length.
The application is in critical sag, which must be avoided.



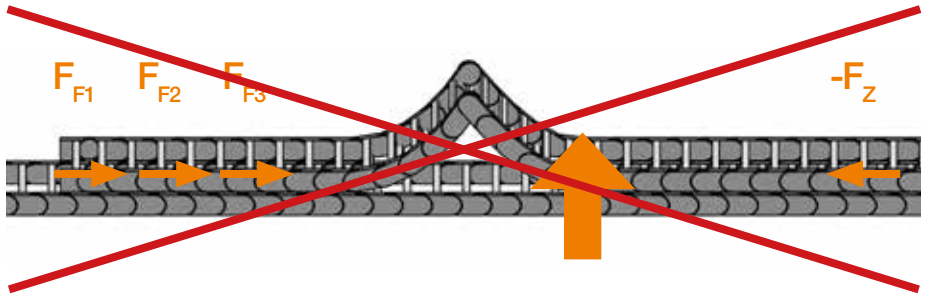
If the installation height is left at the height of the e-chain® radius, the maximum allowable fill weight and push/pull force (F_{PPF}) decrease drastically. Therefore, in such an application, either the **connecting height must be** reduced **or** a **stronger e-chain®** must be selected.

Pivoting

Why a pivoting mounting bracket (end piece) on the moving end is beneficial:

- With a mounting angle between 3-5°, the e-chain® is slightly forced downward by the push/pull force. This **prevents the rising up of the e-chain®**.
- The angle of incidence of the upper run to the lower run is approximately 3-5°. This angle is also ideal for reducing wear.

- If the upper run is installed in parallel directly onto the lower run, the **upper run can rise due to the push force exerted**. This **reduces the service life** of the e-chain®. Therefore we recommend an installation with a downward mounting angle (3-5°). This reduces the service life of the e-chain®. Therefore we recommend an **installation with a reduced connecting** height **H2.**



- To lower the mounting height and save space, we rotate the first chain links, so that the moving end forms a shallow “S” shape.
- This reduces the built-in pretension improving the behaviour of the e-chain® in gliding mode.
- By rotating the chain links we support the downward force helping to prevent the e-chain® from rising up.
- Without the rotation of these links, we would need more space, to allow the upper run to rest on the lower run resulting in a longer unsupported length. This would mean less fill weight and acceleration would be possible.

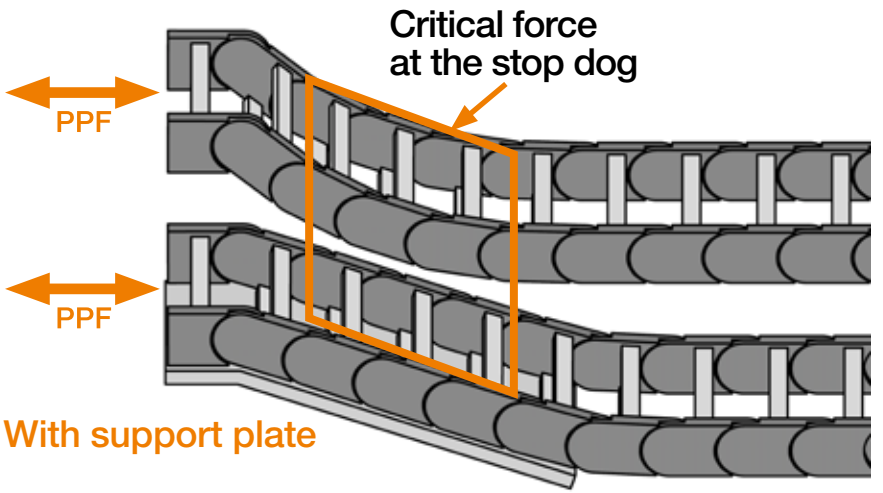
Supports:
Support plate:

A support plate is needed if the calculated push/pull force is greater than 50% of the max. push/pull force specified for a given e-chain® series.

Attention: Support plate needed if $F_{PPF} >= \frac{F_{max.PPF}}{2}$

Support plates are there to prevent forces produced at the stops of the rotated chain links. It protects the first chain links against over-stressing.

