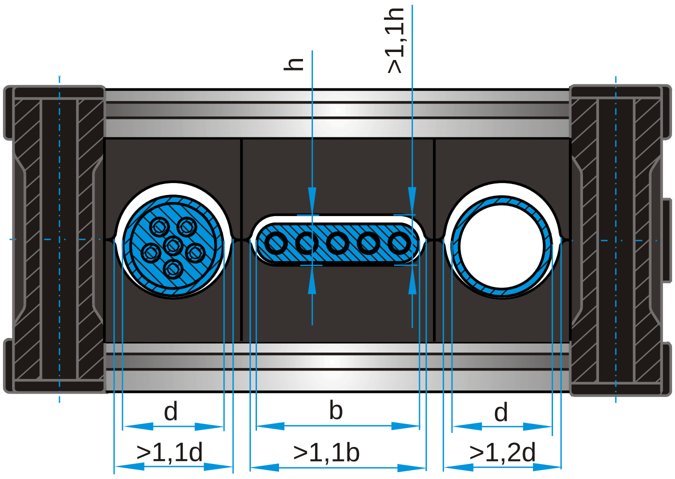
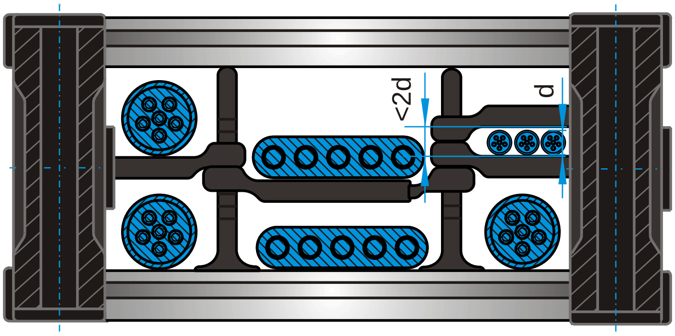
DESIGN GUIDELINES



Selection of the energy chain and material

For most applications energy chains made of plastic is your first choice. Chemical resistance, light weight and low costs are the major advantages. Steel chains are used under extreme payloads and high mechanical or other particular requirements. For extreme cycles the hardened (carburized) steel is required to achieve long life.

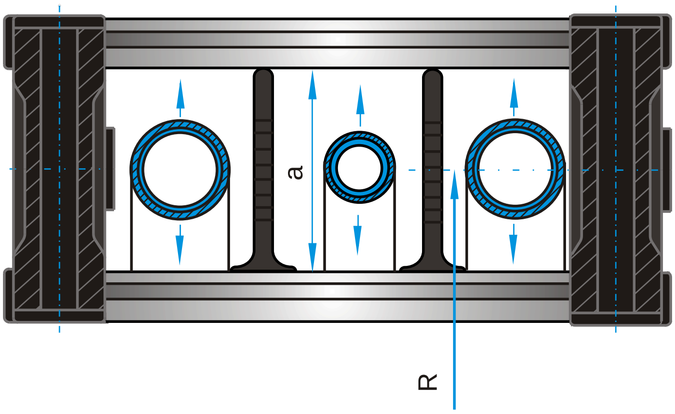
Calculation of cross-section



First, the cross-section required for the wires is determined, and then specific motions or arrangements, aggressive environmental conditions or other factors lead to your selection.
A pre-selection of the product series may use the fields of application (see product series chapter).
All lines must be able to move freely in the energy chain. This requires an individual clearance to be taken into account for each line:

round cable:	10% of the diameter
flat cable:	10% of the cable width and height
hoses:	20% of hose diameter

Optimum requirement is the separation of all lines by means of individual chambers. Especially with varying diameters or multi-layer wiring a separation by vertical and horizontal dividers is required.

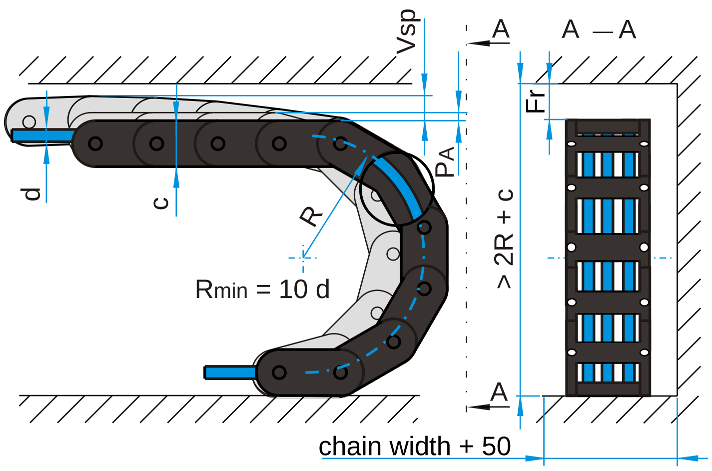


If several lines are to be laid in one chamber, the chamber dimensions have to be restricted so that they maintain their relative positions.
Even multi-layer arrangements of flat cables have always to be seperated with horizontal dividers.

