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igus® readychain®

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More than 3500 m² testlab for e-chains® and chainflex®-cables. Up to 15.000 tests per year.

Laboratory and practical experience

Our calculations and analyses are based on the result of ongoing practical tests in our technical center and our experience with moving applications. The focal points of our tests are push-pull forces, friction values and abrasion under widely varying conditions and speeds, as well as factors such as dirt, weathering or impact. We test all system components such as cables, hoses, strain relief and other accessories, in addition to the e-chains® or e-tubes and guide troughs.

An all-in-one energy supply system - the-chain

There are many options to supply your equipment and systems with energy and data. But there is hardly a solution as universal and durable as the e-chainsystem®. Whether you have a circular motion, a suspended or upright application, a long travel distance, high loads or large cables and hoses - igus® plastic e-chains® will help you solve nearly any type of energy supply problem, quickly, safely and with ease. Whether you wish to reliably guide many large hoses for any type of media, sensitive fibre optic signals over long distances, disruption-free data in torsional movements, or only air at high accelerations, igus® can supply you with the matching energy supply system in addition to the optimally matched chainflex® cables. By tapping into the expansive igus® construction kit (more than 90.000 e-chain® types and 1.030 chainflex® cables), you will find the solution to match your needs and application from the individual component to the completed installation at your facility. We have developed an online tool to help you find these resources with greater ease | www.igus.eu/the-chain. Should you have trouble finding exactly the product you need, our engineers are always at your disposal to help you design the-chain®.

Online tool | www.igus.eu/the-chain
**Short cuts and description**

- \( \alpha \) = The rotation angle of the rotating machine element [°]
- \( \Delta M \) = Deviation of the center point [mm]
- \( a \) = Acceleration [m/s²]
- \( AR \) = Outer radius, e-chain [mm]
- \( BA \) = Outer e-chain' width [mm]
- \( BI \) = Inner e-chain' width [mm]
- \( B_{oa} \) = Guide trough outer width [mm]
- \( B_{oi} \) = Guide trough inner width [mm]
- \( D \) = Over length e-chain' radius in final position [mm]
- \( D_2 \) = Over length for long travels, gliding [mm]
- \( F L_{ba} \) = Unsupported length with sag [m]
- \( F L_{bu} \) = Unsupported straight length [m]
- \( F L_{bu} \) = Unsupported lower run [m]
- \( FZ_{max} \) = Maximum fill weight [kg/m]
- \( F \) = Required clearance height [mm]
- \( H \) = Nominal clearance height [mm]
- \( H_{ha} \) = Outer e-chain' height [mm]
- \( H_{hi} \) = Inner e-chain' height [mm]
- \( H_{ha} \) = Outer trough height [mm]
- \( H_{hi} \) = Inner trough height [mm]
- \( IR \) = Inner radius, e-chain (twisterchain) [mm]
- \( K \) = Add-on for bending radius (K is taken from the data tables of the individual Series) [mm]
- \( K_2 \) = Further add-on if the mounting bracket location is set lower (for long travels) [mm]
- \( L_e \) = e-chain' length [mm]
- \( LK \) = e-chain' lengths [mm]
- \( M \) = Bending radius [mm]
- \( R \) = Reverse bending radius [mm]
- \( R_{BR} \) = Bending radius [mm]
- \( S \) = Length of travel [mm]
- \( S/2 \) = Half length of travel [mm]
- \( T \) = Pitch [mm]
- \( V \) = Speed (travel) [mm/s]
- \( X_1 \) = Inner machine-construction space (twisterchain) [mm]
- \( X_2 \) = Outer radius e-chain, including clearance (twisterchain) [mm]

**igus® formula**

- \( SFL_{ba} = 2 \times F L_{ba} \) Calculation of maximum travel length, unsupported with sag
- \( SFL_{ga} = 2 \times F L_{ga} \) Calculation of maximum travel length, unsupported straight
- \( B_{oa} = B_{oa} + 4 \) Calculation of the minimum guide trough width
- \( H_{ha} = 2 \times h_{ha} \) Calculation of the minimum guide trough height
- \( K = R \times R + (2 \times R) \) Add-on for bending radius
- \( LK = S/2 + \Delta M + K \) Calculation of e-chain' lengths, fixed end is outside the center of travel (FLb, FLg and \( \Delta M \))
- \( LK = S/2 + K \) Calculation of e-chain' lengths. For all types of applications, fixed end in the center of travel, except rotary movements and most long travels
- \( LK = S/2 + K_2 \) Calculation of e-chain' lengths for long travels, fixed end in the center of travel [m]

**HF - e-chains**

**Principle of camber for igus®**

Camber is the curve of the upper run along its unsupported length. All igus® e-chains are manufactured with a special “no camber” e-chains available on request. The camber allows for longer unsupported lengths and increases service life and operating safety. In the **Installation dimensions** section of each respective e-chain description, you will find the measurement \( H_{RI} \), which specifies the necessary clearance height, taking the camber into account. Upon request, we can deliver e-chains without camber for restricted space applications - however, these “no camber” e-chains do not have the same load-bearing capacity. Please consult igus®.

**Calculation | e-chain’-lengths and camber**

**Calculation of e-chain’ lengths**

If the fixed end of the e-chain is located in the center of the travel, the e-chain’ length \( L_e \) is calculated by using half the length of travel and adding the value \( K \) for the curved length. (You can obtain the value \( K \) from the tables in the catalogue.) Placing the Fixed End in the center of the travel is the most cost-effective solution because it requires the shortest e-chain’, cables and hoses.

\[
LK = \frac{S}{2} + K
\]

This formula is generally valid for all types of applications if the fixed end is in the center of the travel. Exceptions: rotary movements and most long travels.

\[
LK = \frac{S}{2} + \Delta M + K
\]

This formula is valid if the fixed end is outside the center of the travel.

\[
SFLG = 2 \times FLG
\]

Calculation of maximum travel length, unsupported straight.

\[
SFLB = 2 \times FLB
\]

Calculation of maximum travel length, unsupported with sag.

\[
BR_{ri} = BR_{ra} + 4
\]

Calculation of the minimum guide trough width.

**Camber**

Camber is the curve of the upper run along its unsupported length. All igus® e-chains are manufactured with camber, special “no camber” e-chains are available on request. The camber allows for longer unsupported lengths and increases service life and operating safety. In the **Installation dimensions** section of each respective e-chain description, you will find the measurement \( H_{RI} \), which specifies the necessary clearance height, taking the camber into account. Upon request, we can deliver e-chains without camber for restricted space applications - however, these “no camber” e-chains do not have the same load-bearing capacity. Please consult igus®.

\[
H = \text{Nominal clearance height [mm]}
\]

**Application examples and more information online | www.igus.eu**
Unsupported Short travels

The FLG type of installation always generates the longest service life and can be operated with the max. values for speed and acceleration.

Unsupported Short travels

Unsupported applications

If the upper run of the e-chain operates without touching the lower run over the entire travel, it is called an "unsupported" application. The distance between moving end and the beginning of the radius curve of the e-chain is called the "unsupported length." The unsupported application is the most common. igus® e-chains® are very well suited for high dynamics and long service life. The maximum unsupported length is dependent upon the fill weight and the type of e-chain® or e-tube. As a result, we differentiate among three types of unsupported length:

01) Unsupported with straight upper run FLG

The e-chain® is unsupported FLG when the upper run still has camber, is straight or has a maximum sag of 1/2 of the e-chain® link height. Installing the e-chain® in FLG is always recommended. The e-chain® runs smoothly without additional vibration.

02) Unsupported with permitted sag FLB

The e-chain® is unsupported FLB when the sag is more than 1/2 e-chain® link height and less than the smallest available radius of this e-chain® series. In most applications the e-chain® can be used unsupported FLB without any problems. There are restrictions concerning the maximum speed and acceleration.

03) "Critical sag"

When the sag of the e-chain® is higher than allowed for FLB, it is in critical sag. Using an e-chain® in critical sag should be avoided or solved with special solutions. Applications may reach the area of critical sag after long service times. The e-chain® should be replaced in these cases. Please contact us!

Unsupported Short travels

Example for unsupported straight FLG

Example of unsupported permissible, FLB

Unsupported applications

What to do if the unsupported length is insufficient

If your application, fill weight and travel fall outside the "unsupported length" parameters of the desired e-chain®, you have the following options:

- Select a stronger igus® e-chain®
- Support the e-chain® in the unsupported area (this possibility has restrictions for acceleration, speed and noise as a consequence - three fundamental examples are detailed below - please consult igus® if you are considering this possibility - we will gladly provide you with a detailed proposal)
- Use a "multiband" e-chain® or "nest" two igus® e-chains® inside one another (please consult igus® regarding these options)
- Design the travel distance as a "gliding application."

Example of unsupported permissible, FLB

Support of the "FLG" area. A) The overall "straight, unsupported travel" can be increased here by a maximum of 50% of the FLG and in case of option B) by a maximum of 100%

C) Support of the "FLB" area. The overall travel distance can be extended to a maximum of 100% from FLB

More application examples for short travel applications → www.igus.eu

More application examples for short travel applications → www.igus.eu
Unsupported | Short travels

Speed, acceleration and service life

For unsupported applications, the acceleration \( a\) is the critical parameter. High acceleration can cause the e-chain\(^1\) to vibrate and reduce its service life. This is a particular danger if the e-chain\(^1\) already has a sag greater than the \( F_{\text{LZ}}\) value. Max. values for acceleration, speed and service life are achieved only with e-chains\(^1\) incorporating the \( F_{\text{LZ}}\) design. \( F_{\text{LZ}}\) designed e-chains\(^1\) can sustain very high loads. To date, a peak acceleration of 784 m/s\(^2\) has been achieved during continuous use. Through ongoing testing in the igus\(^1\) laboratory and from practical experience, standard values for service life have been formulated. Our tests confirm that these standard values apply to all igus\(^1\) e-chains\(^1\) and e-tubes. It is crucial to determine whether the application will be designed as unsupported straight \( F_{\text{LZ}}\), or unsupported, with sag \( F_{\text{LZ}}\).