Without support plate



With support plate

PPF = Push/Pull force (driving force/friction force calculation)

Vertical hanging application | Definition

Definition

A vertical hanging application is when the e-chain® is suspended in the **vertical direction of motion** and the arc of the chain radius does **not touch the ground**.

Application

A vertical hanging or standing energy chain should be used where portable energy consumers or data receivers move vertically and have to be supplied with media carriers. This might be required for example for crane elevators or machine gantries. The use of an e-chain® ensures that individual cables do not get caught or damaged by other parts of the system structure or machinery.

Application parameters

Maximum travel length:		100 m
Velocity:	v_{max}	20 m/s (dependant on travel length and stability)
Acceleration:	a_{max}	50 m/s² (depending on lifting height and stability)

Special criteria

With hanging applications, installation heights of over 100 m are possible for a purely vertical movement. If the application has a purely **vertical movement**, a lateral support is **not necessary**. A normal e-chain® with camber can be used for a hanging application assuming it has sufficient space. If horizontal movement is required in **addition to the vertical movement** (lateral acceleration), **e-chain® guidance is required.** Cables and hoses in the e-chain® must have strain relief at both ends in order to carry their own weight. **Locking mounting brackets** are **recommended** so that the structure does not sway.
The e-chain® is subject to **far less stress in the hanging version** than in the standing one because the e-chain® and the **media carriers** (cables) laid in it are **suspended by mounts** and **bear their own weight**. In other words, the cables hang freely in the e-chain® and do not touch its radius.

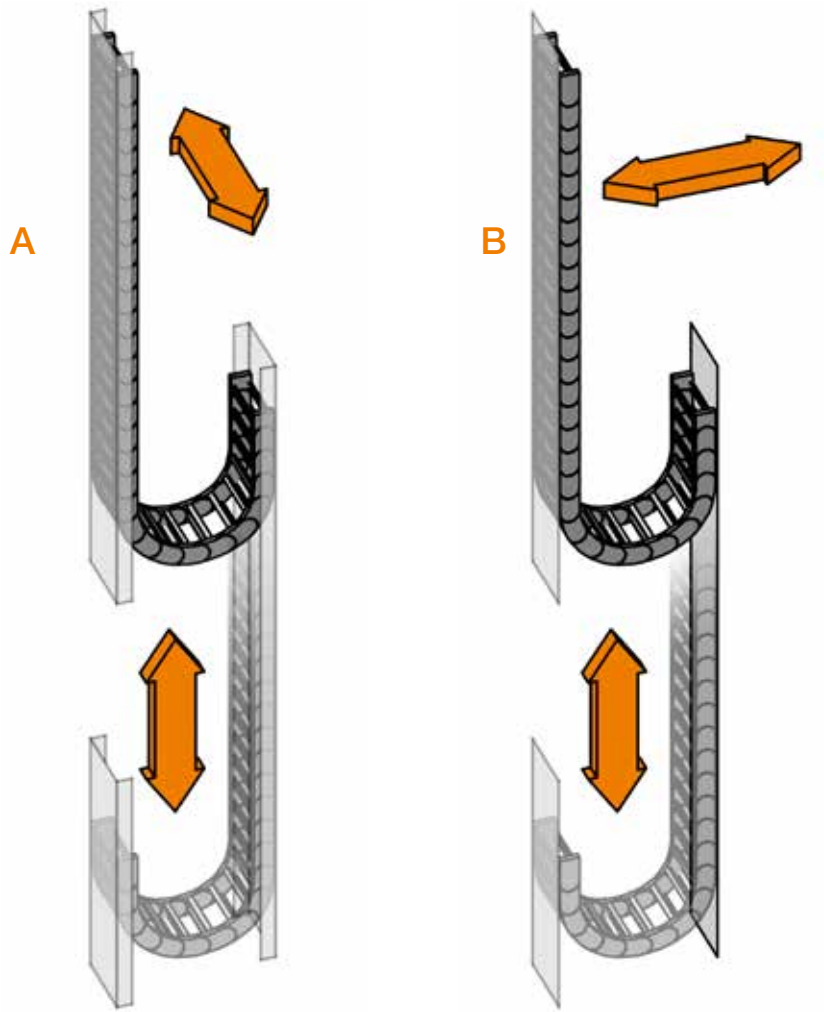
Vertical hanging application | Installation options

Vertical application without horizontal acceleration

If the application requires a purely vertical movement, **extra support is not required**. A normal e-chain® with camber can be used for a hanging application assuming it has sufficient space. If space is restricted, an e-chain® without camber is required, which slightly reduces the required installation space. In this case, please contact us!

