

Cleanroom

igus® solutions for cleanrooms



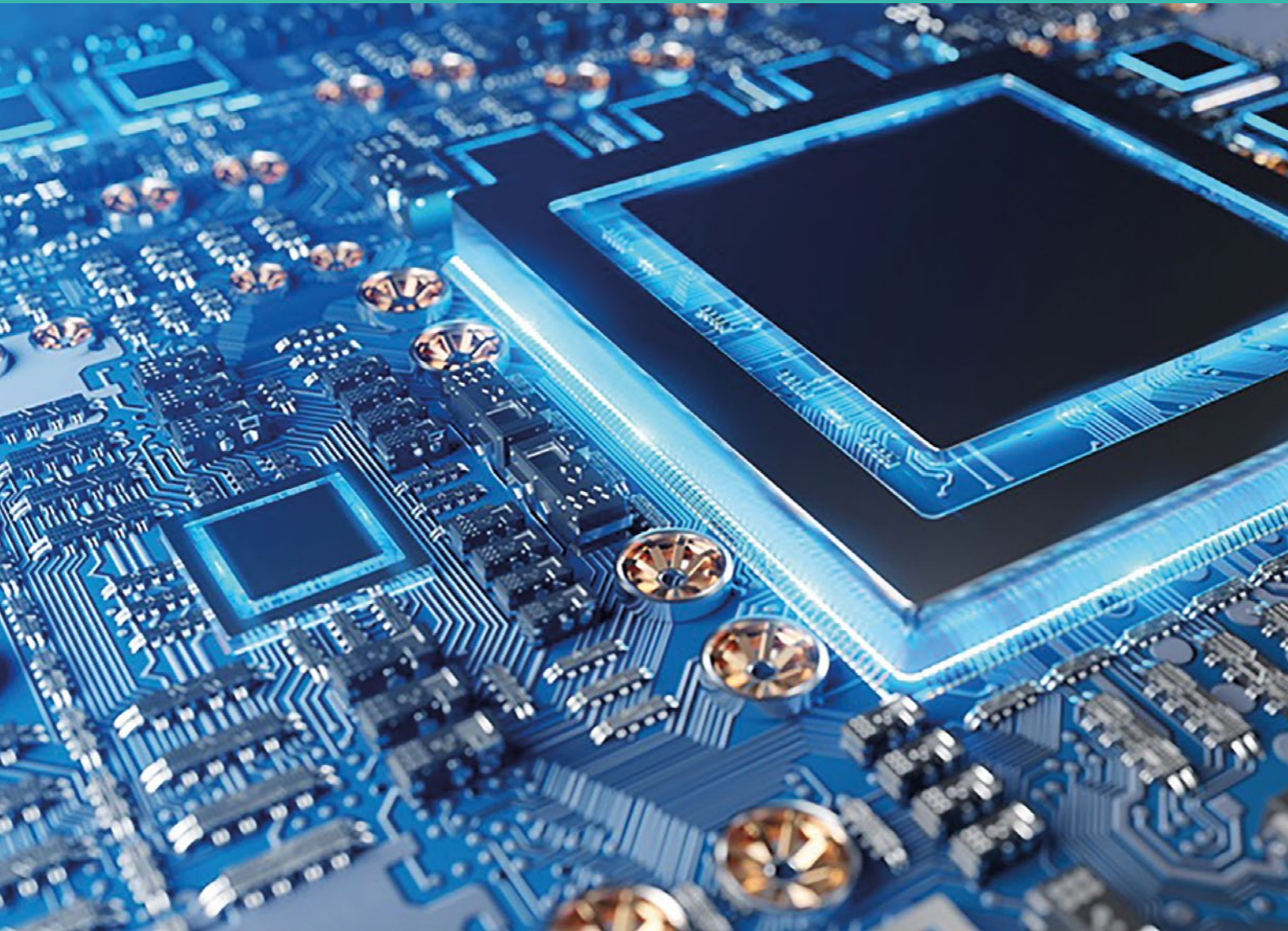
 **Fraunhofer**
TESTED®
DEVICE
igus GmbH
EG-22160-100.0
Report No. IG 2303-1408

igus®

motion plastics®

... Tech up, cost down. It's our job!

0.1µm = 0.0001mm



motion plastics® in
the #cleanroom

igus.eu/cleanroom

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"The market demands openable energy supply solutions for cleanrooms."

Peter Mattonet
Product & Industry Manager
Mikroelectronics

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igus® facts at a glance

\$37.9 billion

Cost of production plants and production equipment 2018¹⁾

For more than **25 years**, electrical cores have been used in the industry ...⁵⁾

Expensive

High maintenance cost and effort

Cable usually not available from stock

! Problem: if a single core breaks, the entire system has to be replaced

Customer-specific manufacture means long waiting times

Requirements in one cubic metre of ambient air: no more than ten particles ...
Maximum particle size

0.1 µm
or 0.0001mm²⁾

80% productivity target in semiconductor manufacturing³⁾

\$50 billion ... in Europe⁴⁾

Semiconductor sales 2022 ...
\$372 billion
... in Asia⁴⁾

\$83 billion ... in the US⁴⁾

Growth of the global chip market to
\$575 billion
2022⁴⁾

1) <https://evertiq.de/news/26283>
2) igus® GmbH
<https://blog.igus.eu/a-boost-to-your-overall-equipment-effectiveness-oeef/>
3) igus® customer testimonial
4) PwC research
<https://www.pwc.de/de/technologie-medien-und-telekommunikation/studie-gute-aussichten-fuer-den-globalen-halbleitermarkt.html>
5) igus® GmbH



With igus® clean plastics clean for cleanrooms

In robots or pick-and-place applications, in semiconductor manufacturing and microelectronics, igus® offers components for any cleanroom that bring Tech Up and Cost Down.

In cleanrooms, moving component abrasion must be especially low, as any contamination is harmful to products and processes. This costs money. We

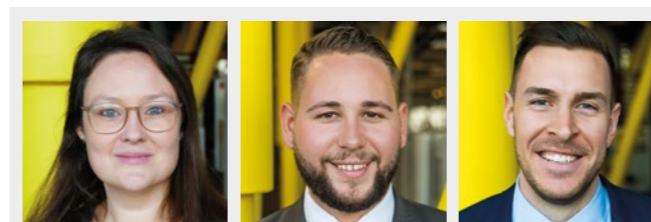
develop and test our high-performance polymer products in our own cleanroom laboratory with the greatest care, and in order to show that our products are ideal for use in cleanrooms, we have the Fraunhofer Institute subject them to further tests. This gives us an IPA-tested product portfolio with the best possible cleanroom classification (ISO Class 1).