Mounting surfaces

Unsupported igus\(^1\) e-chains\(^1\) normally require some type of surface on which the lower portion of the e-chain\(^1\) runs. A wide range of configurations is available, as the drawings on the right demonstrate. Many material options are feasible: Metals, polymers, stone, wood, concrete, glass, etc. We also have solutions to minimise the noise generated by the e-chain\(^1\) lower portion. Please consult igus\(^1\). When selecting the running surface, be sure dirt and debris cannot collect in the e-chain\(^1\) path.

Mounting brackets

We recommend pivoting mounting brackets as standard for unsupported applications. Pivoting mounting brackets compensate for the camber, which can be installed more easily and decrease the load on the first e-chain\(^1\) link in operation. Exceptions: If the acceleration is greater than 20 m/s\(^2\) or if the height is limited to the \( H_2\) measurement, locking mounting brackets keep the e-chain\(^1\) under the \( H_2\) measurement.

Unsupported lower run

e-chains\(^1\) without support along the lower run have restricted use. The value \( F_{\text{LZ}}\) usually must be determined in a test by igus\(^1\). The maximum permissible amount of the projection depends on the fill weight, the selected e-chain\(^1\), the dynamics, and other factors, because the various combinations of these parameters can produce very different results. If the lower run of the e-chain\(^1\) cannot be supported over the whole travel, please consult igus\(^1\).

More application examples for short travel applications \(\Rightarrow\) www.igus.eu

Unsupported | Noise-optimised

Minimise noise levels with igus\(^1\) e-chain systems

The igus\(^1\) programme offers you optimal noise reduction e-chains. The table below briefly illustrates the differences in noise level among various e-chains. In addition to the e-chain, the running surface, the dynamics and the cable and hose package play a role in overall noise generation. Have our specialists design the quietest e-chain system\(^2\) for your application, for example:

System T3 ≤ 33 dB(A)

Optimal smoothness of motion was the prime development goal, as well as making it an economic solution. The igus\(^1\) T3 e-chain is very flexible and runs due to the special geometry very smooth. A measurement indicates a value of ≤ 33 dB(A) at 1 m/s\(^2\) and with an unsupported length with Series T3.29.050.038.0, and all this with a sound pressure level generated by external noise.

System E3 ≤ 38 dB(A)

Long-term tests in the igus\(^1\) acoustic laboratory showed reductions of 19-20 dB(A) compared with standard e-chains\(^1\), measured at a speed of 1.8 m/s\(^2\) and an acceleration of 3 m/s\(^2\). Figure determined in the igus\(^1\) laboratory in accordance with DIN 45635, taking into consideration back-ground noises, for the Series E3.22.060.044.0.

System E6 ≤ 46 dB(A)

A measurement conducted by the Rhineland Technical Inspection Authority (TÜV Rheinland) in May 2002 indicates a value of ≤ 46 dB(A) at 2 m/s\(^2\) and with an unsupported length of 1.5 m with Series E6.52.10.100.0, and all this with at least 10 dB(A) sound pressure level generated by external noise. The System E6 runs very smoothly due to its small pitch.

System E4 ≤ 46 dB(A)

A measurement by the Rhineland Technical Inspection Authority (TÜV Rheinland) for System E4/101, Series 221.10.200.0 indicates a value of ≤ 46 dB(A) at 2 m/s\(^2\) and with an unsupported length of 0.5 m with Series 221 E4/00. The System E4 is already very reduced in noise due to their standard designed stop dog.

Selected noise tests - external noise corrected measurement values

<table>
<thead>
<tr>
<th>e-chain</th>
<th>System</th>
<th>Averaging of the corrected sound pressure levels</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>igus(^1) Series T3.29</td>
<td>T3</td>
<td>≤ 33 dB(A)</td>
<td>unsupported 1.0 m/s(^2)</td>
</tr>
<tr>
<td>igus(^1) Series E3.22</td>
<td>E3</td>
<td>≤ 38 dB(A)</td>
<td>unsupported 1.8 m/s(^2)</td>
</tr>
<tr>
<td>igus(^1) Series E6.52</td>
<td>E6</td>
<td>≤ 46 dB(A)</td>
<td>unsupported 2.0 m/s(^2)</td>
</tr>
<tr>
<td>igus(^1) Series 221</td>
<td>E4/00</td>
<td>≤ 46 dB(A)</td>
<td>unsupported 1.5 m/s(^2)</td>
</tr>
<tr>
<td>igus(^1) Series E54.42</td>
<td>E4.1</td>
<td>≤ 46 dB(A)</td>
<td>unsupported 1.0 m/s(^2)</td>
</tr>
<tr>
<td>igus(^1) Series E4.42</td>
<td>E4.1</td>
<td>≤ 50 dB(A)</td>
<td>unsupported 1.0 m/s(^2)</td>
</tr>
<tr>
<td>igus(^1) Series 255</td>
<td>E2 medium</td>
<td>≤ 53 dB(A)</td>
<td>unsupported 1.5 m/s(^2)</td>
</tr>
<tr>
<td>igus(^1) Series e-band</td>
<td>e-band</td>
<td>≤ 59 dB(A)</td>
<td>unsupported 1.5 m/s(^2)</td>
</tr>
<tr>
<td>Chain 1 Third Party Product</td>
<td>e-band</td>
<td>≤ 77 dB(A)</td>
<td>unsupported 2.0 m/s(^2)</td>
</tr>
<tr>
<td>Chain 2 Third Party Product</td>
<td>e-band</td>
<td>≤ 78 dB(A)</td>
<td>unsupported 2.0 m/s(^2)</td>
</tr>
<tr>
<td>Chain 3 Third Party Product</td>
<td>e-band</td>
<td>≤ 73 dB(A)</td>
<td>unsupported 2.0 m/s(^2)</td>
</tr>
</tbody>
</table>

Source: TÜV Rheinland, except Series E3.22 - Source: igus\(^1\) laboratory

More application examples for short travel applications \(\Rightarrow\) www.igus.eu

We have received an official certificate from the Rhineland Technical Inspection Authority (TÜV Rheinland Berlin-Brandenburg) and we are able to provide you with a copy on request.
### Quick overview and preselection | < 3.0 kg/m fill weights

Unsupported length vs. fill weight vs. inner height

<table>
<thead>
<tr>
<th>Unsupported length [m]</th>
<th>Fill weight [kg/m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.40</td>
<td>0.25</td>
</tr>
<tr>
<td>0.5</td>
<td>0.35</td>
</tr>
<tr>
<td>0.75</td>
<td>0.5</td>
</tr>
<tr>
<td>1</td>
<td>0.75</td>
</tr>
<tr>
<td>1.5</td>
<td>1</td>
</tr>
<tr>
<td>1.75</td>
<td>1.75</td>
</tr>
</tbody>
</table>

#### Preselection for the following series
- easy chain® → page 158
- zipper → page 194
- E2 micro → page 216
- E2 mini → page 248
- E2 R 1000 → page 268
- E2 R e-tubes → page 326
- E2/000 → page 348
- RX e-tubes → page 370
- E4.1 → page 390
- E4.1 light → page 454
- E4 light → page 474
- E6 → page 516
- E6.1 → page 534
- E3 → page 572
- T3 → page 72

Remark: This matrix is just a preselection. Exact values can be found in the chapters of the chosen series and on the next pages.

---

### Quick overview and preselection | ≥ 3.5 kg/m fill weights

Unsupported length vs. fill weight vs. inner height

<table>
<thead>
<tr>
<th>Unsupported length [m]</th>
<th>Fill weight [kg/m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.40</td>
<td>4</td>
</tr>
<tr>
<td>0.5</td>
<td>5</td>
</tr>
<tr>
<td>0.75</td>
<td>7</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>1.5</td>
<td>15</td>
</tr>
<tr>
<td>1.75</td>
<td>20</td>
</tr>
</tbody>
</table>

#### Preselection for the following series
- easy chain® → page 158
- zipper → page 194
- E2 micro → page 216
- E2 mini → page 248
- E2 R 1000 → page 268
- E2 R e-tubes → page 326
- E2/000 → page 348
- RX e-tubes → page 370
- E4.1 → page 390
- E4.1 light → page 454
- E4 light → page 474
- E6 → page 516
- E6.1 → page 534
- E3 → page 572
- T3 → page 72

Remark: This matrix is just a preselection. Exact values can be found in the chapters of the chosen series and on the next pages.

Find the values ➤ in every individual Series chapter!
Unsupported | **Straight FL<sub>G</sub>** | Fill weights up to 1.5 kg/m

Load diagram use unsupported

Unsupported | **Sag FL<sub>B</sub>** | Fill weights up to 1.5 kg/m

Load diagram use unsupported

---

**Important information**

- Fill weight: Weight of all cables and hoses, including contents (for media hoses) within the e-chain, typically given [kg/m]
- FL<sub>G</sub>: unsupported e-chain with straight upper run
- FL<sub>B</sub>: unsupported e-chain with permitted sag
- To the right of the FL<sub>B</sub> graph of the diagram, the application is shown in "critical sag", which must be avoided!

These values are essential for: Finding a suitable e-chain for your fill weight and travel distance; Identifying the max. load for the selected e-chain. If you cannot meet your application demands using these parameters, keep in mind these specifications are conservative maximum values. In individual cases, they can be exceeded by up to 30%. Special solutions are also possible. Please consult igus.