Vertical application with horizontal acceleration

If the vertical movement involves an **additional horizontal movement**, a **support is required** for the e-chain®. On a radial running motion (B) the back of the e-chain® must be supported. If the horizontal motion is an **axial lateral motion**, the e-chain® is guided laterally too (A). **An e-chain® with pretension is used if a guide is used.** This ensures that the chain is pressed into the trough.



Vertical hanging application | Installation options

Camber

A normal **e-chain® with camber** is used for a hanging application assuming there is **sufficient space**. If space is restricted, an e-chain® without camber can be used. In a vertical hanging application of the e-chain® in a guide, an e-chain® must be used with pretension. This ensures that the chain is pressed into the trough.

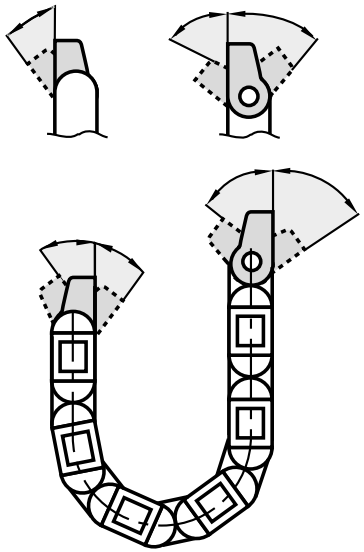
Installation space

The installation space required is double the chain radius plus the outer depth of the e-chain® -Outer width and dimensions of a possibly installed guide device.

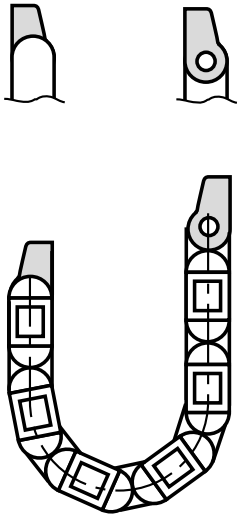
Fitting

We recommend the use of fixed mounting brackets as standard. Other solutions are also possible in confined spaces. In this case, please contact us!

Pivoting mounting bracket



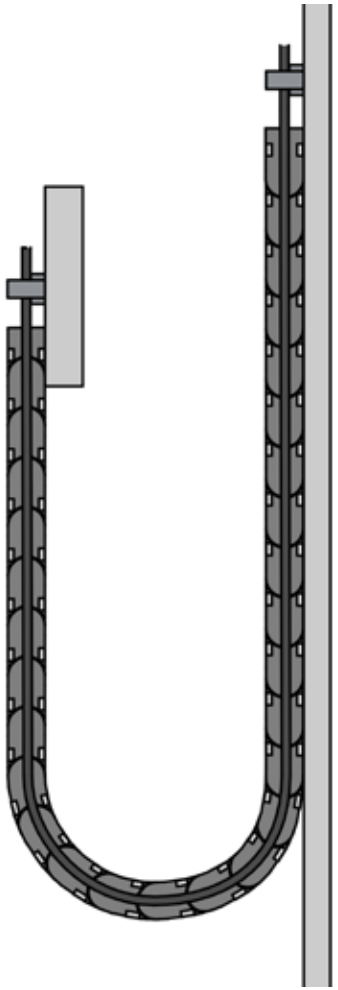
Fixed mounting bracket



Vertical hanging application | Filling

Layout

When setting up a hanging application, the distribution of the cables and hoses within the e-chain® is secondary, since they should be strain relieved at both ends and should be **suspended in the e-chain® without actually touching it**. The e-chain® only fulfils the function of containing and protecting the cables and hoses, and should **not absorb any tensile forces**. If this should be the case, the service life of the application is reduced! **Recommendable is the igus® interior separation for the tidy separation of all media carriers (cables).**



Strain relief

The cables and hoses should have **strain relief at both ends** and should **not actually touch the e-chain®**. In this way they **bear their own weight**. The **tensile strength of both the e-chain® and the cables** and hoses must be checked before commissioning of the application and adjusted if necessary. A **regular inspection** is strongly recommended.

