igus®

tech talk

Caring for cables

Cable carriers guide and protect cables and hoses on moving machinery, and prevent tangling or damage from debris or contact with the machine itself. Proper use of a cable carrier extends the service life of both the cable and the machine itself. Any application involving moving machinery and repetitive motion will benefit from a cable carrier system, including machine tools, woodworking machinery, robotic arms, cranes, and many more.

igus® energy chain systems® are maintenance-free, corrosion-resistant, and highly reliable all-plastic cable carriers designed to replace steel carriers in almost any application. A variety of energy chains® are available for all application requirements, including micro-chains for the smallest applications, E-Z chains for quick installation, E6 chains for low vibration and noise, fully-enclosed e-tubes for applications with flying debris, and multi-axis triflex® carriers for robotic applications.

Types of installation

Cable carriers are essentially the lifetime of any machine, and should be considered early-on in the design process. The carrier can be installed in number of ways depending on the movement of the machine, but the most common method for installation is in a horizontal, unsupported configuration for a short travel distance. In this style of installation, the upper run of the carrier operated without touching the lower run throughout the entire length of the travel. The maximum unsupported length is different for every application, but this type of installation is generally expected to have the longest service life.

If the length of travel is too long for an unsupported installation, it can be considered a gliding application. In this configuration, a guide trough can be added to keep the carrier in place as it glides over itself over a longer travel.

A number of other installation configurations are possible for energy chains®, including rotary, zig-zag, and side-mounted installations.

Steps for Specifying a Cable Carrier

1. Gather necessary technical data. This includes the length of travel, the cables and hoses to be installed along with their diameters and weights, required speed and acceleration of the carrier, and environmental factors like heat and chemical exposure or flying debris.

2. Measure the largest cable or hose: The largest cable or hose in your system will determine the minimum size of a cable carrier. Add 10% to the size of the largest cable, or 20% to the largest hose, to determine the minimum interior height of a cable carrier to ensure proper clearance.

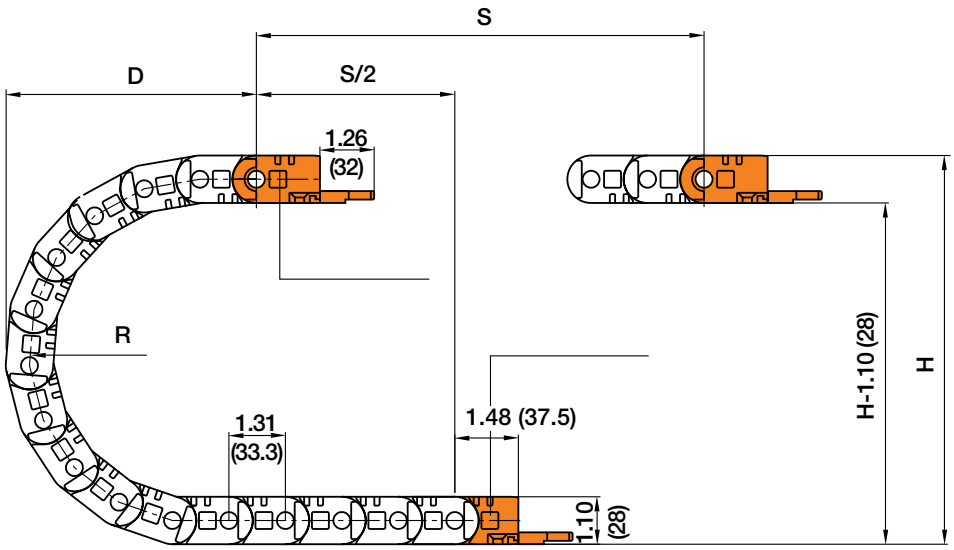
3. Select your style: Next, it's time to select the style of cable carrier. igus® recommends that you always choose the snap-open style if appropriate, as these types of carriers will allow the easiest access to cable and hoses at any

point within the carrier. If debris or other environmental factors are of concern, tube-style carriers are available to fully enclose the carrier and provide complete protection. This style is exceptionally useful in applications where flying woodchips, metal filings, and other destructive debris is present. If a high level of protection isn't required, but quick access to cable is required, energy chains® are available with options like split or hinged crossbars, or even zipper-style carriers with interconnected, pull-off lids. A number of other styles of energy chain are available to suit specialized applications, such as cleanroom-compatible options, those for high temperatures, carriers with integrated wheels for long gliding applications, quiet, low-vibration options, and more.