The improved corrugated hose for cleanroom applications received the 2nd prize in the 2018 Fraunhofer clean technology award.
<https://www.ipa.fraunhofer.de/en.html>



2021 "Reiner!" award for pioneering developments in clean technology. The IPA Fraunhofer Institute awards this prize for outstanding innovations in clean technology.
<https://www.ipa.fraunhofer.de/en.html>



Kira Weller

Product Manager e-chains®

Peter Mattonet

Product & Industry Manager Microelectronics

Bastian Lenz

Key Account Microelectronics

Cleanroom classes according to DIN EN ISO 14644-1



Six-part e-chains®
Corrugated tube e-skin®
▶ Page 37

e-skin® flat
e-chain® E3
▶ Page 29 ▶ Page 45

T3 e-chain®
▶ Page 47

e-chain® E2/000 series 1500
▶ Page 55

E14 e-chain®
▶ Page 55

iglidur® PRT
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e-chain® E2/000
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E4.32 e-chain®
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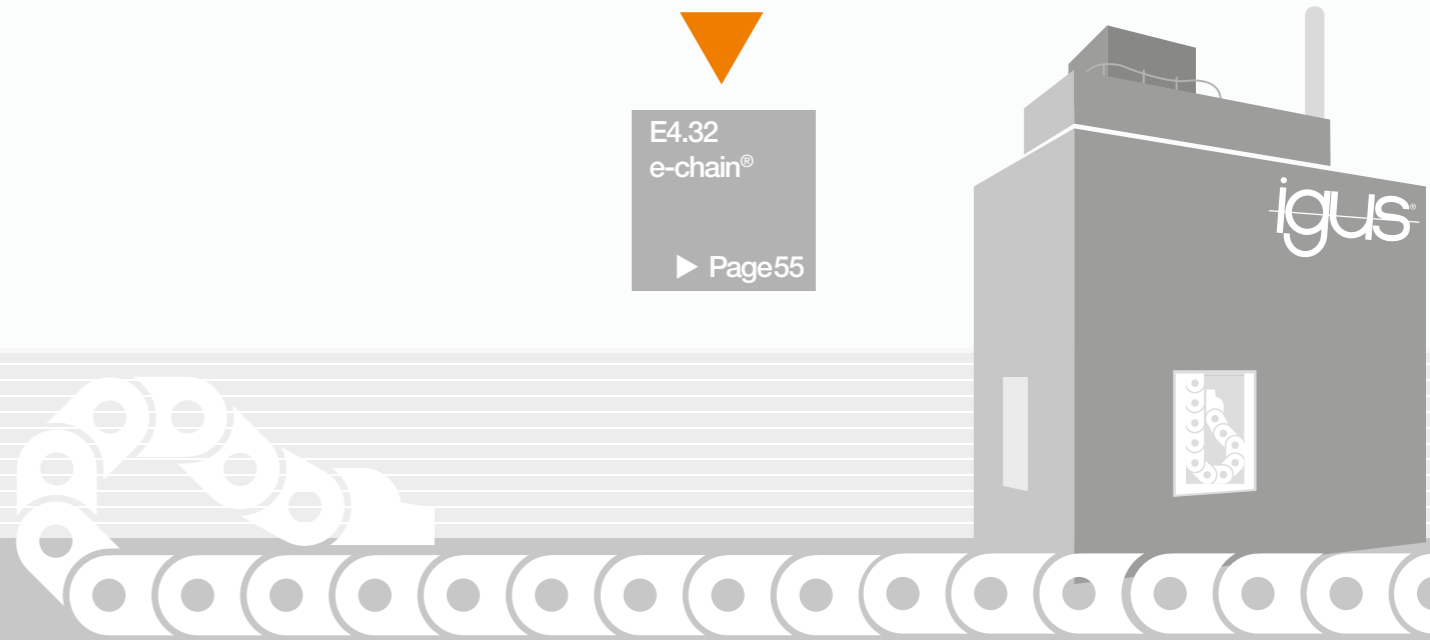


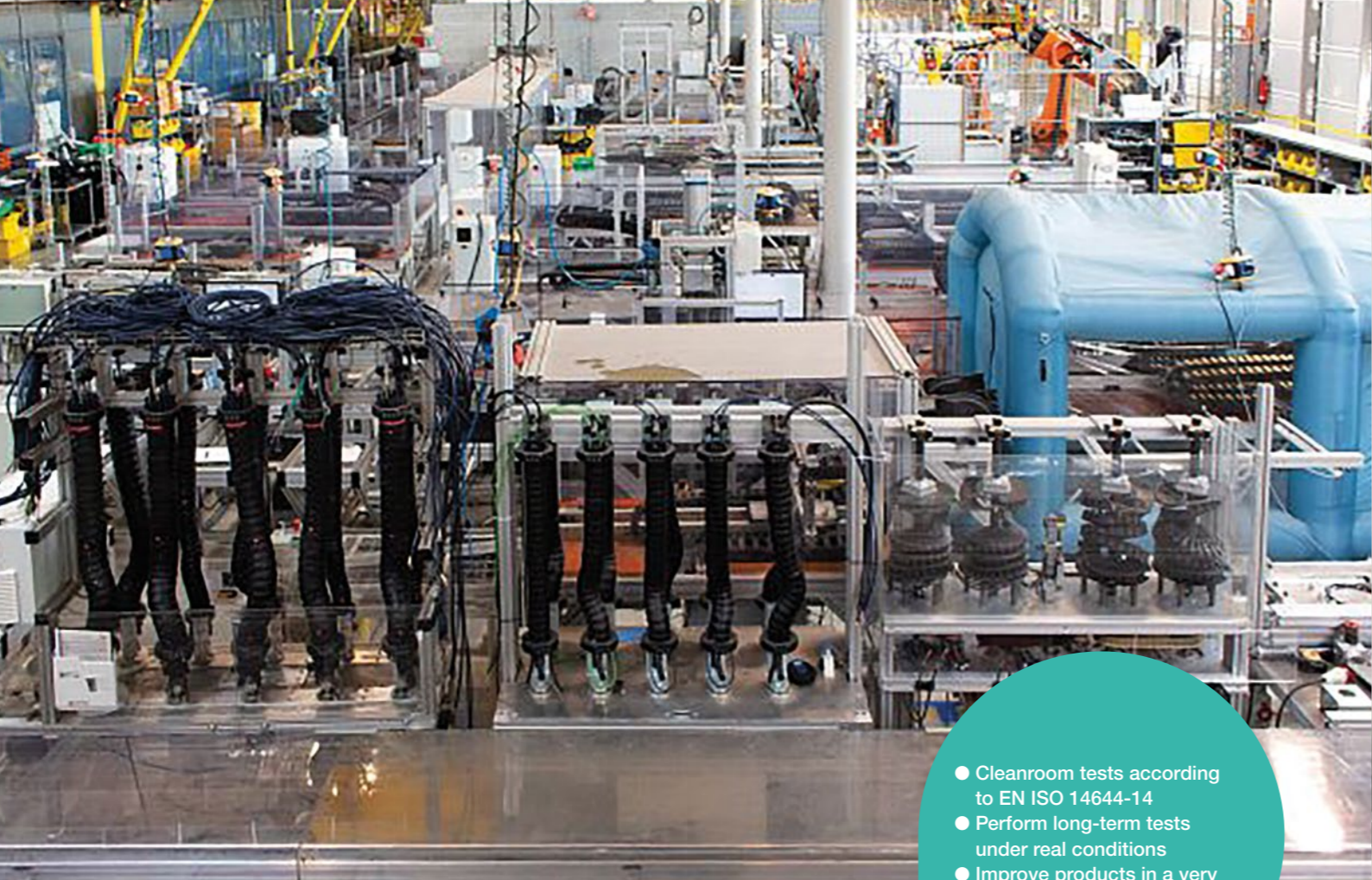
How big is a micron?