Vertical hanging application | Support

A support of the e-chain® is only necessary with a horizontal transverse acceleration. The e-chain® must then be guided horizontally and/or laterally. igus® offers numerous possibilities to achieve this. Where possible we recommend the use of our guidelok® systems. Details are available in our catalogue or in data sheets. The support is not required for the entire travel, but must be used in the area in which the e-chain® could swing.

(For information on assembly, please refer to the section on trough installation)

Vertical standing application | Definition

Definition

A **vertical standing application** is when the e-chain® has a vertical direction of motion and the arc of the chain radius moves **upward** on top of the chain links.

Application

A vertical hanging or standing application should be used where moving power or data is required for a **vertical motion**. A vertical hanging or standing application **should be used where moving power or data is required for a vertical motion**. This might be required for example for **crane elevators or machine gantries**. The use of an e-chain® ensures that individual cables do not get caught or damaged by other parts of the system structure or machinery.

Application parameters

Maximum travel length without support:		≈ 4 m
Maximum travel length with the support of the first chain links:		≈ 6 m
Maximum travel length with full support:		≈ 20 m
Velocity:	v_{max}: 20 m/s (depending on lifting height and fill weight)	
Acceleration:	a_{max}: 50 m/s² (depending on lifting height and fill weight)	

Special features

the application has a **purely vertical movement**, a **support is not necessary**. A normal e-chain® with camber can be used for a standing application with sufficient space. If the vertical movement involves an **additional horizontal movement**, a **support is required** for the e-chain®. In a standing application travels of up to 20 m are possible. **Locking mounting brackets are recommended** for mounting the e-chain®. The **mounting brackets are highly stressed** in the vertical standing application, since they have to **bear the weight of the application** and the gravitational forces are concentrated on this point.

Vertical standing application | Installation options

Vertical application without horizontal acceleration

If the application has a **purely vertical movement**, a **lateral support is not necessary**. For longer chain lengths we recommend using a guide trough for the whole e-chain®.

Vertical application with horizontal acceleration

If the vertical movement involves an **additional horizontal movement**, a **support is required** for the e-chain®. If the horizontal motion is a **lateral movement** the e-chain® is **guided laterally**. For longer chain lengths, supporting at least the first 3 links on the outside of the radius is generally recommended. For maximum heights and fill weights, it is advisable to support the complete chain. Given the numerous combinations of fill weights, travels, chain types and bend radii available, we will be pleased to offer our advice for your application.

Camber

A normal **e-chain® with camber** can be used for a standing application **with sufficient space.**

Fitting

The mounting brackets should be attached in such a way that the e-chain® **cannot move outwards**. For almost all chain series igus® offers locking mounting brackets. The use of locking KMA mounting brackets is recommended, as they have more attachment options.

Installation space

The required installation space corresponds to twice the radius of the e-chain® plus outer height of the e-chain® and the dimensions of any guide plate used.