**Find the values for "FL<sub>G</sub>" and "FL<sub>B</sub>" also ★ in every individual Series chapter!**

---

**Series diagrams**
You will find both diagrams for each series listed individually in the catalogue:
- Easy chain ★ page 158
- Zipper ★ page 194
- E2 Micro ★ page 216
- E2 mini ★ page 248
- E2/RX e-tubes ★ page 326
- System T3 ★ page 516
- System E3 ★ page 524

---

**The maximum travel**
always amounts to 2 x FL<sub>G</sub> or FL<sub>B</sub> if the fixed end is in the center of the travel. In this case, the following applies:

**e-chain** length: L<sub>u</sub> = S/2 + K

S = Length of travel
R = Bending radius
H = Nominal clearance height
HF = Required clearance height
K = π x R + (2 x T) Add-on for bending radius

Find the values for "FL<sub>G</sub>" and "FL<sub>B</sub>" also ★ in every individual Series chapter!
Unsupported \( \text{Straight FL}_G \) | Fill weights up to 9,0 kg/m
Load diagram use unsupported

Unsupported \( \text{Sag FL}_B \) | Fill weights up to 9,0 kg/m
Load diagram use unsupported

Important information
- Fill weight - Weight of all cables and hoses, including contents (for media hoses) within the e-chain, typically given [kg/m]
- \( \text{FL}_G \) - unsupported e-chain with straight upper run
- \( \text{FL}_B \) - unsupported e-chain with permitted sag
- To the right of the \( \text{FL}_G \) graph of the diagram, the application is shown in “critical sag”, which must be avoided!

These values are essential for:
- Finding a suitable e-chain for your fill weight and travel distance
- Identifying the maximum load for the selected e-chain. If you cannot meet your application demands using these parameters, keep in mind these specifications are conservative maximum values. In individual cases, they can be exceeded by up to 30%. Special solutions are also possible. Please consult igus.

The maximum travel - always amounts to \( 2 \times 2 \times \text{FL}_G \) or \( \text{FL}_B \) if the fixed end is in the center of the travel. In this case, the following applies:
\[
\text{e-chain length: } L_e = S/2 + K
\]
\[
S = \text{Length of travel}
\]
\[
R = \text{Bending radius}
\]
\[
H = \text{Nominal clearance height}
\]
\[
H_F = \text{Required clearance height}
\]
\[
K = \pi x R + (2 \times T) \text{ Add-on for bending radius}
\]

Find the values for \( \text{FL}_G \) and \( \text{FL}_B \) also in every individual Series chapter!
Unsupported Straight \( FL_G \) | Fill weights up to 90 kg/m

Unsupported Sag \( FL_B \) | Fill weights up to 90 kg/m

Important information
- Fill weight: Weight of all cables and hoses, including contents (for media hoses) within the e-chain®, typically given [kg/m]
- \( FL_G \): unsupported e-chain® with straight upper run
- \( FL_B \): unsupported e-chain® with permitted sag
- To the right of the \( FL_B \) graph of the diagram, the application is shown in "critical sag", which must be avoided!

These values are essential for:
- Finding a suitable e-chain® for your fill weight and travel distance
- Identifying the max. load for the selected e-chain®. If you cannot meet your application demands using these parameters, keep in mind these specifications are conservative maximum values. In individual cases, they can be exceeded by up to 30%. Special solutions are also possible. Please consult igus®

The maximum travel - always amounts to \( 2 \times FL_G \) or \( FL_B \) if the fixed end is in the center of the travel. In this case, the following applies:

\[
L_k = \frac{S}{2} + K
\]

\( S \) = Length of travel
\( R \) = Bending radius
\( H \) = Nominal clearance height
\( H' \) = Required clearance height
\( K = \pi R + (2 \times \text{Add-on for bending radius}) \)

Series diagrams
You will find both diagrams for each series listed individually in the catalogue:
- E2/000 page 268
- E2/RX e-tubes page 326
- E4.1 page 390
- E4.1 light page 454
- E4/light page 474
- E6 page 534
- E6.1 page 572

To the right of the \( FL_B \) graph of the diagram, the application is shown in "critical sag", which must be avoided!

Find the values for \( FL_G \) and \( FL_B \) also in every individual Series chapter!
Gliding | Long travels

Recommended ratio of inner width $B_i$ and bending radius $R$

The minimum inner width of an e-chain® on long travels depends on its bending radius. igus® specifies: $B_{i\text{min}} \geq \frac{R}{4}$

Example of lowered mounting height

GL 5/2 + K2

L_k = S/2 + K2

L_k = e-chain® length

S = Length of travel

S/2 = Half length of travel

R = Bending radius

$\Delta CL$ = Offset fixed point

H2 = Installation height

H2 = Installation height

D2 = Over length for long travels gliding

K2 = Add-on® with lowered mounting

Long travel with E4 rol e-chain®, guided in a igus® steel guide trough

The function of an e-chainsystem® for gliding applications (schematically). The fixed end of the e-chain® is located in the center of the travel distance

For a configuration involving two opposed e-chains®, the travel is measured as shown and can be used when there are high loads or restricted space

Advantages for long travel applications with igus® e-chains®

- Travels over 800 m
- 6 m/s speed (up to 10 m/s possible after consultation with igus®)
- Service life of 10 years and more with igus® e-chains systems
- Fill weights up to 70 kg/m

Further advantages of the design are:
- Many different types of cables and hoses can operate side by side in the same system (i.e. electrical, data, fibre optic cables with hydraulic and pneumatic hoses)
- Space-saving installation
- Quiet operation
- High accelerations
- Durable in wind, weather, dirt, and chemicals
- Simple assembly of the modular system on the spot
- Rapid assembly and replacement of cables and hoses

E4 e-chain® with extension links for many cables and large hoses on a long travel application

Design assistance, free of charge

We recommend that igus® calculate every gliding application for you. We will always offer the most cost-effective solution, taking the technical requirements and operating safety into consideration.

The system solution designed by us is also automatically given an igus® system guarantee.

To be able to advise you accurately, we require the following specifications:

- Travel [m]
- Travel speed [m/min or m/s]
- Acceleration [m/s²]
- Fill weight [kg/m]
- Maximum cable/hose outer diameter [mm]
- Type and number of cables and hoses
- Required bending radius [mm]
- Cycle frequency (n/day or n/hour)
- Technical environment

To be able to advise you accurately, we require the following specifications:

- Travel [m]
- Travel speed [m/min or m/s]
- Acceleration [m/s²]
- Fill weight [kg/m]
- Maximum cable/hose outer diameter [mm]
- Type and number of cables and hoses
- Required bending radius [mm]
- Cycle frequency (n/day or n/hour)
- Technical environment

More examples for long travel applications | www.igus.eu
Long travels with igus® guide troughs

Guide troughs are used for long travels. They allow igus® e-chains® and e-tubes to continue smooth, low-friction operation in these long-travel situations. Principle sketches are shown on this page. The height of the trough must be at least twice that of the e-chain® link height. The sides must provide a chamfered opening. The trough inner width is the same as the e-chain® outer width, plus 4 mm (in Alu SuperTroughs) $B_{Ti} = B_{a} + 4$. Along the side of the trough, where the upper run cannot glide on the lower run, glide bars must be installed. We recommend the use of polymer glide bars from igus®. They are optimally matched to the e-chain® material and achieve the lowest values for friction, noise and wear. Guide troughs with and without glide bars can be obtained for almost all igus® e-chains®.

Important: When assembling the trough parts, the following points must be given particular attention:

1. Properly align all trough parts upon installation
2. All screw heads should be flush with the trough
3. Smooth levelled transition between the end of the e-chain® and the glide bars
4. Solid connection with the glide surface. These points must be observed when using assembly-friendly igus® guide troughs.

Glide friction values for igus® e-chains®

Made of igumid G and various glide bars

<table>
<thead>
<tr>
<th>Material</th>
<th>Friction value, $0.19$</th>
<th>$0.45$</th>
<th>$0.54$</th>
<th>$0.48$</th>
</tr>
</thead>
<tbody>
<tr>
<td>igumid G</td>
<td>G glide bar</td>
<td>0.19</td>
<td>0.45</td>
<td>0.54</td>
</tr>
<tr>
<td>igumid G</td>
<td>Glider sheet steel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>igumid G</td>
<td>Anodised aluminium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>igumid G</td>
<td>Stainless steel</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: igus®, Labor

The friction factors, as specified above, are valid for travels from 600 mm up to 800 mm. For travels up to 500 mm, the friction factors are slightly higher, and from 800 mm and more, they are slightly lower.

Calculation

The friction coefficient $\mu$ can be calculated with the formula:

$$\mu = \frac{F}{W}$$

where $F$ is the friction force and $W$ is the applied load. The friction force $F$ can be further subdivided into:

- Static friction $F_s$:
  $$F_s = \mu_s \cdot W$$
- Dynamic friction $F_d$:
  $$F_d = \mu_d \cdot W$$

Service life

We offer service life calculations for your application based on our extensive gliding application experience. As developers of polymer plain bearings, we possess vast material behavior knowledge which we apply to the development of e-chains® as well. Units with 200 m travels have been in operation for 8 years with minimum maintenance. Units up to 60 m travels have been in operation for 15 years with almost no maintenance. (Please consult igus® for references and calculations for your project.) The maintenance-free aspects of igus® e-chain systems over long periods and under harsh operating conditions is often the deciding factor in choosing igus®. Our system guarantee (depends on the application) provides additional peace of mind.

Technical environment

Long travel applications using igus® e-chains® run in water, in dirt, in the tropics, in explosion risk areas (with special design features) and many other conditions. Guide troughs can be supplied in corrosion-free materials. You will find more details in the Technical Environment section of this chapter.

Travel speeds and accelerations

Travel speeds up to 5 m/s in continuous operation are possible and in use on current applications. In special cases, even higher speeds are possible. For example, E4 e-chains® achieve speeds of 22 m/s and accelerations of 784 m/s² in crash test units. (Only a few thousand cycles per year are required in this situation.) Acceleration plays a large role in the calculation. Differentiations must be made between normal operational acceleration and a sudden jolt of acceleration such as unexpected stops or so-called “E-stops.” Even in these situations, igus® e-chains® prove to be very durable.

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Technical environment

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Calculation

Comprehensive tests place us in the position of knowing our products capabilities. Important factors in these tests are: Push-pull forces under both ambient and extreme temperatures. Humidity and dirt. Friction values of the polymers, alone and against various glide surfaces. Behavior of electrical conduits under push-pull conditions. Behavior of hydraulic and media hoses under push-pull conditions. Service life, and noise generation. If we cannot calculate your application based on these factors, we can carry out a test for you in our laboratory. Please consult igus®.