When using pressure hose a change in length has to be taken into account through additional clearance in the chain bow (radius), which can be achieved by a corresponding chain height (a).

The distribution of the energy chain cross-section should be symmetrical in order to ensure an uniform load. In addition heavy lines are laid out close to the links to minimize the bending loads on the transverse bars.

Determination of the bending radius



$R = R_{set}{}^{+0/-5\%}$

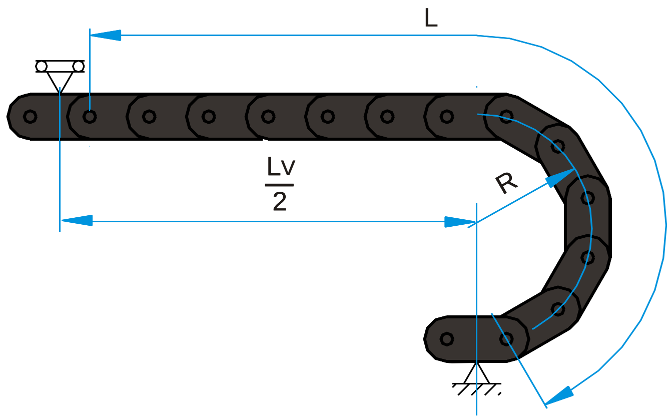
Fr > 50 if c < 70
Fr >100 if c > 70

The bending radius of the energy chain is determined by the minimum permissible bending radius of the cables and hoses, the available installation space and the polygone oscillation PA of the energy chain.
In general, a minimum bend radius of 10d is considered, where d is the largest existing line diameter. Cables with smaller minimum bend radii are available by some manufacturers.
The polygon oscillation PA influences the moving of an energy chain. A large bend radius at the same pitch results usually in a calmer movment of the energy chain.
The installation space must have a height of more than 2R + c, where R is the set-radius and c is the link height of the energy chain. The real radius is the set radius +0/-5%.The pretension of the energy chain should also be considered.

Energy chain length

In standard applications the fixed connector of the energy chain is arranged in the middle of the travel distance. The moving connector moves horizontally over the fixed connector between the end positions of the travel. The required length of the energy chain between the first and the last pivoting link is then determined as follows:

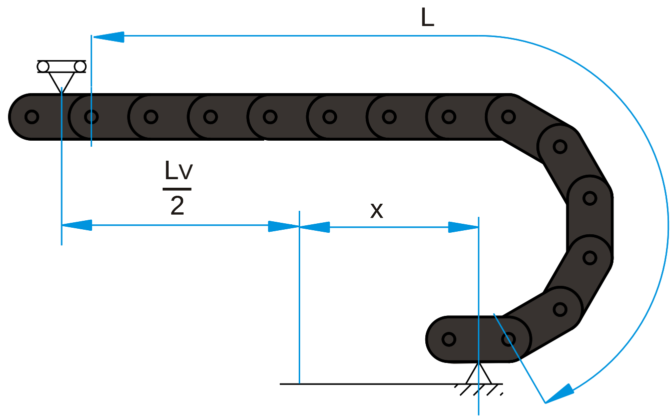
$$L = \frac{L_V}{2} + 4\,R$$



L length of the energy chain
L_V length of travel
R bending radius of the energy chain

If the fixed connector is not in the middle of the travel, the energy chain has to be extended by a displacement of x:

$$L = \frac{L_V}{2} + 4\,R + x$$

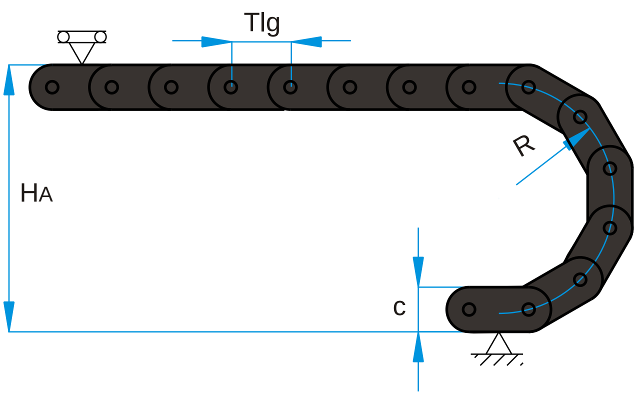


x offset of the fixed connector

After the selection of the energy chain, the length is rounded up to the link pitch. This length is the ordering length of the energy chain.