Vertical standing application | Filling

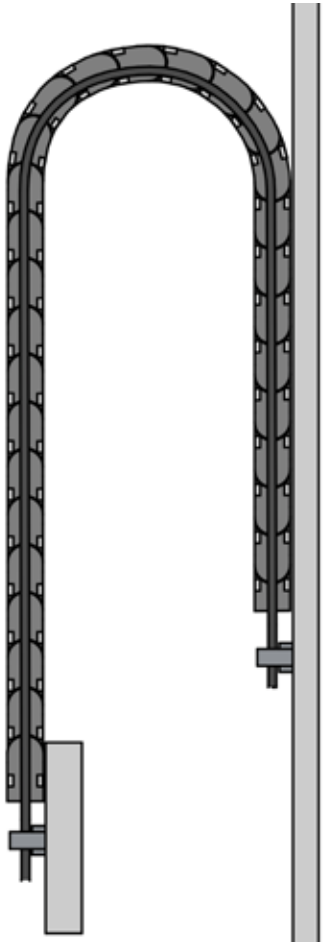
Layout

In a standing application, the weight distribution of the cables and hoses should be symmetrical, and must have strain relief at both ends. Cables and hoses must be laid out in the e-chain® in such a way that they are free to move in the longitudinal direction. To accurately guide the media carriers, we strongly recommend the igus® interior separation.

Strain relief

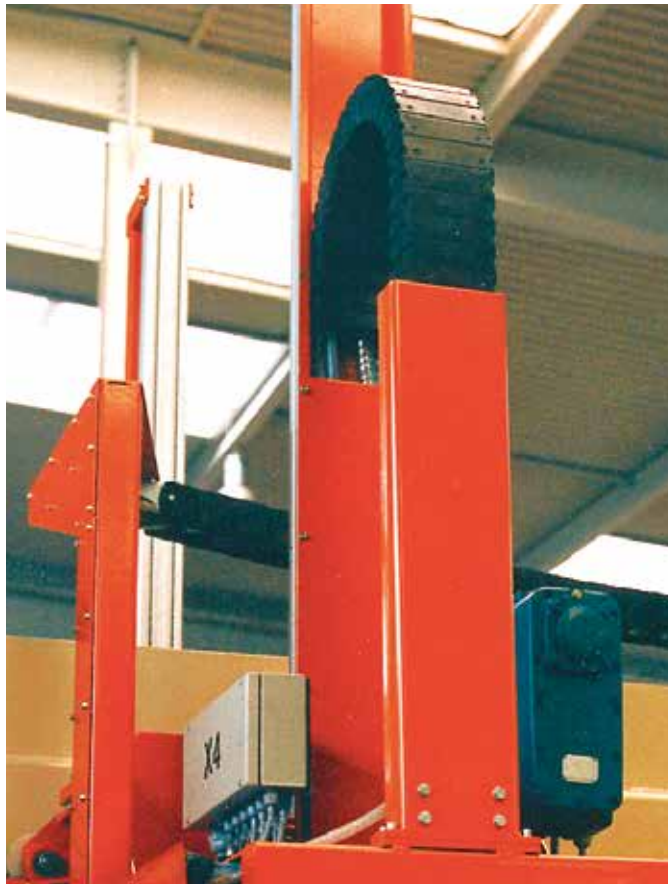
Cables and hoses must be able to move freely. The media carriers (cables) must be fixed at both ends with strain relief.

igus® strain relief can be attached directly the mounting brackets - no minimum distance to the last curved chain link is required!



Vertical standing application | Support

If **locking mounting brackets are not used, a guide plate must support the first 3-4 chain links.**
If **no horizontal acceleration** is present, no guide is required for the e-chain®, unless the chain length necessitates it.
For **longer chain lengths**, **supporting at least the first 3 links** on the outside of the radius is generally recommended. **For maximum heights and fill weights often the entire chain must be supported to ensure stability.**
The support for a standing application is achieved by using a **guide plate on the outer radius side** of the e-chain®. The camber of the chain ensures that the e-chain® presses against the guide plate. In this way **swinging up of the e-chain® radius is prevented at high speeds or accelerations**. A guide plate therefore **increases the expected service life** of this application!
If you are planning such an application, please get in touch with us!



Content | Guide troughs, support trays and special solutions for long travels

Guide troughs | "Super Aluminium" guide troughs

Super aluminium guide troughs - The igus® standard for guide troughs

- Very simple, modular assembly
- Side-mounted glide strips for wear protection at high-speed
- Corrosion resistant, seawater resistant aluminium profile
- Flexible assembly - easy mounting on existing structure
- Regardless of profile lengths and joints
- Trough can be fixed directly to the surface or on a C profile - inside or outside of the trough
- Heavy duty bracket for a secure hold even in demanding applications

Basic version

Heavy duty version

Heavy duty installation kit

The heavy-duty version uses a different type of installation set. The heavy-duty installation set consists of a strong aluminium bracket, fastened outside of the guide trough. The heavyduty installation sets are recommended for heavy duty plant, construction equipment and other extremely demanding areas. The part numbers for these can be found in the Super- Alu-Trough pages in our catalogue.