More examples for long travel applications >> www.igus.eu
We recommend locking mounting brackets for hanging applications.

In most cases, vertical motion applications do not require lateral guidance.

Lateral acceleration can occur in two directions - guidance is necessary.

Vertical, hanging applications

In accordance with the principle of "hanging" applications, heights of over 100 m are possible with igus® e-chains®. e-chains® with interior separation allow many different types of cables and hoses to operate together in the same system without becoming entangled.

Cables and hoses

Two important factors in vertical hanging applications are how the cables and hoses lay in the e-chain® and how they are secured at the end points: All cables and hoses must be hung so that they bear their own weight. The e-chain® fulfills the function of orderly conduit bundling only and should not absorb any further tensile forces. igus® interior separation elements should be used for distinct division of all cables and hoses. The cables and hoses must be secured carefully to both end points of the e-chain®. The strain relief must be designed so that the opposite run cannot catch. Safe strain relief and clear separation of the cables and hoses are the basic prerequisites for hanging installations. Cables must be able to move freely and bear their own weight.

Vertical motion with lateral acceleration

If lateral acceleration occurs, lateral guidance of the e-chain® must be provided in most cases. The diagram shows the principle of such guidance. Partial guidance is also an option - however, it must at least cover the area in which the e-chain® may sway. Lateral acceleration can occur in two directions. The lateral guidance must be installed accordingly. If you have a choice, the layout in Figure A is preferred. Additional guidance along the side of the e-chain® helps to stabilise the igus® e-chain® further.

No Camber version with igus® special "NC" e-chains®

A normal igus® e-chain® with camber is suitable for hanging use if enough space is available. Camber contributes to quiet operation of the e-chain®, required by the slightly bulbous appearance a little more space. If there is no room - as is frequently the case for storage and retrieval systems in narrow aisles - a "no camber" e-chain® must be ordered. igus® offers numerous NC versions without camber. NC version by simply turning the outer link at E4.1 system. With igus® E4.1 it's easy to create a NC version. Simple turn e-chain® outer link. Order example: E4.32.10.175.0.NC (NC = no camber).

The E4.1 system is one of igus® best solutions for hanging applications

Technical data - vertical hanging

<table>
<thead>
<tr>
<th>Travel height max.</th>
<th>100 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>v max.</td>
<td>20 m/s dependent on height and stability of the e-chain®</td>
</tr>
<tr>
<td>a max.</td>
<td>50 m/s dependent on height and stability of the e-chain®</td>
</tr>
</tbody>
</table>

Special solution guidelok slimline F - safe vertical guidance

- Up to 7 m/s and 10 m/s
- Up to 80% less trough required, saving costs and weight
- For hanging systems up to 50 m
- No swinging of the e-chain®, high reliability due to the locking mechanism and guiding rails
- Faster and easier installation
- Reduced noise
- Easy access for servicing
- Energy and data and all kinds of media are safely guided.

More information and product range ➤ from page 878
Application | Vertical standing

**Vertical standing applications**
Standing applications are standard on many machines and plants. Cables will be guided safely in vertical strokes.

**Mounting brackets**
The mounting brackets must be attached so that the e-chain® cannot bow out. The igus® programme offers locking or one-sided, locking mounting brackets for almost all types of e-chains®. Locking KMA mounting brackets are highly recommended because they can be attached flush to the machine.

**Cables and hoses**
Cables and hoses must be laid in the e-chain® so that they can bend freely. For precise guidance of the cables and hoses, we strongly recommend igus® interior separation elements. Cables must be strain relieved at both ends.

**Lateral acceleration**
If lateral acceleration occurs, the e-chain® should be supported along the outer radius. For higher e-chain® heights, it is generally recommended that at least the first three links on the outer radius be supported. For maximum heights and weights, the whole distance must often be supported. Due to the wide variety of combinations involving weights, stroke heights, e-chain® types and bending radii, we strongly recommend you make use of our consulting services.

**Combined movements**
Combined vertical and horizontal movements are possible with igus® e-chains® for a cost-saving solution.

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Application | Zig-zag | Liftband

**Zig-zag design**
The modular design of igus® e-chains® facilitates this space-saving and unconventional solution. For modern platform technology, such as performance stages, a variety of cables and hoses which adjust the stage height must be accommodated. Lack of space almost invariably presents difficulties. The photo above shows an e-chain® in a “zig-zag” configuration produced by incorporating reverse bend radii or “RBR”. The unextended e-chain® is stored in a “basket”. If the platform is raised, the e-chain® unfolds, generating little or no noise. This construction is possible with the E4.1 System as well as many other types. Please consult igus® for these kinds of applications.

**Technical data - zig-zag**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel max.</td>
<td>40 m</td>
</tr>
<tr>
<td>v max.</td>
<td>0.4 m/s</td>
</tr>
<tr>
<td>a max.</td>
<td>1.0 m/s</td>
</tr>
</tbody>
</table>

**Available in 2 sizes**
**Alternative to Zig-Zag solution**
**Lighter and smaller installation space**
**Vertical applications implemented with ease**
**Max. expansion length: 13 m**
**More information and product range > from page 880**

---

**Technical data - vertical standing applications**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. stroke height - without support</td>
<td>4 m</td>
</tr>
<tr>
<td>Max. stroke height - with support of the first e-chain® links</td>
<td>6 m</td>
</tr>
<tr>
<td>Max. stroke height - with full support</td>
<td>20 m</td>
</tr>
<tr>
<td>v max. (dependent upon stroke height and weight)</td>
<td>20 m/s</td>
</tr>
<tr>
<td>a max. (dependent upon stroke height and weight)</td>
<td>50 m/s</td>
</tr>
</tbody>
</table>
Application | Side-mounted

Short travels with or without support

Igus’ e-chains placed on their side can be used unsupported to a limited extent. The turned “unsupported length” in this case is dependent on the following factors: ● Fill weight ● Width of the e-chain ● Bending radius ● Parallel placement. The greater the fill weight of the e-chain, the shorter the available unsupported length. When placed on its side, the e-chain’s width, in effect, becomes the height. As this “height” increases, the e-chain system becomes proportionally more-stable. Small bending radii provide greater stability. If further movement in a second axis is added to the parallel motion of two e-chains, the unsupported length is impaired. For applications with low fill weight, the standard mounting brackets are adequate. If, however, the fill weight is high and the travels are long, the e-chain must then be supported either in whole or in part. Due to the variety of application possibilities, we strongly recommend you make use of our consulting services.

We recommend locking mounting brackets for side-mounted applications

Side-mounted e-chains – are strongly recommended if the installation height is restricted

Standard values for unsupported lengths, side-mounted, upon request. The unsupported lengths can be extended by supporting the links next to the mounting brackets

Igus’ e-chain®, side-mounted, supported System E4

System E4/light e-tube in direct chip area

Long travel, gliding

Side-mounted e-chains® can travel over 100 m with adequate guidance. All e-chain® types are designed to operate gliding on their side. The corresponding glide surface is usually an igus® polymer, stainless steel or galvanised steel, depending on how high the demands on the travel speed and service life are. Roller and ball bearings or additional gliding elements are not necessary for igus® e-chains®.

Cables and hoses

Cables and hoses must be guided so that the e-chain system can move freely at all times. The igus® modular separation options offers numerous possibilities, such as vertical separators and spacers, to keep these cables and hoses separated and bending freely for maximum service life. Igus® will gladly provide an application analysis, free of charge.

Load diagram with examples “90°, side-mounted”. The unsupported lengths can be extended by supporting the links next to the mounting brackets. Please consult igus® for more series and details

Series E4 with partial support

More examples for side-mounted applications ▶ www.igus.eu

More examples for side-mounted applications ▶ www.igus.eu
Rotary motion with “RBR”

“RBR” is “reverse bending radius” and means that the e-chain can bend in two directions. Each igus® e-chain can incorporate RBR designs, with the exception of several radii, for the e-tubes R117 to R9850 and for the Series 07, 09, 14, 15, and 17. The RBR does not necessarily need to be identical to the normal bending radius of an e-chain. For example: Part No. E4.32.15.100/425.0 describes a Series E4.32 e-chain with an inner width of 150 mm, standard bending radius of \( R = 100 \) mm and \( \text{RBR} \) of 425 mm.

Most rotary motions can be achieved with the RBR option. Angles of rotation up to 540° have been realised. Below is an example of rotary motion using an RBR e-chain. Please consult igus® for your particular application.

Rotary motion requirements less installation height. The e-chains® glide mostly on surfaces made of polymer, stainless steel or steel and are guided through channels into a rotary movement. (See “side mounted” for further design tips.) Bending radius, circular radii and e-chain widths are variable with this product line.

Rotary motion with standard e-chains

The photo to the left shows an application which was achieved using “standard” e-chains (in this case, standard means that the e-chain only bends in one direction). Such solutions are possible if a great deal of space is available and if the angles of rotation are limited to a maximum of 450°. All igus® e-chains®, e-tubes and chainflex® cables are appropriate for this situation.