Human hair
0.0998mm

Pollen
0.04mm

Micron
0.001mm





- Cleanroom tests according to EN ISO 14644-14
- Perform long-term tests under real conditions
- Improve products in a very short time
- Implement customer-specific assemblies

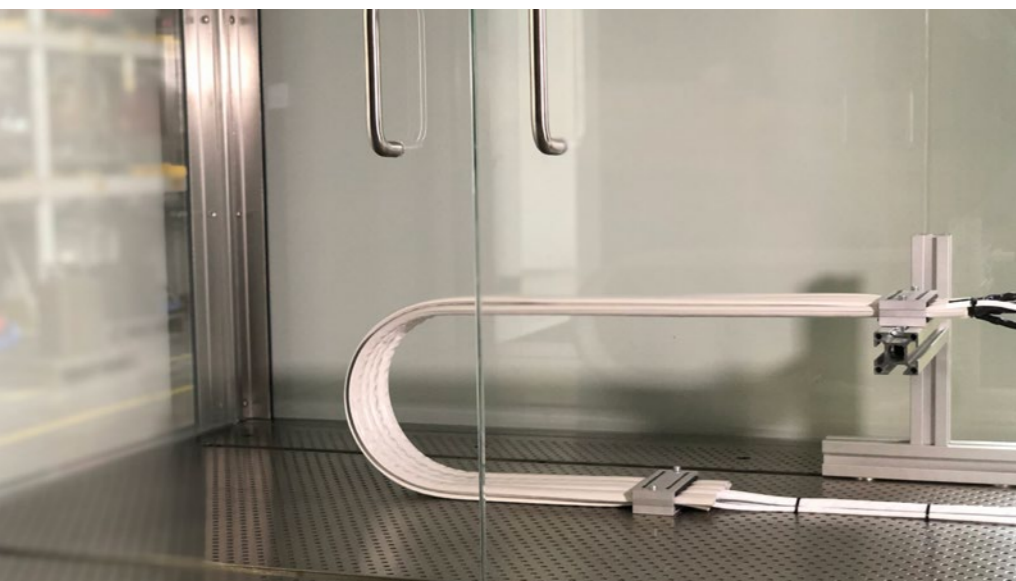
Laboratory and development

Clean plastics testing

igus® is among the leading manufacturers of energy chains for cleanroom technology and has been having its products successfully tested since 1997. To develop new cleanroom-compatible motion plastics faster, Fraunhofer IPA, working as a development and certification partner on behalf of igus®,

has designed and built a customised cleanroom laboratory with an ISO Cleanroom Class 1 system in Cologne. Customer tests can be performed and new igus® developments tested in advance under real-world conditions in a very short time in the new laboratory.

igus.eu/cleanroom-lab



... in manufacture

igus® cleanroom facility in Korea ... packaging products in a cleanroom

For semiconductor producers such as Samsung and SK Hynix, even particles as small as 0.0001mm are a business risk. This is why they are placing ever stricter requirements on suppliers of cleanroom-compliant machine components. In Korea, we are responding by building a cleanroom to assemble and package our energy supply systems.

Suppliers like igus® must also take care not to contaminate cleanroom products during assembly and shipping. This is because more and more customers want to be able to use the components without having to clean them first. In order to assemble and package cleanroom products so that they are as sterile as possible, we commissioned a cleanroom in Korea. A filter system

creates constant negative pressure in its interior and replaces the air 450 times per hour. In order to keep contamination as low as possible, employees wear protective clothing.

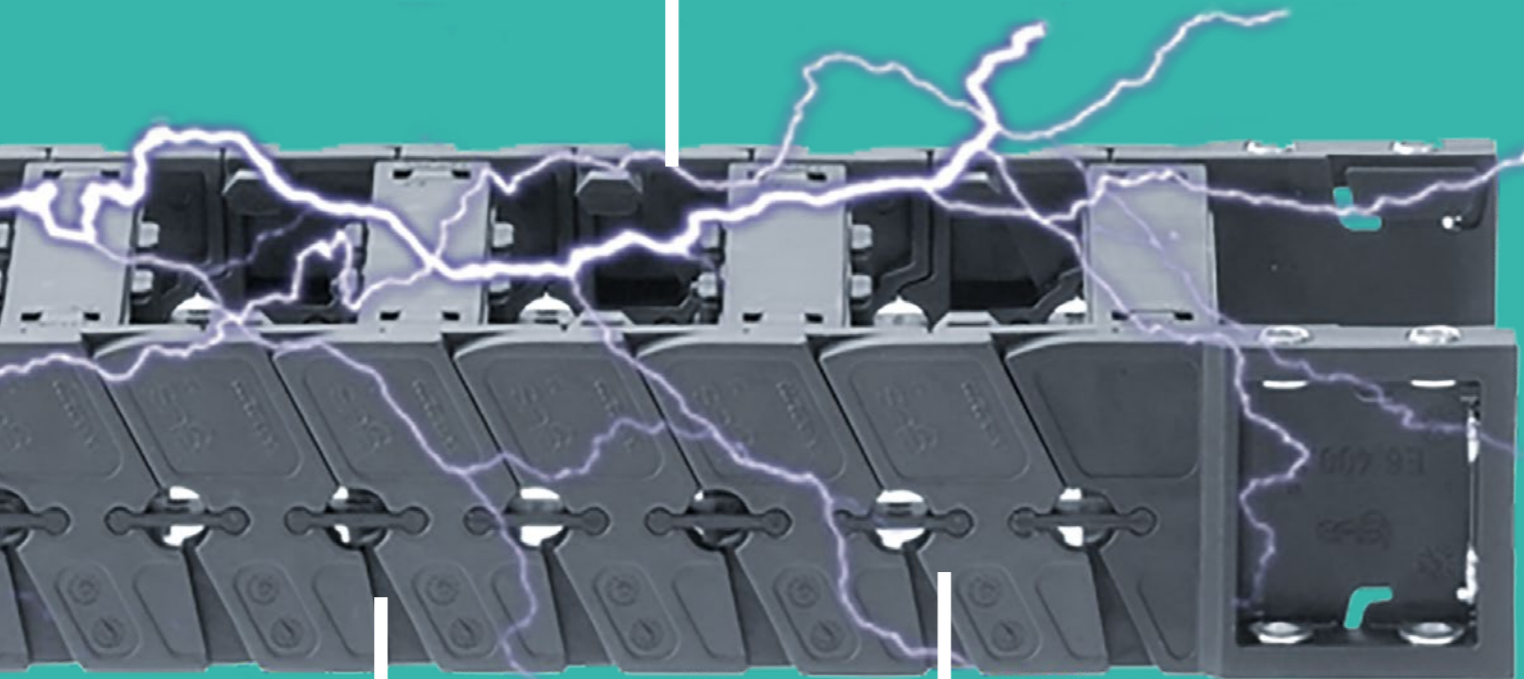
The concept of assembling and packaging products in the cleanroom can be found at other igus® locations as well, such as the headquarters in Cologne, Germany, where another cleanroom is being built. Fully harnessed systems will be manufactured and can be shipped to the customer sealed in film.