Guide troughs | Steel guide troughs

Steel guide troughs, very stable and rugged for heavy-duty plant engineering

- Very stable and robuste for heavy-duty plant engineering
- Simple assembly
- Large selection, 2-piece, easily adjusted to the chain width
- Available in galvanised steel and stainless steel (material: 1.4301)
- Plastic glide bar made of PE

Guide trough | Support for the lower run

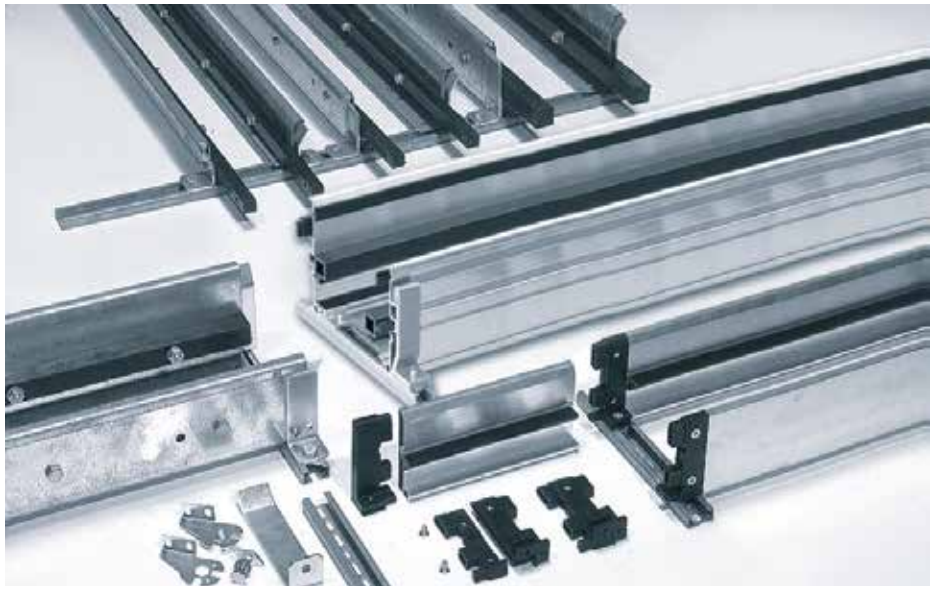
Support of the lower run - for unsupported applications
Guide trough as modular construction kit

- Complete system in a single unit
- Removes need for bespoke designed parts
- Simple attachment options for your machine on optional profiles or wall brackets

igus® guide troughs | Guide troughs

igus® guide troughs

Guide trough is used in long travels where the e-chain® glides (according to chain type from 5-12 m). It supports the smooth low friction operation of the e-chain® and e-tubes. The infeed point is at the centre of the travel, and the e-chain® glides by itself on one half of the travel. For the other half, we recommend installing glide bars in the trough on which the e-chains® can glide. igus® guide troughs have highly abrasion resistant polymer glide bars.



Trough type

igus® offers guide trough made from corrosion-resistant aluminium, galvanised steel, stainless steel (material: 1.4301, optionally also 1.4571/1.4404) as well as tubes and other troughs (side plates made of steel). The trough type to be used depends on the requirements of each application.
As standard we recommend the igus® super aluminium guide trough.