Circular motion of 180° with standard e-chain® on a crane turret drive

Technical data - rotary motion RBR

<table>
<thead>
<tr>
<th>max. angle of rotation</th>
<th>540° more upon request</th>
</tr>
</thead>
<tbody>
<tr>
<td>V max.</td>
<td>2.0 m/s more upon request, depending on the application</td>
</tr>
<tr>
<td>a max.</td>
<td>20 m/s more upon request, depending on the application</td>
</tr>
</tbody>
</table>

Table of “RBR” e-chains® available from stock

<table>
<thead>
<tr>
<th>Part. No.</th>
<th>Series</th>
<th>Part. No.</th>
<th>Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>03.05.10/70</td>
<td>E2 micro</td>
<td>10.4.038/600</td>
<td>E2 mini</td>
</tr>
<tr>
<td>05.16.018/018</td>
<td>E2 micro</td>
<td>10.4.048/048</td>
<td>E2 mini</td>
</tr>
<tr>
<td>06.20.018/018</td>
<td>E2 micro</td>
<td>10.4.048/400</td>
<td>E2 mini</td>
</tr>
<tr>
<td>06.30.018/018</td>
<td>E2 micro</td>
<td>10.4.075/220</td>
<td>E2 mini</td>
</tr>
<tr>
<td>06.64.018/018</td>
<td>E2 micro</td>
<td>1400.050.075/075.0</td>
<td>E2 mini</td>
</tr>
<tr>
<td>10.1.028/028</td>
<td>E2 mini</td>
<td>1500.038.075/450.0</td>
<td>E2 mini</td>
</tr>
<tr>
<td>10.1.038/600</td>
<td>E2 mini</td>
<td>2400.09.055/250</td>
<td>E2 mini</td>
</tr>
<tr>
<td>10.1.048/048</td>
<td>E2 mini</td>
<td>250.05.060/600</td>
<td>E2 mini</td>
</tr>
<tr>
<td>10.1.075/220</td>
<td>E2 mini</td>
<td>250.07.060/600</td>
<td>E2 mini</td>
</tr>
<tr>
<td>10.2.028/028</td>
<td>E2 mini</td>
<td>2700.15.150/090</td>
<td>E2 mini</td>
</tr>
<tr>
<td>10.2.038/600</td>
<td>E2 mini</td>
<td>B15.050.100/460</td>
<td>E2 mini</td>
</tr>
<tr>
<td>10.2.048/048</td>
<td>E2 mini</td>
<td>E/Z14.1.038/038</td>
<td>easy chain®</td>
</tr>
<tr>
<td>10.2.075/220</td>
<td>E2 mini</td>
<td>E/Z14.2.038/038</td>
<td>easy chain®</td>
</tr>
<tr>
<td>10.3.028/028</td>
<td>E2 mini</td>
<td>E/Z14.3.038/038</td>
<td>easy chain®</td>
</tr>
<tr>
<td>10.3.038/600</td>
<td>E2 mini</td>
<td>E/Z14.3.075/075</td>
<td>easy chain®</td>
</tr>
<tr>
<td>10.3.048/048</td>
<td>E2 mini</td>
<td>E/Z14.4.038/038</td>
<td>easy chain®</td>
</tr>
<tr>
<td>10.3.075/220</td>
<td>E2 mini</td>
<td>TE14.50.028/028</td>
<td>snapchain</td>
</tr>
<tr>
<td>10.4.028/028</td>
<td>E2 mini</td>
<td>TE26.120.063/063</td>
<td>snapchain</td>
</tr>
</tbody>
</table>
Guide troughs | Rotary motion | RBR

**igus’ guide troughs - standard modular system RM**

For rotary motions up to 540°, igus offers a modular system of guiding trough systems. Those systems are divided into an inner and an outer ring. Since one ring is moving together with the e-chain, there is no relative movement between e-chain and trough, so the wear is reduced to an absolute minimum. Depending on the application they are made from galvanised steel or stainless steel.

**Realise 900° and more with igus® Multi Rotation Modules (MRM)**

Igus’ Multi Rotation Modules help to realise rotating movements up to 900° and more. Thanks to stackable add-on modules, the angle of rotation can be extended “virtually” indefinitely. The Multi Rotation Modules are ideally suited also for rotary motions with high fill weights and limited space.

- Several individual systems are stacked on each other and form a complete system.
- The maximum rotation of the individual levels can be easily added, thereby enabling rotary motions up to 900 degrees and more.
- Compact design enables the operation even in tight spaces, extendable “at will”.
- High fill weights possible
- E-chains can be freely assembled
- Peripheral speeds up to 1 m/s
- One layer for rotation movements up to 540°, two layers for up to 900°, higher rotation angle possible with more layers

**Functional principle**

- 125° is the defined rotation angle of the lower layer reached, the next upper module is carried along automatically due to an integrated connection system
- The construction minimises potential interference. The Multi-Rotation Module System is ideal for rotary applications, heavy loads and for harsh environments
- Unlike other systems using sliding contacts, the e-chain can also guide hoses for air, gas or fluids, as well as bus and fibre optic cables

**Circular and spiral movements up to 540° - twisterchain®**

Higher loads and smoother running | igus® 2nd generation of twisterchain® circular e-chains’ significantly improved smoothness, stability and strength. The twisterchain® has a modular construction for width, height and radius. Sturdier with intermediate link - more fill weight possible.

- 25% less weight than existing twisterchain®
- Rotary speeds up to 1 m/s and more, rotary/spiral movements up to 540°
- Highly dynamic and smoother running (with the guide trough Type 01)

**More information and product range | from page 630**

**twisterband - rotary movements in minimum space**

- Compact
- Cost-effective
- Low wear and low maintenance in a confined space
- Energy (in the process), data and media are kept secure.
- Rotary movements up to 7000° (installation position, vertical: up to 3000°, horizontal: 7000° and more possible)
- Rotary speeds up to 3600° possible
- Minimum installation space, fits closely around the rotary axis
- Can be reliably used in various installation positions (horizontal or vertical)
- Compact, modular and lightweight

**More information and product range | from page 650**

**Special solution e-spool - the cable drum without a slip ring**

- Route many different cables in very narrow spaces
- Different media and diameters possible in one drum
- No tensile load of the cables
- Energy supply in all possible directions (horizontal, vertical, diagonal)
- Space-saving, no “e-chain” junction - e-chain® rolled into the home position, access paths remain free
- Cable diameters up to 17 mm
- Cables can be retrospectively added or changed
- Alternative to zig-zag solutions
- Max. deployment and retract speed: 1 m/s

**More information and product range | from page 882**

**Special solution c-chain® - continuously revolving energy supply system made of standardised modular components**

- Energy, data and media in a single module, continuously revolving instead of moving backwards and forwards thanks to C-chain® modules
- No unused return travel
- Compact modular system ready to install
- Energy guide plus BUS cable and pneumatic
- Travel length up to 50 m

**More information and product range | from page 890**

**Distribution rules**

**Cable and hose packages**

**General rules for cables and hoses in igus® e-chains**

The key advantage of an igus® e-chain system is the safe accommodation of various forms of data cables and energy suppliers in one system. We recommend the optimal separation layout of the cables and hoses in the e-chain, but you, the customer, are still afforded the final choice. It is possible, for instance, to maintain minimum distances between bus and motor cables and mix pneumatics, electric and hydraulics in the same compartments. In addition to the quality of the cables used, the arrangement of each conduit within the e-chain and the space allowed, are important for the service life of the system. Various separation options enable the adaptation of the e-chains to the specific requirements of each respective application. In this chapter, we give you detailed recommendations. Due to the variety of the application parameters, we strongly recommend you take advantage of our free consultation services. Simply give us a list of your cable requirements (or merely the required electrical or other services) and you will receive our recommendation by the end of the next business day.

**Maximum cable and hose diameters**

The maximum cable and/or hose diameter corresponds to the inner height of the selected e-chain/e-tube, with additional minimum clearance. This minimum clearance would be, for example, 10% for electrical round cables, 20% for hydraulic hoses. An e-chain is ideal if a minimum lateral gap to the next cable or hose has been factored in. Depending on the nature of the cables, the dynamics, and the expected service life, more clearance must be allowed. In specific cases, clearances may be altered further. Please consult igus.

**e-chain® interior separation**

Cables and hoses with very different diameters should be laid separately. The separation is achieved using modular separators. Cables and hoses must under no circumstances have the opportunity to tangle. Therefore, the clearance height of a compartment with several similar cables or hoses next to one another must not amount to more than one and a half times the cable/hose diameter.

**Orderly cables with igus® interior separation**

**Reasons for distribution rules**

The cables and hoses must be laid so that they can move freely at all times and so that no tensile force is exerted at the radius of the e-chains. For high-speed applications and high cycles, cables or hoses must not be laid on top of each other without horizontal separation. The standard values for this are: Travel speed over 0.5 m/s and cycles over 10,000 p.a. igus® interior separation offers a safe solution for this situation.

**Further guidelines for distribution**

The cable or hose weight should be symmetrically distributed along the width of the e-chain. Cables and hoses with different outer jacket material must not be allowed to stick together. If necessary, they must be laid separately. All igus® chainflex® cables can be combined with each and other brands of cable or hose. The cables and hoses should always be fixed at the moving end. The fixed end should always involve strain relief. Exceptions are made only for certain hydraulic hoses with length compensation issues or other high pressure hoses (i.e. hydraulic hoses). Generally, the faster and more frequently the e-chain operates, the more important the exact positioning of the cables and hoses inside the e-chain becomes. Due to the wide variety of the possibilities, we strongly recommend you take advantage of our free consultation services for your specific applications. igus® tip: Interior Separation configurator [www.igus.eu/quickchain100]

**Distribution rules**

**D1 + D2 > 1,2 x hi**

**Rule 1:**

If D1 + D2 > 1,2 x e-chain’s inner height, no separation between the two cables/hoses is necessary. Two cables/hoses should never be left unguarded on top of one another or be allowed to become tangled.

**D1 + D2 ≤ 1,2 x hi**

**Rule 2:**

If D1 + D2 ≤ 1,2 x e-chain’s inner height, a vertical separator or a horizontal shelf must be used to reduce the inner height, thereby preventing the entanglement of cables. The clearance space “all around” for round electrical cables is e-chain® all-around clearance space in % for various cables/hoses

- Electrical round cables: 10%
- Electrical flat cables: 10%
- Pneumatics: 5-30%
- Hydraulics: 20%
- Media hoses: 15-20%

Please note: don’t fill e-chains® and e-tubes more than 80% of the cross-section.