The connectors height is double bend radius plus link height:

$$H_A = 2\,R + c$$



H_A connector height
c link height of the energy chain

Review of the free carrying length

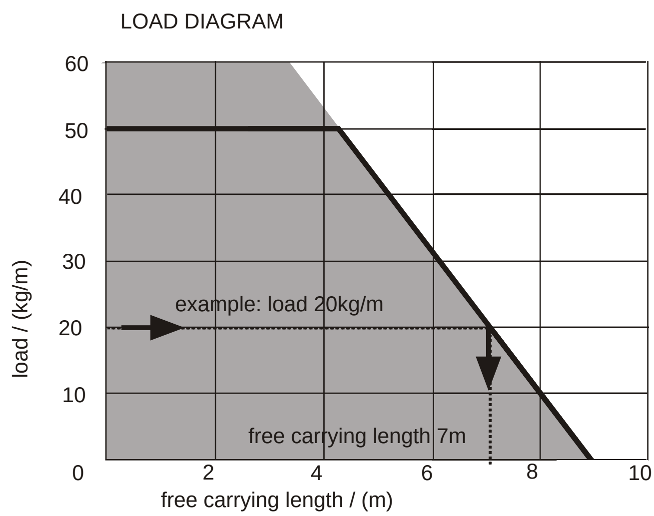
The additional load is the weight of all cables and hoses, divided by the lengthof the chain:

$$m_S = \frac{m_L}{L}$$

m_L cable weight
m_S specific additional load

Thus with calculated additional load and the help of the load diagram the free carriying length of the energy chain can be verified.

If the additional load is too high for a particular chain an energy chain with greater free carrying length is chosen or constructive changings have to be done that allow the operation with the chosen energy chain (eg, gliding arrangement, support rollers, SYSTEM MARATHON or similar).



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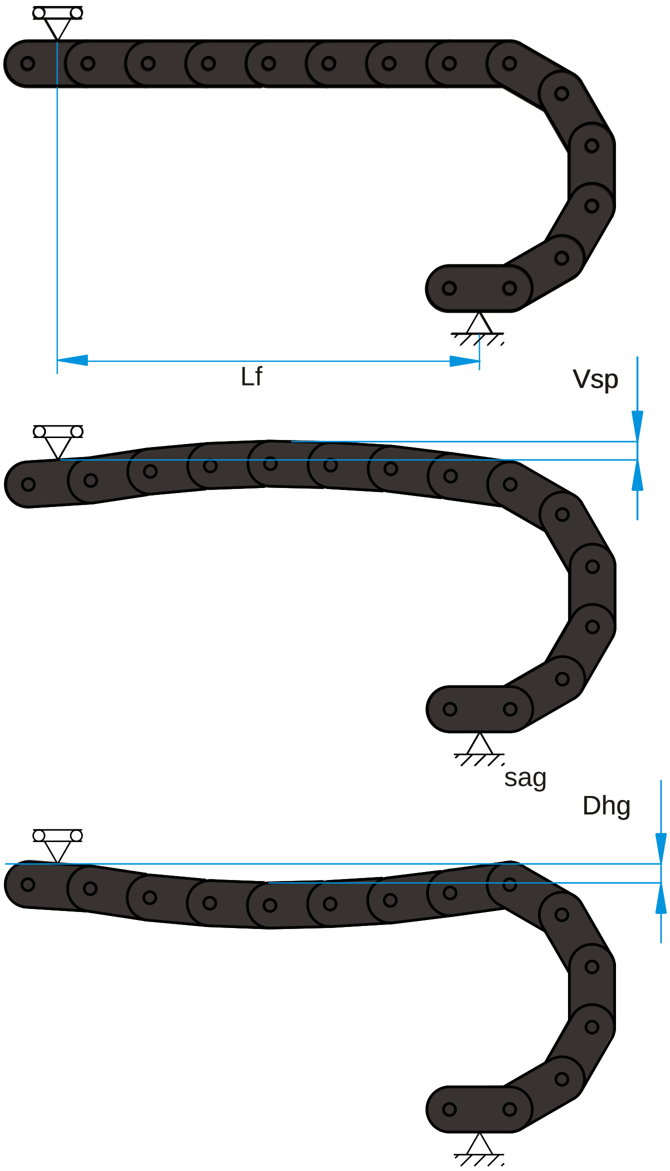