For ESD-sensitive cleanroom parts ...



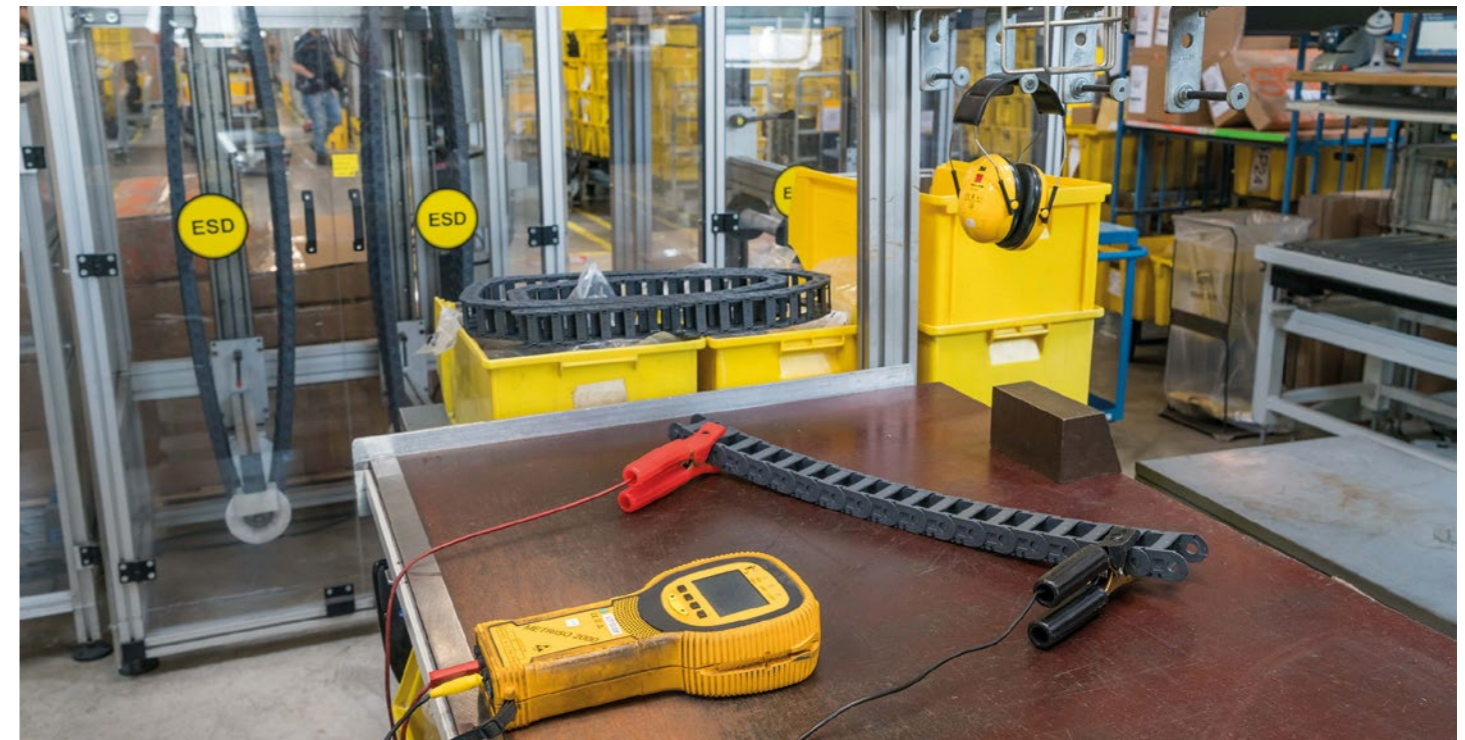
Electrostatically dissipative thanks to side links made of conductive material



For highly dynamic applications with extremely low vibration

Long service life with modular crossbar system

Revolutionises your overall effectiveness
ESD with igus® e-chains®



100% of the produced igus® ESD e-chains® are checked for their continuous conductivity from one end to the other

The need to prevent static buildup in moving applications has been increasing in modern production equipment. Measurements of the electrical surface leakage resistance for igus® e-chains® made from the special igumid® GC material were made 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 ZH1/200 of the Federation of Trade Associations. igus® recommends using the igumid® ESD material to discharge such electrostatic energy in the production of sensitive electrical components. igumid® ESD has been fully tested for over 10 million cycles in the igus® test laboratory.

- ESD material tested in over ten million cycles for the most extreme requirements
- Openable e-chains® with mounting brackets and interior separation in ESD and ATEX design, available from stock
- Proven through years of use in explosion-proof areas
- Short delivery times

igus.eu/esd

Conductivity of igus® products made of igumid® ESD

In contrast to temporary conductive surface coatings or volatile incorporated anti-static agents, the additives used offer long lasting and maintenance-free conductivity. If individual e-chain components offer conductivity, this is not sufficient: the whole e-chain® from one end to the other must

have continuous conductivity. All igus® products made from igumid® are optimised in this regard and the continuous conductivity is measured and documented prior to delivery with 100% testing. Only e-chains® that have passed this test are provided with the test seal and delivered.

Colour* of igumid® ESD products: similar to RAL7015, slate-grey to ensure distinguishability from standard materials.