**Pine principle sketch bending radius “R”**

**Bending radius R**

The bending radius of our e-chain depends on the “thickest” or “stiffest” cable or hose in your application. The bending radii of the e-chains should be adjusted to the recommendations of the cable or hose manufacturer. The selection of a larger radius than the minimum will positively affect service life. The specification of minimum bending radii for cables and hoses refers to use at normal temperatures - other bending radii may be recommended. Please ask your cable or hose supplier for details. We recommend complete e-chain systems, where bending radii for all cables and hoses, interior separation and service life are optimally matched. igus® chainflex® cables permit the smallest bending radius of 4 x d for one million strokes.

**e-chain® with extension links supports a smaller e-chain® with electric cables**

**Application examples and more information online [www.igus.eu]**
### Distribution rules | Cable and hose packages

#### Round electrical cables
For round electrical cables, the round cable is a safe, modular and cost-effective solution for e-chain systems.

We recommend the following criteria for selecting the proper round cables:  
- Small minimum bending radii and mounting heights
- Strain relief integrated directly into the mounting bracket
- Uncomplicated installation process - no hanging, laying out, etc. of cables
- Long service life at minimum bending radius
- Service life expectations for your application (short or long travel, hanging, etc.)
- Test data on service life from realistic tests
- Flexible shields for shielded cables
- Abrasion-resistant and non-adhesive outer jackets
- Large selection to avoid expensive custom designs.

For bus cables and fibre optic cable, special attention must be paid to how effective transmission rates and shielding remain after millions of cycles at the minimum bending radius.

#### Installation and strain relief of round electrical cables
1. The cables must be laid straight, without 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.
2. The cables must be laid so that each individual cable can move freely from side to side.
3. The cables must be able to move freely along the radius. This must be double-checked if the upper run operates at the cable's maximum bending radius.
4. The division of the e-chain's interior using *Igus®* interior separators or shelves is necessary if several cables, and/or hoses with varying diameters are laid out. It is important to prevent cables and hoses from tangling.
5. For cables and hoses with different jacket materials, it is important to prevent them from sticking to one another if necessary. They should be separated. *Igus®* chainflex® cables can be combined with all others.
6. Round electrical cables must be secured with strain relief at both ends. In exceptional cases, the cables can be fixed with strain relief at the moving end of the e-chain only. A gap of 10-30 x cable diameter between the end of the bending segment and the fixed point is recommended for most cables. *Chainflex®* cables can, on the other hand, be secured directly to the mounting bracket with strain relief (this has been confirmed with testing).

We will be pleased to provide you with recommendations for complete e-chain systems: Bending radii of all cables and hoses, interior separation and service life are then optimised.

#### Pneumatic hoses
In principle, the same rules apply for pneumatic hoses as for round cables. In practice, it has been demonstrated that pneumatic hoses are less susceptible to wear. After consultation, they can be laid together more closely than the “10% clearance all-around” rule. A double-sided strain relief is required under these conditions. For pneumatic hoses made of rubber, we recommend strictly following the “10% clearance” rule because they tend to adhere to each other and to other cables and hoses.

#### Flat cables
Flat cables must be able to move freely along the bending radius. Two flat cables next to one another should be kept apart with separators. If two flat cables are laid on top of one another, we strongly recommend the use of horizontal *Igus®* shelving. Flat and round cables should be laid separately in the e-chain. Strain relief should be attached at both ends. Flat cables are only conditionally recommended for use in e-chains.

#### Hydraulic hoses
Hydraulic hoses need more space: 20% all-around clearance.

### Distribution rules | Cable and hose packages

#### Pneumatic hoses

The igus® programme also offers polymer pneumatic hoses called: “chainflex® Air”

#### Flat cables

- Flat cables
- Outer jackets made of rubber must be specified particularly carefully because of potentially high friction

#### Hydraulic hoses

- Hydraulic hoses
- Hydraulic hoses need more space: 20% all-around clearance
Ideally, the cables/hoses should be strain relieved at both ends of the e-chain. At the very least, they must be strain relieved at the moving end of the e-chain.

Strain relief for electrical cables
Strain relief can consist of standard elements or can be custom-made. For most applications, our standard programme of C-profiles with mounting brackets and space-saving chainfix clamps can be used. We also offer simple strain relief solutions using cable tiewraps and tiewrap plates. In ideal cases, the cables should be secured at both ends of the e-chain with strain relief (in a few instances, strain relief at the moving end of the e-chain is sufficient - please consult igus for these cases).

Minimum gap of the strain relief and the beginning of the bending radius
Tests on our premises and in field applications have shown strain relief located at the last bending point of the e-chain has no influence over the durability of igus chainflex cables. It is possible, therefore, to integrate the strain relief with the mounting bracket. This space-saving option for strain relief is offered by igus for almost all e-chains.

Ideal installation of cables in e-chains. chainfix cables can be directly strain-relieved in the mounting bracket (minimum gap to the last rotating e-chain link is not necessary).

Features of chainfix clamps
Optimal igus chainfix housing with reduced height • Long service life for dynamic applications thanks to improved clamping elements • Integration with KMA mounting brackets - saves both time and space during installation and available for complete systems with cables and strain relief • Improved housing foot clamp for easy fit into C-profile • Black housing and setscrews for attractive appearance • Setscrews, tightened with Allen wrench, for easy installation • Mark of the installation direction • Now with better fixation due to optimized design

Tiewrap plates as individual parts
Separate parts in switch cabinet construction or machine assembly • Strain relief accessory for igus e-chainsystems • Attachment to mounting brackets • Integration into the C-profile of KMA (polymer/metal mounting brackets)

Tiewrap plates with clip-on connection for the C-profile
The plates 3050.ZC and 3075.ZC can be clipped directly into the C-profile without bolts or any extra hardware. Clip-on tiewrap plates can be repositioned and reused with just a screwdriver used as a lever. 4 options available: • Tiewrap plates with clip-on connection for the C-profile • Integrated strain relief for E2 e-tubes - Series R • Tiewrap plates for fixed crossbars • Tiewrap plates for opening crossbars

chainfix clip - modular snap-on strain relief device
chainfix clip is a series of clamps and bottom parts made of plastic for cable diameters ranging from 4 mm to 24 mm. Chainfix clip is available for C-profiles, also suitable for assembly in the KMA mounting brackets and clip-on strain relief for cross bars. Quick installation without any tools • 2 and 3 layers on top of one another possible • Each layer can be detached and changed later on • High tensile forces in case of single-layer installation, decreasing with the number of layers

Strain relief separator
• Can be integrated in mounting bracket • Strain relief separator can be positioned as required • Double strain relief possible • Easy installation, cost-effective • For most Series from stock

Strain relief element outside of the e-chain cross section
• Easy strain relief for cables, even in enclosed tubes • Stepped strain relief - good access when retrofitting several cables with strain reliefs • Matching for e-chains and e-tubes • Easy retrofit assembly possible • Simple installation into top-hat rails and C-profile on KMA mounting brackets

chainfix nugget - for top hat rail and C-profile
Option 1: Universal cable fixation, for diameter with Ø 20 mm and Ø 30 mm
Option 2: Fastening through clipping onto standard top hat rail
• The smart helper for electricians in the machine building industry • Accessory for all KMA with integrated C-profile • Strain relief for top hat rail • Easy to assemble, without any screws and tools • Adjustable to every e-chain filling • Very small space requirement • Easy strain relief due to fixation with pre-harnessed cable strap

Application examples and more information online • www.igus.eu
Flammability of igumid G

The flame retardant characteristics of igumid G can be described using various classifications:
- Test procedure VDE 0304 parts 3-5.70 - classification llc. Tested according to UL94 “Standard Tests for Flammability of Plastic Materials for Parts in Devices and Appliances” classification 94 HB for 3.2 and 1.6 mm thickness of the body. Tested according to DIN 4102 ‘Fire Behavior of Building Materials and Parts’ classification materials class B-2. For further requirements, please consult igus® for special solutions, such as materials with self-extinguishing properties (UL94-V0, or UL94-V0). All e-chains® (except for the easy chains® and Series 14) are made of igumid G.

Flammability of igumid NB

All easy e-chains® and Series 14, F17 e-chains® are made from the flame retardant igumid NB material. These e-chains® have the following flame-retardant classifications:
- UL94 classification - V2
- VDE 0304 Parts 3-5.70 classification - llb
- DIN 4102 flammability of materials - B2
- Please consult igus® for material availability of V0

Temperature resistance

Igumid G is very suitable for outdoor applications. In our experience, the mechanical properties of the e-chain® are not impaired. Igumid G is also UV-resistant. Igus® e-chains® are used in applications as cold as -40°C (40°F). Installation may be eventually compromised at temperatures below -25°C (-13°F). In such cases, we offer special solutions made from cold-elastic materials. 120°C (248°F) continuous temperatures are possible. However, the mechanical values are reduced and the service life is impaired.

Resistance to radiation

Igus® offers several solutions for high-radiation areas. Igumid G is very resistant to high-energy radiation. Under gamma radiation, in the range of 8 x 10³ rd, the mechanical properties of igumid G change very little. Please consult igus®.

More on “plastics for longer life®” ➤ www.igus.eu/plasticsforlongerlife

Application examples and more information online ➤ www.igus.eu
100% of the produced ESD e-chains are checked for their continuous conductivity “from one end to the other”.

Your benefits with ESD products:
- ESD material tested with over 10 million cycles for the highest requirements
- Snap-open e-chains with mounting brackets and interior separation in ESD and ATEX design available from stock
- Standardised product: igumid ESD with PTB certificate
- Proven over years of use in explosion-proof areas
- Short delivery times: 8:00 am to 8:00 pm - ordering and delivery service

Conductivity of igus products from igumid ESD
In contrast to temporarily acting applied conductive surface coatings or volatile incorporated antistatic agents, the additives grant a long-lasting and maintenance-free conductivity. An e-chain is not sufficient to ensure sufficient conductivity; if only the individual components exhibit conductivity, but the whole e-chain from one to the other end must have a continuous conductivity. All products in this catalogue are optimised in this regard and the continuous conductivity is measured and documented prior to delivery by a 100% test.

Only e-chains that have passed this test are provided with the test seal and delivered. Colour of igumid ESD products: similar to RAL 7015, slate-grey to secure distinguishability with standard materials. Exceptions: Cover zipper e-chains: 0100 - here black in colour.