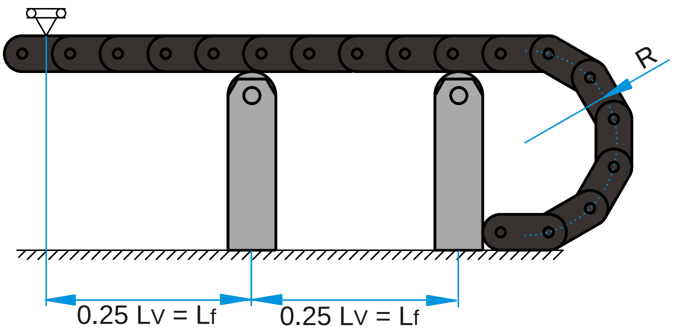

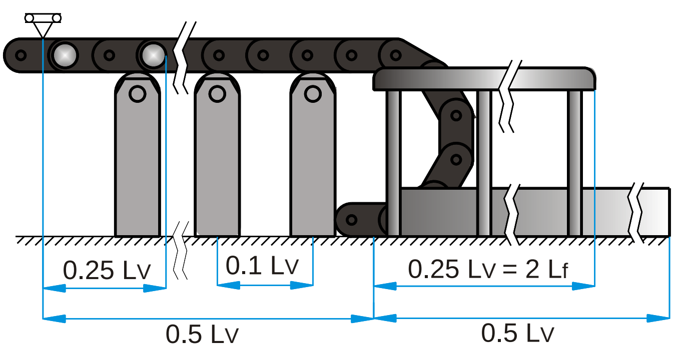

Pretension and permissible sag

ekd energy chains are supplied with pretension. Exceptions are energy chains for vertical or sliding arrangements as well as on the side lying energy chains, for example, in a circular arrangement.

The pretension is a manufacturing tool to achieve energy chains with increased free carrying lengths.
The values for the pretension is set by the manufacturer. ekd energy chains made of steel are manufactured with 5 mm / m and plastic energy chains up to 25 mm / m as pretension with no load.

The sag is due to the additional load and the weight of the energy chain. Due to the significantly lower elongation of steel (0.2% linear elongation) compared to plastics the permissible sag of the steel chains is limited lower than for plastic energy chains.
On the other hand, the effect on plastic energy chains of a long-term static load with a long unsupported length of the upper strand chains will increase the sag (creeping of plastics).
Elevated temperatures and humidity increases this effect. The sag of energy chains is also increased by use-wear.

The maximum allowable sag can only be judged in the assessment of all operating conditions. Within the limits for the free carrying length specified in the load diagram the sag is within the permissible range at normal operating and environmental conditions.

In addition the following factors have to be taken into account :

Using toughs and slow moving energy chain sag is limited.

For high accelerations and high travel speeds too much sag is a problem. A defined force application at the moved connector is not guaranteed and uncontrollable chain oscillations can occur. Thus the energy chain material is subjected to extreme dynamic stresses.
In such cases, corrective steps should be taken.

The first step is the selection of an energy chain with increased free carrying length. If this can not be done, these are the following alternatives:

Support rolls and support rails

Support rollers can increase the maximum travel Lv of steel chains by up to four times the free carrying length Lf.
With additional support rollers and a support rail the maximum range of movement can be expanded up to eight times the free carrying length.

The use of support rollers with support frames, is limited to speeds below 1 m / s.