4. Consider the environment: The environmental factors of an application typically determine which type of cable carrier to use. In applications where sharp metal fragments or woodchips are present, or if the application is in a dirty or contaminated area, an enclosed tube (pictured R.) is ideal.

Many applications also have space requirements that will affect the design and selection of the cable carrier system. It is imperative that the performance of the system selected is not compromised to meet these space requirements. For example, keep in mind the camber of the cable carrier when determining how much height is available for the installation. Camber is the curve of the upper portion of the carrier along its unsupported length. While most carriers are manufactured with camber, special no-camber options are usually available on request, but be advised, as these types of carriers do not offer the same load-bearing capacity as those carriers with camber.

5. Bend radius: All cable carriers have a predetermined stopping point on each link. When assembled, these link stopping points restrict the carrier from fully pivoting and form a curve loop, or minimum bend radius. All cable carriers have multiple bend radii to choose from, and a manufacturer will offer a suggested minimum bend radius. If this recommended bend radius is unknown, the general rule is ~8-10 times the outer diameter of the largest cable or hose. the larger the bend radius, the less stress is placed on the cable, and the longer the service life will be. Bend radius is measured from the center of the curve loop to the center of the pivot pin on the side link. Do not confuse bend radius with the dimension of the overall curve height!



R = Radius of the carrier
H = Overall curve height, or the measurement from the top to the bottom of the curve
D = Depth of the curve

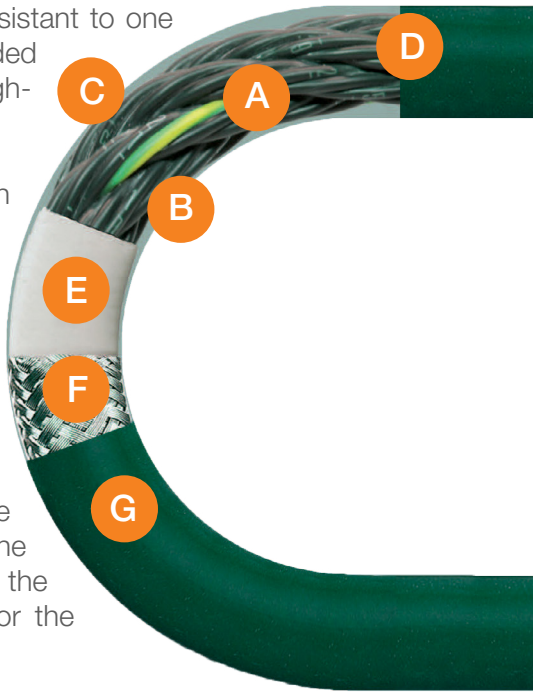
6. Cable and hose package: As the primary function of the cable carrier is to ensure that all cables bend

properly, it is critical to install conduits correctly. To ensure the maximum cycle life for a machine, the easiest solution is to only use cable designed for use within a cable carrier, like Chainflex® continuous-flex cables. These types of cables follow the following design guidelines for maximum service life in dynamic applications:

A. Strain-relieving core: The center core should be filled with a high-quality, high tensile strength core to protect the twisted conductors from falling into the center.

B. Conductor structure: The copper stranding in chainflex® is chosen in accordance with tested and proven designs. igus®' test results indicate that a medium to fine strand diameter is preferable. Most typical flexing cable designs will employ an extra-fine conductor strand, and have a tendency to kink when subject to high-duty cycles. As a result of long-term testing, igus® uses a combination of single-wire diameter, pitch length and pitch direction to achieve the best flex life performance in even the most demanding applications.