Glide bars

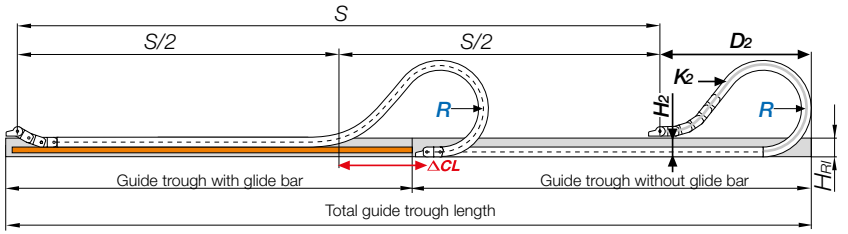
Our glide bars are optimally tailored to the e-chain® material and offer the lowest friction, noise and wear properties. Glide bars are used when the fixed point is located in the middle of the travel, which means half of the guide trough is supplied with glide bars, and the other half without.

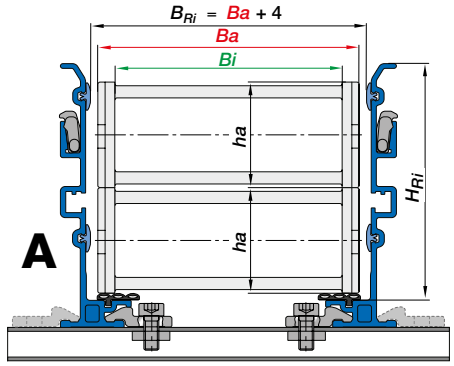
Delivery condition

The trough is supplied from the factory in 2 m pieces, although special lengths of up to 6 m are possible. The left and right side parts are mounted at a set distance apart according to the width and series of the chain. The required width (B_{Ri}) can be found in our catalogue or by referring to the information in the Annexe. The trough side plates can be connected to the base by bolting, welding or the standard igus® installation set. The fixed end module for the igus® super aluminium troughs is a quick way to secure the fixed end of the e-chains®. With this module, easy attachment of the e-chain® with plastic-metal mounting bracket (KMA) to the super aluminium trough is possible, even without drilling.

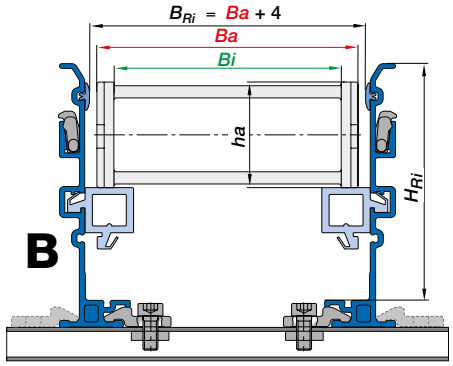
Long travels with igus® Guide troughs

For long travels, the upper run of the igus® e-chain® rests on the lower run. The upper run glides partly on the lower run of the echain and partly on a glide bar set at the same height. For lateral guidance, a guide trough is necessary. If the fixed end mounting bracket and cables and hoses can be placed in the centre of the travel, the e-chain® length is calculated as: $L_k = S/_2 + K_2$. Placing the fixed end in the centre of the travel requires the shortest e-chain® length. The length of the e-chain® then corresponds to slightly more that half of the travel length.





Guide trough without glide bar
Upper run glides on the lower run



Guide trough with glide bar upper run
Glides from the half on the glide bar

Ba = e-chain® outer width
Bi = e-chain® inner width
ha = e-chain® outer height
H_{Ri} = Trough inner height

H_{Ra} = Trough outer height
B_{Ri} = Trough inner width ▶ depending on the measure Ba
B_{Ra} = Trough outer width
$L_k = S/2 + K_2$ | $H_{Ri} \geq 2 \times ha$ | $B_{Ri} \geq Ba + 4$

Design and installation of the guide trough

The height of the guide trough must be equal to at least **double the chain height**: **$H_{Ri} \geq 2 \times ha$**. The sides must have a smooth return surface on the top to smoothly guide the e-chain® into the trough. The trough inner width is equal to the chain outer width plus 4 mm: **$B_{Ri} >= Ba + 4$.** Glide bars must be installed on the trough side where the upper run cannot glide onto the lower run.

igus® Guide troughs | Fixed-end module for steel troughs

Fixed-end module for steel troughs

When installing the mounting brackets at the fixed end, the steel trough normally needs to be drilled to match the mounting bracket hole pattern. That is now history. With the new fixed end module the holes are pre-prepared so that the 2,000 mm long component can be used for centre fed, end fed and even for reverse fed applications . Fast bolted connection of the mounting brackets, additional C rails for strain reliefs and the fast fitting of the glide bars are now possible.