(*Exception: cover zipper and triflex® R - here black in colour)

For dry rooms and cleanrooms

NEW

A series usable for all areas: cleanroom, dry cleanroom, and standard environments

Certification (the first of its kind) by Fraunhofer IPA for dry cleanroom, ISO 4

Important contribution to e-mobility

The first e-chain® for IPA ISO Class 4 dry cleanrooms

The proven E6.29 series made of standard material is now certified by Fraunhofer IPA for use in dry cleanrooms for ISO Cleanroom Class 4. The E6.29 was tested in a dry cleanroom with a dew point of -40°C (corresponding

to a relative humidity of < 1%) of ISO Cleanroom Class 3 with three different parameter sets ($v=0.5\text{m/s}$, $a=1\text{m/s}^2$; $v=1\text{m/s}$, $a=2\text{m/s}^2$ and $v=2\text{m/s}$, $a=4\text{m/s}^2$) and has achieved the best possible result (ISO 4). Standard catalogue parts with seven interior heights and various widths and radii available directly from stock.



Battery production for the mobility of tomorrow

The first certified energy chain for dry cleanrooms

The days of the combustion engine seem to be numbered because the car of the future will be electric. The battery system is essential for electric mobility. So lithium-ion batteries are a key technology of our time, one that has been greatly refined in recent years. To guarantee error-free production and thus long battery life, the production process must be continuously optimised. Battery production systems require special environmental conditions achieved by combining dry rooms and cleanrooms. System automation and the increasing number of plants has also increased the need for reliable cable guidance that meets these high requirements.

So the Fraunhofer Institute for Manufacturing Engineering and Automation IPA has teamed up with the Cellforce Group to develop a mobile dry cleanroom "tent". Classic stationary cleanrooms are a suboptimal solution for some applications due to the long planning and implementation times, large space requirement, and the longterm occupancy of valuable production areas. The new DryClean-CAPE®, a more flexible and cost-effective alternative, creates an environment that is not only high-purity, but also low-humidity. The

tent-like cleanroom system consists of two different covers, resulting in dryness combined with freedom from particles due to separate, independent air treatment units. This unique combination offers an ideal, flexible production environment, and environment plays a decisive role in product quality, especially in battery cell and automobile production. That is why the IPA has now also developed a new type of certificate to document the ISO cleanroom classification under dry room conditions. The igus® E6 e-chain® series is the very first cable guidance system to be certified by the IPA under dry room conditions. The result: ISO class 4. This makes igus® one of the pioneers in this area. The e-chain® was tested in a dry cleanroom with a dew point of -40°C, which corresponds to a relative humidity of <1% at room temperature of 22°C. The energy chain, which has been proven for many years, is now also suitable for safe use in dry room applications. At the same time, the E6 crossbars are being subjected to an endurance test in a dry room in the in-house igus® test laboratory. They have already undergone 10 million double strokes – and the tests are still going.

The durable e-chain® made of high-performance plastics optimised for friction and wear is available directly from stock as a standard catalogue part with various inner heights, widths, and radii.



E6.29

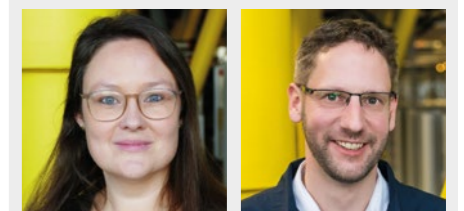
Crossbars removable along the inner and outer radius

Inner height	29mm
Inner width	30 - 140mm



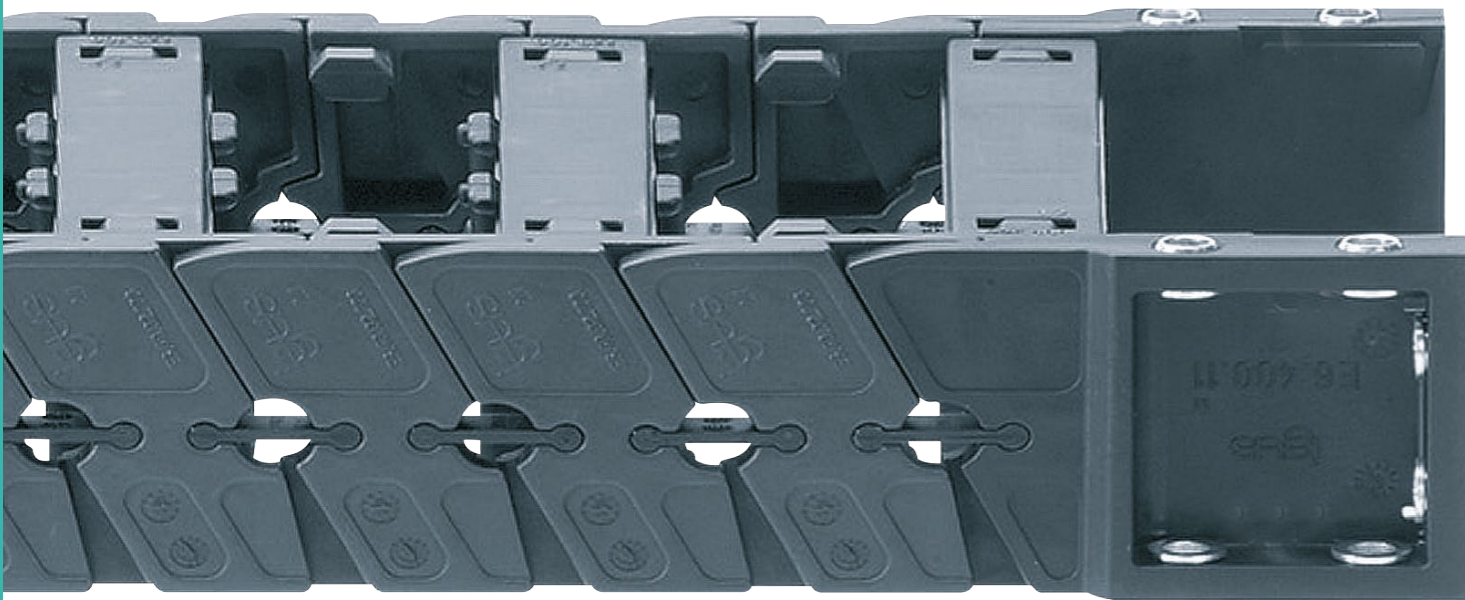
DryClean-CAPE® for dry-room testing

Source: Fraunhofer Institute for Manufacturing Engineering and Automation IPA



Kira Weller, e-chain® product manager (left) and Dominik Barten, development engineer (right) explain the meaning of the new certificate.