C. Conductor insulation: Insulation materials must be adhesion-resistant to one another within the cable. The insulation must also support the stranded individual wires of the conductor. Only the highest-quality, high-pressure-extruded PC or TPE materials should be used.



D. Cable core: Individual conductors are bundled into groups, which are cabled together in a single layer surrounding the cable core. This design enables pulling and compressive forces if the bending motion to balance and cancel out torsional forces. Special attention is given to pitch length and direction. The cable's inner jacket will also help to maintain the integrity of the cable core and provide a continuous surface for the shield.

E. Inner jacket: A pressure extruded inner jacket should be used for cables subjected to continuous-flexing, as opposed to inexpensive fleece wrap or filler. This extruded inner jacket both ensures that the insulated conductors are efficiently guided, as well as maintaining the integrity of the cable core and providing a continuous surface for the overall shield.

F. Shield design: A high-quality braided shield provides electromagnetic interference (EMI) protection for the cable. An optimized braid angle prevents the shield strands from breaking over the linear axis and increases torsional stability. The shield has an optical coverage of approximately 90%, providing maximum shield effectiveness.

G. Outer jacket: The outer jacket material must be resistant to UV radiation, abrasion, oils, and chemicals, as well as being cost-effective. However, the outer jacket of a cable for dynamic applications must be resistant to abrasion, and remain flexible while providing support. For best wear rates and service life, the outer jacket should be extruded under pressure.

7. Cable carrier length: To determine the length of cable carrier that an application requires, first determine the position of the fixed end. Ideally, and most cost-effectively, this point will be at the center of travel. This positioning will require the minimum amount of carrier to achieve the necessary movement.

Use the following formulas to determine the necessary cable carrier length:

$L_K = S/2 + K$ (If the fixed point is at the center of travel)

$L_K = S/2 + \Delta M + K$ (If the fixed end is anything other than the center of travel)

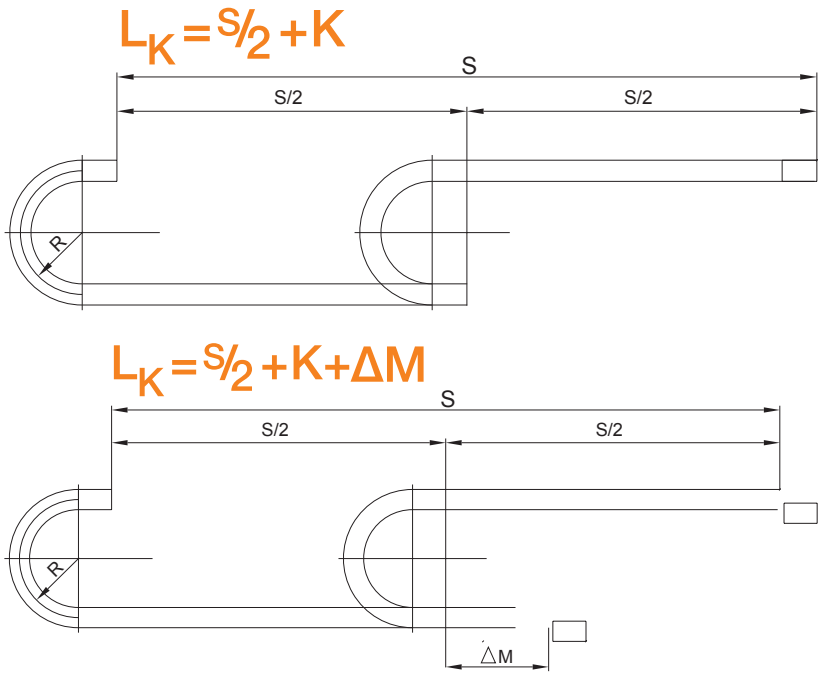
S = Maximum machine travel distance

K = Curve length

L_K = Carrier length

R = Bending Radius

ΔM = Deviation from the center point



8. Acceleration and inertia: It is critical to ensure that a cable carrier is strong enough to support the application in questions to avoid devastating breakdowns. In order to determine if a carrier is strong enough, igus® recommends working through the following formula:

First, determine the acceleration force, which is required to keep the carrier moving once motion has started.