Alternatives for long travels

Due to the complexity of these applications and our years of experience in the design of long travel systems, we are always keen to advise you when you are planning such an application. In addition, our current catalogue or our website will give you information and alternatives for long travel applications.

Bolted connections

There are following tightening torque of screws on mounting brackets and supports prescribed:

Achtung! / Attention!	Gewindegröße Thread size	Werkstoff Material	Anzugsmoment Torque
Alle Schrauben müssen mit einem Drehmomentschlüssel angezogen werden!	M6	8.8 / A2 / A4-70	10 Nm
	M8	8.8 / A2 / A4-70	23 Nm
	M10	8.8 / A2 / A4-70	35 Nm
	M12	8.8 / A2 / A4-70	75 Nm
All screws have to be tighten with a torque spanner!	Befestigung der Kunststoff-Gleitschiene Fastening of plastic slide bar		
	M10	8.8 / A2 / A4-70	7 Nm

Basically all bolted connections must be secured by using thread-lock (LOCTITE) or self-locking nuts. The use of adhesive, serrated lock washers and snap rings for screw locking etc is not advised.

Fax | e-chainsystems® | Project application

Date:	**Phone: +49 2203 9649 800** **Fax: +49 2203 9649-222**
From: **Phone:** **Fax:**	**To:** **igus® GmbH** **Technical Sales** **e-chainsystems®** **Spicher Str. 1a** **51147 Cologne (Porz-Lind)**

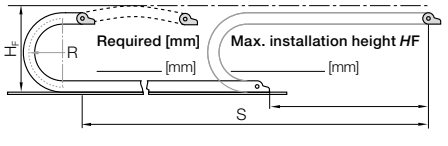
Installation Space

(Type of Application - please mark with a cross)

Unsupported application: ☐ | Gliding application ☐ | Hanging application ☐ | Standing application ☐ | Side-Mounted application ☐ | Rotary motion application ☐ | Horizontal + Vertical ☐ | Nested application ☐ | "Side-by-side" application ☐ | Zig-Zag application ☐ | Combined motions ☐

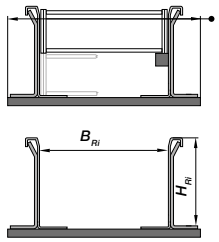
Length of travel S _____ [mm]

Fixed end center of travel ☐ yes or _____ [mm] from the center



Required [mm] _____ [mm]

Max. installation height *HF* _____ [mm]



Installation width
Max. width permitted? _____ [mm]

Guide trough? ☐ yes. if yes, which:
Dim: B_{Ri} _____ [mm]
Dim: H_{Ri} _____ [mm]

Assembly point (floor, wall, console, etc.) _____ [mm]

Span (standard = 2 m) _____ [mm]

Dynamics

Speed _____ [m/s] **Acceleration** _____ [m/s²] **Outer Ø** _____ [mm]

Cycles/day _____ **Days/year** _____

Environment

Temperature _____ [°C] **Humidity** _____ [%] **Dust, dirt, chips** _____

Special parameters _____

Cables/Hoses

Number	Manufacturer/Part No.	Conductor/AWG	Ø [mm]	Weight kg/m]	permissible bending radius

Further individual components required:

e-chains/e-tubes	☐	e-chain®	☐
chainflex special cables	☐	e-tube	☐
Guide troughs	☐	To be opened on both sides	☐
Strain relief	☐	To open along outer radius	☐
Harnessing	☐	To open along the inner radius	☐
Installation	☐	Special requests _____	
Others _____			

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igus® GmbH is the leading manufacturer in the field of energy chain system® and polymer bearings. The family-run company based in Cologne operates in 35 countries and employs about 2,950 people worldwide. The igus® operates the largest test laboratories and factories in its sector which enables it to offer customers innovative products and solutions, tailored to any application in the shortest possible time.

/9001:2008
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