Measurements of the electrical surface leakage resistance for igus e-chains with the special material igumid GC were made already in 1992 by the igus GmbH together with the PTB (Physikalisch Technische Bundesanstalt) in Braunschweig, supplemented by additional certifications in 1998 and 1999 according to DIN 53482 and the guidelines for static electricity “2H1/200” of the Federation of Trade Associations. In the course of further innovation, the material igumid ESD was certified by the PTB (Physikalisch Technische Bundesanstalt) in May 2002. The material igumid ESD combines in its properties the requirements of the ESD as well as ATEX criteria. In some mechanical requirements, the igumid ESD surpasses even the standard material igumid and has been tested with over 10 million cycles in the igus technology center.

Connections of igus e-chains,®

More information online: www.igus.eu/esd
Technical environment | **Cleanroom and ESD**

**Safe and clean with e-chains**

Cleanroom qualification of igus® e-chains

In many applications where cumbersome special solutions are used, a simple standard e-chain can be used instead. A comprehensive test programme was devised and performed for both gliding use and unsupported use. For many applications, the e-chains in special materials are practically abrasion-free. Detailed test results are available upon request. IPA tests confirm that standard igus® e-chains meet cleanroom requirements. "Tested and certified as very good" e-chains for cleanroom applications in the test stand. Details on cleanroom environments demand very high wear resistance of moving parts. e-chains, for example, must be very wear resistant, in order to meet normal requirements for such a sensitive environment.

IPA Fraunhofer Institute has tested the following igus® series according to DIN EN ISO 14644-1

<table>
<thead>
<tr>
<th>Class per DIN EN ISO 14644-1</th>
<th>Equivalent to VDI 2083</th>
<th>Classification Series</th>
<th>Report Number</th>
<th>Speed [m/s]</th>
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</tr>
</tbody>
</table>

*Special material "cleanroom"

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**Technical environment | **Dirty environments**

**Splatter, hot chips**

Laboratory tests and numerous field applications have proved that igus® e-chains and e-tubes reliably protect cables in welding robots and machine tools since 20 years. e-chains made from the igus® igumid HT material are resistant against hot chips up to 850°C (1,562°F), no chips stick. This opens new possibilities for replacing more complex and expensive steel tubes. Product range: All standard E2 and E4 e-tube sizes, upon request. Please note: igumid G in direct contact with large amounts of melted aluminium is not recommended.

**Dirt, dust, chips**

Materials and design make igus® e-chains excellent problem-solvers in harsh environments. Experience and application references are available upon request. Please consult igus® with your application.

**Vacuum**

igus® e-chains made of igumid G can be used in vacuum applications. Very little outgassing occurs.

**Chemical resistance**

Igumid G is resistant to fuel, lubricants, oils, fats, alcohol, ester, ketone, and aliphatic and aromatic hydrocarbons. Oxidants and acids are damaging. The table [page 139](#) shows an excerpt of the resistance to chemicals. Acid-resistant e-chains are available upon request.

**Coolant resistance**

e-chains® and e-tubes have proven resistant to cooling agents. However, we are always willing to perform individual tests if you have particular problems or advanced developments. Table on resistance to chemicals [page 139](#)

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**Particle generation measurement**

Result: Particle generation

E14.3.038.0

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**Field strength measurement**

Result: Field strength

E6.29.050.055.0

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More information and certificates for cleanroom products ➤ [www.igus.eu/cleanroom](http://www.igus.eu/cleanroom)

Application examples and more information online ➤ [www.igus.eu](http://www.igus.eu)
Material data igumid

### Material data table

<table>
<thead>
<tr>
<th>Material</th>
<th>Units of measure</th>
<th>Values</th>
<th>Values</th>
<th>Values</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>igumid G</td>
<td>igumid NB</td>
<td>igumid ESD</td>
<td>igumid TE</td>
<td>igumid GE</td>
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<tr>
<td>Mechanical properties</td>
<td>Yield stress (dry/wet) MPa</td>
<td>190/130</td>
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<td></td>
<td>Elongation at break (dry/wet) %</td>
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<td></td>
<td>Elasticity module (tensile test) MPa</td>
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<td>2900/1200</td>
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<td>Limit of elasticity (bending) MPa</td>
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<td>Bending strength MPa</td>
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<td>General properties</td>
<td>Density g/m³</td>
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<td>1,02</td>
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<td>Absorption of humidity 23/50 R % by weight</td>
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<td>3,4</td>
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<td>% by weight</td>
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<td>7,3</td>
<td>1,6</td>
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<td>Electrical properties</td>
<td>Specific transitional resistance Ω cm</td>
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<td>&gt;10¹¹</td>
<td>&gt;10⁹</td>
<td>&gt;10¹¹</td>
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<tr>
<td></td>
<td>Surface resistance ROA Ω</td>
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<td>&gt;10¹¹</td>
<td>&gt;10⁹</td>
<td>&gt;10¹¹</td>
<td>&gt;10¹¹</td>
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<td>Thermal properties</td>
<td>Lower application temperature °C / °F</td>
<td>120°C / 248°F</td>
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<td>80°C / 176°F</td>
<td>70°C / 158°F</td>
<td>120°C / 248°F</td>
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<tr>
<td></td>
<td>Upper long-term application temp. °C / °F</td>
<td>180°C / 356°F</td>
<td>170°C / 338°F</td>
<td>150°C / 302°F</td>
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<td>Fire resistance as per UL94 -</td>
<td>HB</td>
<td>V-2</td>
<td>HB</td>
<td>HB</td>
<td>HB</td>
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<td>Silicone-free –</td>
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<tr>
<td></td>
<td>Colour –</td>
<td>RAL 9004</td>
<td>RAL 9004</td>
<td>RAL 7015</td>
<td>RAL 9004</td>
<td>RAL 9004</td>
</tr>
</tbody>
</table>

*Values upon request

### Colours and special solutions

Product prices are always based on the colour black. e-chains® in any colour shown in the colour selection chart are subject to a percentage based colour surcharge. Any other colours that are not shown in the chart are individually calculated depending on the article and quantity, insofar as this is technically possible. As a rule, coloured e-chains® are not available from stock. Delivery lead-time and surcharges for coloured e-chains® are available upon request. As a rule, all specifications related to stability (for instance unsupported lengths) and material characteristics apply only to black e-chains®. The characteristics of coloured e-chains® may differ! This also applies to all e-chains® from special materials, such as conducting e-chains® made from igumid ESD material or other special materials. For technical reasons HT and ESD materials cannot be supplied in other colours.

### e-chain® colour variations with RAL-numbers

- **Black**
  - Standard, from stock: RAL 9004
  - **White** special colour: RAL 9003

- **Slate grey**
  - ESD material only: RAL 7015
  - **Grey-white** special colour: RAL 9002

- **Grey brown**
  - HT material only: RAL 9013
  - **Orange** special colour: RAL 2003

- **Gray**
  - special colour, e-chains® only: RAL 7023
  - **Yellow** special colour: RAL 1018

- **Dusty grey**
  - special colour, e-tubes only: RAL 7037
  - **Light grey** special colour: RAL 7015

**Black e-chains® available from stock! Delivery time® for special colours: from 5 work days.**

*Delivery time means time until shipping of goods (after technical release)*

### Chemical Resistance of igumid

<table>
<thead>
<tr>
<th>Medium</th>
<th>Concentration Weight %</th>
<th>igumid G</th>
<th>igumid NB</th>
<th>igumid TE</th>
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<tbody>
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<td>Acetone</td>
<td>100</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Formaldehyde (aqueous)</td>
<td>2</td>
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<td>Ammonia (aqueous)</td>
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<td>Gasoline</td>
<td>100</td>
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<td>Benzole</td>
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<td>Butyric acid (aqueous)</td>
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<td>Calcium chloride (aqueous)</td>
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<td>Chlorinated hydrocarbons</td>
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<td>Chlorine water</td>
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<tr>
<td>Diesel oil</td>
<td>100</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Acetic acid</td>
<td>2</td>
<td>+</td>
<td>+</td>
<td>O</td>
</tr>
<tr>
<td>Colour</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Fats, cooking</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Fluorinated hydrocarbons</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Formic acid (aqueous)</td>
<td>30</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Hydraulic oils</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Caustic potash</td>
<td>10</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Potassium carbonate (aqueous)</td>
<td>60</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Potassium sulphate (aqueous)</td>
<td>100</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Methyl acetate</td>
<td>100</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Milk</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Mineral oil</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Sodium carbonate (aqueous)</td>
<td>50</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Oil, cooking</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Oil, lubricating oil</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Oleic acid</td>
<td>100</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Paraffin oil</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Perchlorethylene</td>
<td>100</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Polyester resins (w/styrene)</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Propane gas</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Mercury</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>pH 2</td>
<td>O</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>2</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>10</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Ink, printing ink</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Vaseline</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Tartric acid</td>
<td>–</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Zinc sulfate (aqueous)</td>
<td>10</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

The values specified are values determined by laboratory tests and are material-specific. All specifications apply to black e-chains®.

**Resistance classes**

+ = resistant
O = conditionally resistant
– = non-resistant
Sat. aq. sol. = saturated aqueous solution
igus® is certified in accordance with DIN EN ISO 9001:2008 and ISO/TS 16949:2009 in the field of energy chains® with cables and harnessing, as well as plastic plain bearings.

TÜV construction test
igus® e-chains® and e-tubes are construction-tested by TÜV Rheinland. igus® e-chains® were tested and passed by TÜV Rheinland in accordance with the valid machine guidelines. As a result, the user of igus® e-chains® need not worry about meeting CE requirements through testing for this portion of the machinery. The construction test 2PFK 1036 / 10/97 for protective equipment includes the following: ● Application and safety ● Installation ● Fatigue strength ● Resistance to external influences ● Sharp corners and edges

ESD/ATEX
igus® e-chains® made of standard material igumid G correspond to the German federal office of Physics and Technology (PTB) to classification Ex II 3 GD according to ATEX-RL 94/9/EG. igus® e-chains® made of igumid ESD correspond according to the German federal office of Physics and Technology (PTB) to classification Ex II 2 GD according ATEX-RL 94/9/EG.