Acceleration force, in lbs. = Total weight (carrier + fill) in lbs. x Acceleration in ft./s^2
Then determine the push force. This is the force required to get the carrier moving and overcome inertia.
Once those numbers are determined, calculate the force of the application:

Acceleration + Push force = Force required

The force required must be less than the maximum force for the selected cable carrier. Manufacturers typically do not publish maximum force allowances for products, but technicians, like those at igus® will calculate the force required for your application, and select a proper carrier to meet these requirements.

9. Accessories: A variety of accessories are designed to further facilitate an energy supply system. These options can include:

- Interior separators or shelves ensure proper alignment of the cables within the carrier and prevent friction, tangling, and corkscrewing. These are available in both vertical and horizontal options.
- Mounting brackets are almost always required to attached the cable carrier to the machine itself. Plastic or steel single-piece brackets are available for smaller carriers, and others features aluminum bushings to prevent damage when tightening bolts. These brackets can pivot for standard applications, or lock into place for vertical, side-mounted, or gliding application.
- Guide troughs are available for long-travel applications
- Rollers can be used for very long travels to reduce friction and drive requirements
- Extender crossbars enable the use of oversize conduits

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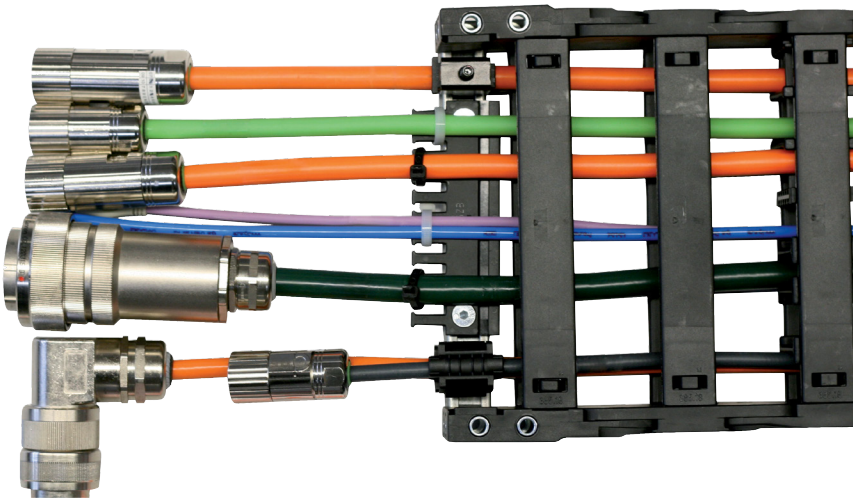
- Strain relief is a common accessory, designed to keep cables in position at both ends of a cable carrier. Sometimes, strain relief is only necessary on the moving end of the carrier, but this is highly dependent on application.

Strain relief can consist of profile rails, clamps, or tie wrap plates. Improper strain relief is a common cause of cable hose failure. Proper strain relief holds the cable in the neutral axis of the carrier, preventing the cables from being pulled against the inner radius, or pushed against the outer radius where damage and wear can occur. While it may seem insignificant, strain relief can truly make or break the success of a cable carrier application.



Of course, specifying, harnessing, and installing a cable carrier can be a complicated process, but igus® offers years of expert experience and can offer unmatched customer support during your selection and design process.

In addition to expert advice and support, igus® can also take all the hassle out of energy supply systems by providing fully-assembled and tested plug-and-play readychain® systems, custom assembled to suit your exact specifications.

To learn more about igus® energy chain systems®, or to speak with a product expert, contact us directly by calling 800.521.2747, or emailing sales@igus.com.