Very quiet, abrasion-resistant

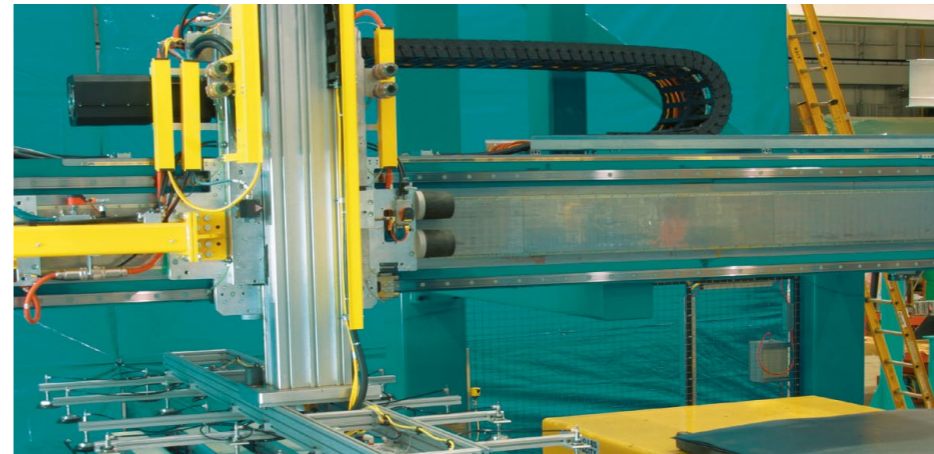


Extremely quiet, low-vibration operation

The E6 series offers numerous advantages in addition to long life. It provides extremely quiet, low vibration operation, complementing low vibration linear drives. It minimises the polygon effect which can occur during the rolling motion of an e-chain®. The ultra-low noise levels have been confirmed in a recent report by the Rheinland Technical Inspection Agency. Our extensive product range offers the right e-chain® size for any application; a wide range of interior separation is also available.

- ▲ Dry-room-compatible energy supply system with a long service life (tested in the igus® laboratory under dry room conditions)
- ▼ A series usable for all areas: cleanroom, dry cleanroom, and standard environments
- Certification (the first of its kind) by Fraunhofer IPA for dry cleanroom, ISO 4
- Important contribution to e-mobility (battery production, see page 12)
- Optional push-pull monitoring

For highly dynamic applications in cleanrooms



A linear drive provides the highly dynamic feed for PCBs. This system is twice as fast as handling units with a toothed-belt drive; designed to withstand high dynamic loads, E6 e-chains® ensure a supply of power, coolant and control data with ultra-low noise and vibration

Benefits

- Undercut design for high lateral stability
- High push/pull strength for long travels and unsupported lengths
- Well-suited for side-mounted applications
- Noise-reducing "brake" and noise dampers (optional)
- Inner and outer links for quick assembly, with or without pretension

Typical application areas

- Cranes, including indoor cranes
- Composting plants, sewage treatment plants
- Machine tools, general mechanical engineering



Attachment from any side: with KMA mounting brackets

Quiet from 37dB(A): small pitch for quiet, smooth running

Long service life: low vibration, high strength

Dynamic: high speeds and accelerations

Quick assembly: openable along the inner and outer radius

Modular design: can be easily lengthened and shortened

High strength: for unsupported applications

Cleanroom qualification of E6 e-chains®

By using a special material, the already low abrasion behaviour of the e-chain® can be reduced even further. In many applications where cumbersome special solutions are required, a simple standard e-chain® can be used instead. IPA tests confirm that standard igus® e-chains® meet cleanroom

requirements. "Tested and certified as very good!" e-chains® for cleanroom applications demand very high wear resistance of moving parts. e-chains®, for example, must be wear-resistant, in order to meet the normal requirements for such a sensitive environment.

High speed cleanrooms



Schmid Technology Systems, Marijan Strugar, Niedereschach, Germany

An igus® e-chain® from the E6 range accelerates work processes in this wafer-handling application in chip production. The E6 easily supplies energy at acceleration rates of up to 4m/s² and speeds of up to

6m/s. Its low abrasion is very important because purity is critical in chip production. The E6 is cleanroom-compatible and has Fraunhofer IPA certification.

Smooth-running energy chains for camera robots in the Tagesschau news studio



The cable guides have to work around the clock and at the same time be maintenance-free and quiet.

Since April 2014, all ARD-aktuell programs have been produced in a new television studio that is equipped with state-of-the-art technology. A highlight are three camera robots suspended under the ceiling that implement camera shots with smooth movements and the highest precision. Smooth running, low vibration and wear resistance are the main requirements for the plastic energy

chains for guiding the extensive cable packages. Consulting skills also played an extremely important role in the project.

Profile

- **What was needed:** E6 energy chains, chainflex® control cables, guide trough
- **Requirements:** Quiet operation; no maintenance; long service life; smooth, fluid movements
- **Industry:** Film and camera technology

● Success for the customer:

The E6 e-chain® achieves a long running performance that can be calculated in advance. Abrasion-resistant connectors and a small pitch ensure extremely quiet, low-vibration operation. A special solution was developed for the longest travels. The solution featured a custom-made moving end, special support rollers, rubber-coated plastic rollers, or special suspensions for the guide trough.

E6 e-chain system®




E6.40 e-chain®
Crossbars removable along the inner and outer radius - standard

Inner height	40mm
Inner width	40 - 300mm



E6.80L e-chain®
Crossbars removable along the inner and outer radius - standard

Inner height	80mm
Inner width	87 - 550mm



R6.29 e-tube
Fully enclosed – lids removable along the inner and outer radii

Inner height	28mm
Inner width	30 - 120mm



E6.29 e-chain®
Crossbars removable along the inner and outer radius - standard

Inner height	29mm
Inner width	30 - 140mm




E6.52 e-chain®
Crossbars removable along the inner and outer radius - standard

Inner height	52mm
Inner width	40 - 300mm



E6.80 e-chain®
Crossbars removable along the inner and outer radius - standard

Inner height	80mm
Inner width	50 - 600mm



R6.40 e-tube
Fully enclosed – lids removable along the inner and outer radii

Inner height	40mm
Inner width	62mm



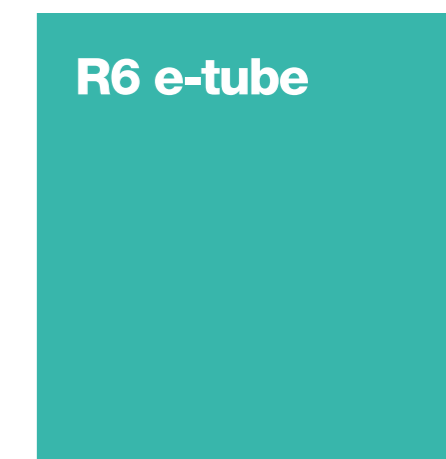
E6.35 e-chain®
Crossbars removable along the inner and outer radius - standard