IPA Cleanroom
A lot of e-chains® are suitable for the use in cleanrooms according to DIN EN ISO 14644-1. Confirmed by the IPA Fraunhofer Institute.

UL, CSA, CE, CEI, CE and VDE
All igumid-materials for e-chains® and e-tubes have got the UL-material approval. The material igumid NB has got the fire protection class approval IIb according to the test VDE 0304 Part 3/5, 70, the approval V2 according UL94 and the construction material class B2 according DIN 4102.

Interbus, CC-Link and DESINA
chainflex® cables are produced according to a lot of international standards:
Interbus certification: For Interbus certification of certain CF11 bus cables.
CC-Link: CC-Link is a Fieldbus established by Mitsubishi Electric Automation. igus® chainflex® CF.BUS035 is CC Link certified. DESINA: Many chainflex® cables are Desina-compliant.

Clearly quieter
igus® e-chainsystems® are clearly quieter. In the acoustic laboratory of the TÜV and the igus® GmbH different e-chains® were compared (see also noise-optimised e-chains® page 103).

igumid
The material igumid is free from toxins, according 2002/95/EC (RoHS).

IF Design Award
31 IF Design Awards since 1987 ➤ www.igus.eu/IF

More information and certificates online ➤ www.igus.eu
**Readychain® - Ready-to-install assembled e-chainsystems®**

Assembled energy supply systems, connectors and cables from igus®... everything from one source... directly from the manufacturer... quick delivery to your machine.

- **Customer-related production**
- **From one off to mass production**

---

**You decide the degree of harnessing**

*Any degree of harnessing is possible*

We harness from simple e-chainsystems® with inserted chainflex® cables to complex systems. These systems may include all cables and hoses (pneumatic, hydraulic), patch plugs, inner partitions, connecting elements and connecting parts as requested.

---

**You decide the size**

*Any size is possible*

Up-to-date production processes, custom-build or serial production. Fast and cost-effective delivery.

- **From batch size 1**
- **to serial production**

---

**You decide the travel**

*Choosing the travel*

readychain® offers the whole spectrum of possible travels of the igus® e-chains. We harness anything from extremely short to long travels. Safe transportation guarantees damage-free delivery of all lengths.

- **From short**
- **to long travel**

---

**Standardised readychain®-packages**

- **readychain® “basic”**
- **readychain® “standard”**
- **readychain® “project”**

---

**readychain® - You decide, igus® delivers**

**You decide the size**

Any size is possible

Up-to-date production processes, custom-build or serial production. Fast and cost-effective delivery.

- From batch size 1
- to serial production

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**Standardised readychain®-packages**

- readychain® “basic”
- readychain® “standard”
- readychain® “project”

---

More application-examples and information online: www.igus.eu/readychain

igus® GmbH Germany | Phone +49 2203 9649-800 | Fax -222 | info@igus.de | www.igus.eu
500 orders/week, over 3,000 m² floor space, “chain-cable-guarantee” since 1989...
3 shifts, 13 project engineers, 127 employees just for assembling

Everything from one source
The readychain® system includes pre-assembled, customised e-chainsystems®. The “plug in and ready” solutions are configured, manufactured and delivered according to individual customer specifications. The use of the mounting rack can yield benefits even at low volumes.

Flexible components
The telescoping supports and braces of the readychain® rack allow flexible adaptation to the installation needs on site. Changes in mass production can be easily undertaken. By using modular parts, additional components can also be easily attached to the rack.

Sustainable use
The components of the readychain® rack are galvanised and thus designed for a long life. Each rack is constructed within a few hours. The individual elements can be reused at any time removing the need to dispose of custom made parts, such as conventional welded transport racks.

Precise fitting “Plug & Play”
All interfaces and attachments are designed in such a way that the installation of the e-chain® can be managed quickly and easily. The complete package includes the matching plugs and connectors, plates, sensor actuator boxes, linear bearings, links to the central lubrication, etc., all reducing the installation time considerably.
**igus® Connectors**

- Round plug connector kit
- D-sub service kit
- Tools and accessories

**igus® readychain®**

- Drive systems: 2,830 cables
- Catalogue standards: Video-/vision-/bus technology
- Catalogue standards: Network/ethernet/FOC/Field bus
- Catalogue standards: CF/INI initiator cables up to 4 x d

**igus® hoses and attachments**

- Configurable online with hose cable configurator...
- "To meet your needs"

---

**readychain® | Configured, fitted, with system guarantee**

1. System acceptance
   - Project phase
   - Initial acceptance of prototype
   - igus® installation

   **readychain® service**
   - We visit you
   - Define interface
   - Logistics planning
   - Cycle integration
   - Time schedule

   **readychain® service**
   - Component selection
   - Interface optimizations
   - Documentation
   - Integrated project management
   - Cost optimization

   **readychain® Skype service®**
   - Initial acceptance from your workplace
   - Build your prototype with an igus® project engineer, live in your meeting
   - Your requests for changes explained with a model
   - ... or visit us for acceptance in production

   *only available in Germany

   **readychain® installation**
   - System installation by igus® specialists
   - igus® supervision service for own installation
   - Transparent, fixed price

---

More application-examples and information online ➤ www.igus.eu/readychain
Capacity for 600,000 assembled cables a year... more than 18,000 test programmes... 1,800 test adapters

Process reliability ... crimp force monitored ... automated ... time-optimised ...

Computer-based high-voltage testing and inspection of all assembled cables

Modern machinery - automatic stripper-crimper

Special cable assemblies

Global Warranty Certificate

Worldwide system guarantee

90,000 e-chain® components

3 million meter of cables on stock

3,500 connector components

Hundreds of meters of guide troughs

1,750 m² test lab - more than 8,000 tests every year

Quickly within reach

Numerous strain relief solutions

More than 8,000 cables per week

Just in time supply

More application-examples and information online > www.igus.eu/readychain

igus® GmbH Germany | Phone +49 2203 9649-800 Fax -222 | info@igus.de | www.igus.eu
readyable® M - injection-molded connectors

As individual as your project - injection-molded connectors from igus

- Various sizes: M8, M12, M23, M40, USB 3.0 etc.
- Sizes M23-M40 with SpeedTec® quickrelease fastener
- Angled versions
- According to UL/CSA standard
- Individual customer logo possible
- ESD material for ATEX-areas
- Tamper-proof
- Tight according to IP66/67 already before the molding process
- 360° shielded
- Space and weight saving

readyable® M - harnessed cables in 24-48h or today

Allen Bradley
B&R
Baumüller
Beckhoff
Berger Lahr
Control Techniques
Danaher Motion
ELAU
Fagor
Fanuc
Heidenhain
Jetter
LTI DRIVES
Lenze
NUM
Omron
Rexroth
SEW
Siemens
Stöber

- Igus® offers more than 2,800 harnessed cables for drive systems according to 20 different manufacturers
- Servo, Power and Signal/encoder cables
- No cutting costs, no minimum order quantity, no costs for packaging
- Cable length according to customer requirements
- Smallest bending radius from 7.5 x d
- Reduce storage cost and increase cashflow
- Available in 24h or today

Electrical cables with connectors according to your needs with QuickPin 2.0

QuickPin 2.0
Connector-cable configurator integrated directly in EPLAN P8.

More application-examples and information online: www.igus.eu/readychain
igus® installation service including guarantee

Improve technology and reduce costs. Complete system from igus®.

Installation service | Save time and money

Save time and money - installation and maintenance of your e-chainsystem®

New installation
- Installation of a tailored e-chainsystem on-site at your facility or your new plant
- Documentation and planning of the project at your construction site
- Configuration of the system interfaces and consulting by igus® engineering
- Fast and error-free installation on your machine
- Everything from a single source - including customised system guarantee

Conversion / Modernisation / Retrofit
- Modernisation and implementation concept for the conversion of existing energy supply systems to e-chainsystems®
- To expand the capability
- Reduction of costs and energy consumption
- Increased service life
- Increased plant reliability and availability

Inspection
- Assessment of the technical condition of your energy supply system
- Determination of the repair and maintenance requirements
- Reporting of deficiencies, risks, and optimisation proposals
- Documentation of the plant condition in the inspection report

Maintenance
- Preventive maintenance of more complex e-chainsystems® proactively recognise and address any damage or issues, therefore extending the service life of your system
- Adjustments on e-chains®, cables and strain reliefs
- Measurement, assessment, and documentation in the maintenance handbook

Repair / Service
- Prompt, flexible, and professional exchange and service on e-chainsystems® and their components

More information online | www.igus.eu/installations
Installation service | Save time and money

From a single source - components, service, and reliability

Your reliable plant
"Improving technology and reducing costs"

System guarantee
up to 36 months
(depending on application)

Supervisor Service
New installation
Installation support

igus® installation service

Inspection Maintenance
Repair Service
Modernisation Retrofit

igus® e-chains®
igus® chainflex® cables
igus® harnessed system

Tested: igus® lab, Cologne

Development and production: igus® GmbH, Cologne

Installation service | Save time and money

Prompt, error-free installation by specialised engineers
Cuts down on installation time and costs, increases service life, avoids accidents.

Predictable fixed prices for installation and maintenance
Cuts down on your admin effort for planning and purchasing.

Predictable installation schedule for your system on your plant
Helps you with your scheduling and contributes toward plant availability.

Quick response with our certified partners in your area
Keeps travel and response times short and cuts down on costs.

Short-notice, flexible installation appointments even on weekends or nights
When you need immediate support or when the scheduled appointment is delayed. Simply give us a call, we will find a solution.

Everything from a single source from the manufacturer - including customised system guarantee!
We will be at your side! Ranging from the initial review to the system configuration, the delivery, and including the on-site installation of the system on your plant. You can refocus on your core business.

More information online | www.igus.eu/installations

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