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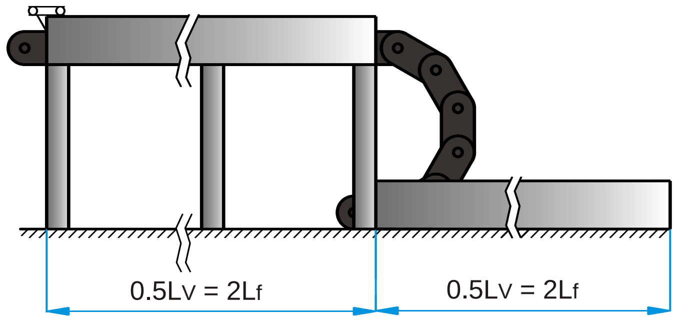
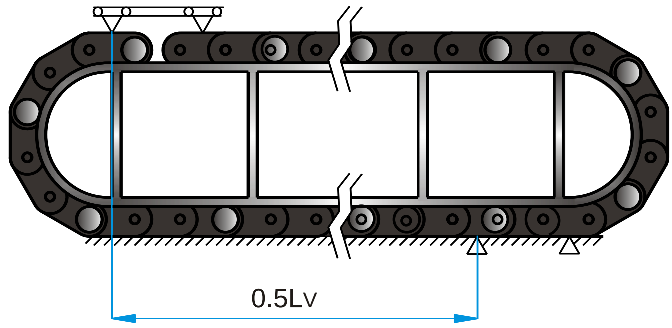
Raised trough

This type is mainly used with plastic energy chain applications. As with the use of support rolls the maximum travel can be increased up to four times the free carrying length.
Because of the larger permissible sagging, support rolls are not suitable for plastic energy chains.



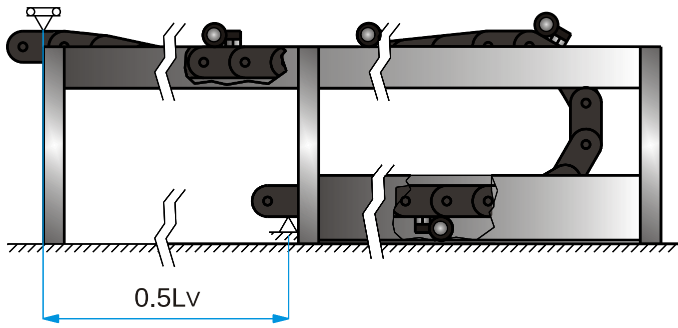
Support carriage

For long travel distances and high additional loads support carriages can be used with reverse travelling energy chains. The side-mounted support rolls carry the energy chain and move the support carriage.
The energy chains now only face pull forces and through this an extremely long life is achieved even at high additional loads.



SYSTEM MARATHON

The patented SYSTEM MARATHON for unlimited travel is also designed for high speeds and high accelerations. The upper run is running with supporting rollers over the entire travel on continuous flat rails and the rollers swing in the radius to lay down the energy chain at the bottom profile. In the back movement the rollers swing out again and lead the energy chain without wear over the entire travel. The SYSTEM MARATHON is not dependant upon the type of energy chain and therefore steel energy chains are as equally suitable as plastic energy chains.

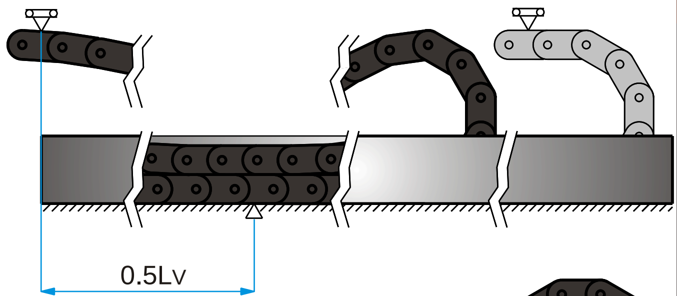


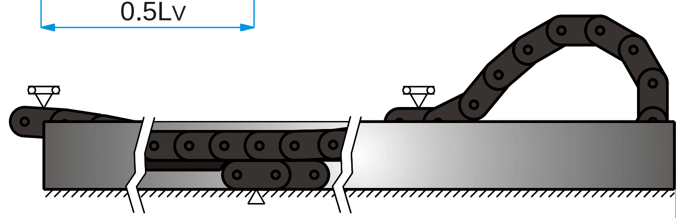
Gliding energy chains

Gliding energy chains require guiding the upper run in a continuous trough. In addition, the first half of travel slide bars are mounted or the energy chain is extended via the fixed end in the middle of the travel out up to the starting point to create a continuous gliding plane (see also chapter troughs).

With high dynamic demands on the energy chain, lowering the moving connection end may be necessary to result in a better introduction of push forces into the energy chain.
In travels over 30 m, velocities above 1.5 m / s and acceleration of 1 m/s^2 lowering the moving end is recommended and requires an additional lengthof the energy chain. Chain links with a opposite bend radius minimize the required additional length and minimize oscillations of the remaining free carrying length of the energy chain.

PKK, PLE and SLE energy chains for gliding arrangements are preferably equipped with sliders that can be replaced after reaching the wear limit without dismantling or replacing the energy chain.





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