Inner height	35mm
Inner width	30 - 140mm



E6.62 e-chain®
Crossbars removable along the inner and outer radius - standard

Inner height	62mm
Inner width	50 - 400mm

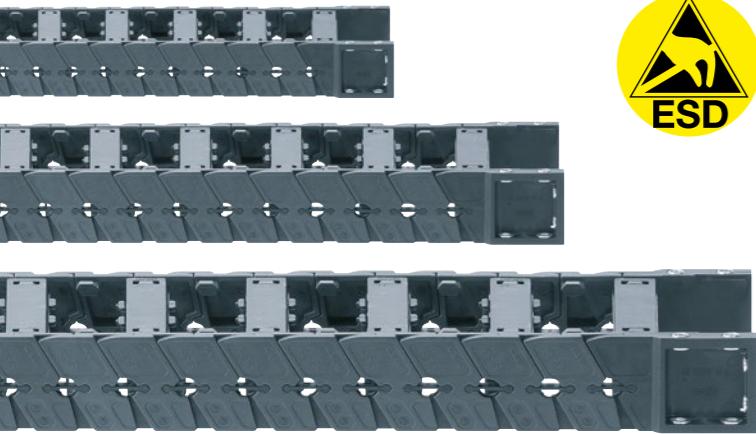



R6.52 e-tube
Fully enclosed – lids removable along the inner and outer radii

Inner height	52mm
Inner width	50 - 200mm

E6 series with inner heights of 29, 40, and 52mm

Three series now available from stock with ESD certificate



Three new E6 series (a total of 88 parts) with inner heights of 29, 40, and 52mm are now available from stock as electrically conductive ESD variants and can be configured online. They can be used to reliably avoid static charges in the area of manufacturing processes for electronic components or assemblies.

- ▲ Avoid ESD faults due to static electricity
- ▼ Catalogue product - no individual set-up costs
- E6.ESD meets the requirements for ESD-protected areas (EPA) according to IEC 61340-5-1 and DIN EN 61340-5-1
- Series production uses fewer resources than individual order-specific production
- 🔗 Optional push-pull monitoring

e-chain system® E6.ESD

E6.40.ESD
Openable along inner and outer radius

Inner width	40 - 125mm
Bend radius	63 - 150mm

E6.29.ESD
Openable along inner and outer radius

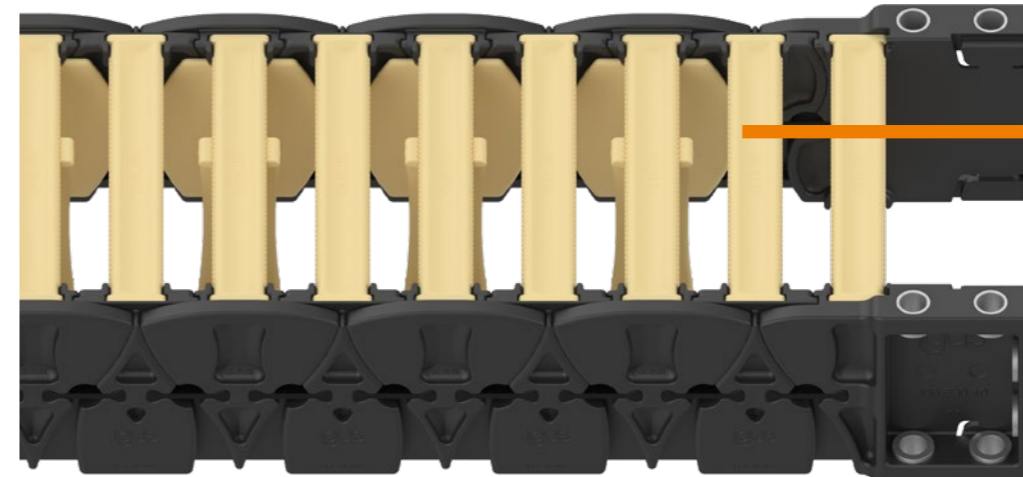
Inner width	30 - 100mm
Bend radius	55 - 150mm

E6.52.ESD
Openable along inner and outer radius

Inner width	40 - 125mm
Bend radius	75 - 150mm

Custom solutions with iglidur® J

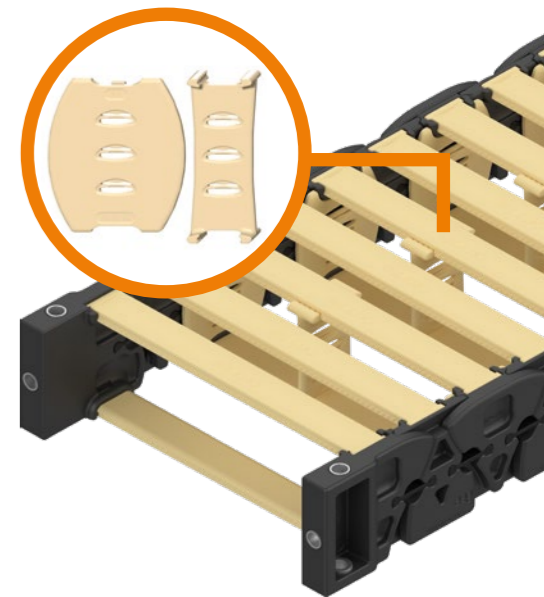
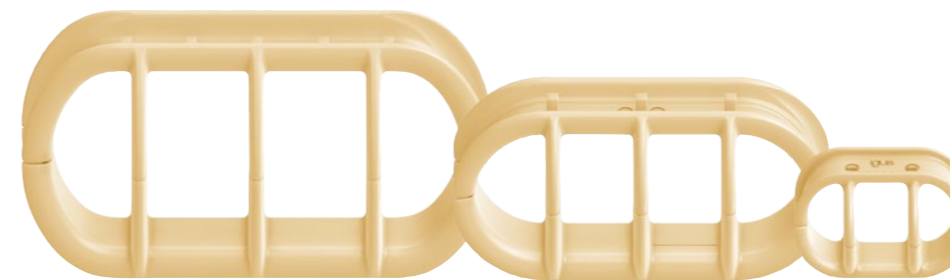
Extremely high wear resistance and long service life



igidur® J, a material known from the iglidur® range of materials, is extremely wear-resistant and drastically minimises abrasion between cables.

Cleanroom-optimised crossbars and interior separation made of iglidur® J reduce the abrasion of the cables guided in the C6 by 77%*

- Quickly configure interior separation in the ring-shaped, oval e-skin®
- Configure wear-optimised ring separators, full-width shelves and separators using drag & drop
- Free download of CAD data

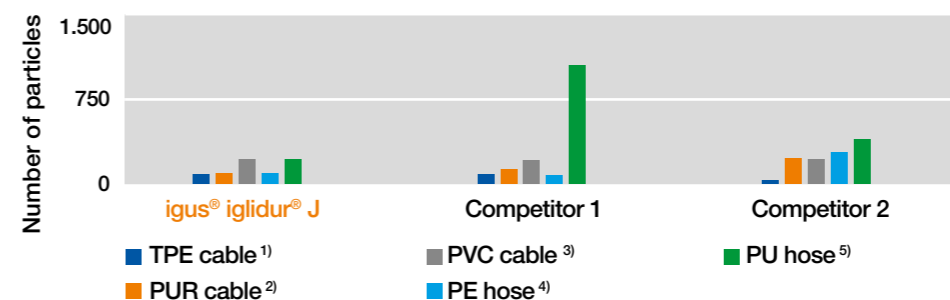


The most important specifications at a glance:

- Very good wear resistance at room temperature
- Very good wear resistance at medium temperatures
- Excellent coefficients of friction
- Low moisture absorption
- High media resistance
- Resistant to edge pressure
- Resistant to shocks and impacts
- Resistant to dirt and dust
- Mould-resistant according to DIN EN ISO 846

Abrasion/cable tests in the igus® laboratory.

The iglidur® J material produces 77% less abrasion*



*Measured and averaged on five different friction partners:
1) CF340.250.01 2) CF270.UL.350.01.D
3) CF886.350.01
4) CAPE.A.10.0 5) CAPU.A10.0
compared to the standard material igumid® G

Long travels in cleanrooms



Extremely low particle emission thanks to optimised IPA ISO Class 5 roller surfaces

Advantages of cleanroom chains, including for long travels. Here, the upper run of the cleanroom-compatible E6.52 e-chain® is supported over long travels, eliminating particle emissions from gliding. Contacts are minimised by motor-controlled roller guide rocking.

- ▲ Very low particle emission thanks to optimised roller surfaces and spring tensile force, can be motorised (optional)
- ▼ One system usable for all production environments
- IPA certification of a complete system with four supports and E6.52 with Cleanroom Class ISO 5
- No material contamination from particles
- 🔍 Optional push-pull monitoring

Test report

Testing cleanroom suitability according to ISO 14644-14

GLO.CR roller supports
For long cleanroom-compatible E6.52 e-chain® travels

Inner width	50 - 300mm
Bend radius	100 - 250mm
Support gap	1,000 - 2,000mm

Parameter Set 1: Speed: v1 = 1.0m/s Acceleration: a1 = 2.0m/s²

Measuring point	MP01	MP02	MP03	MP04	MP05	MP06	MP07	MP08	MP09
Cleanroom class (according to ISO 14644-1)	2	4	1	4	4	1	2	2	3

Parameter Set 2: Speed: v1 = 0.5m/s Acceleration: a1 = 1.0m/s²

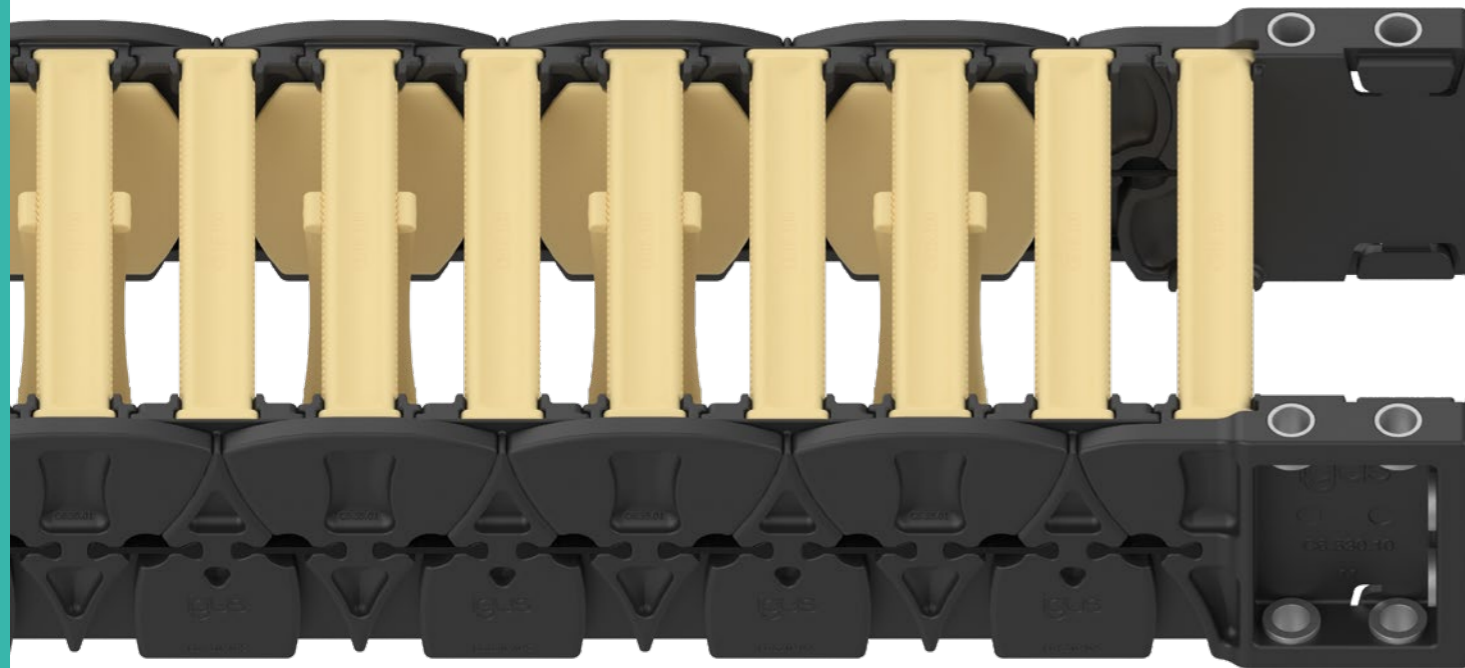
Measuring point	MP01	MP02	MP03	MP04	MP05	MP06	MP07	MP08	MP09
Cleanroom class (according to ISO 14644-1)	5	4	1	4	5	2	2	4	3

Parameter Set 3: Speed: v1 = 2.0m/s Acceleration: a1 = 4.0m/s²

Measuring point	MP01	MP02	MP03	MP04	MP05	MP06	MP07	MP08	MP09
Cleanroom class (according to ISO 14644-1)	4	4	3	4	5	5	5	4	4

Cleanroom guidelok horizontal, GLO.CR.56 with E6.52.175.100.0

For small cleanrooms



Optimised design now with reduced inner height

Addition to the successful C6 product range: clean e-chain for cleanroom applications of the future. Now with inner heights of 53mm and 29mm (new). Standard with crossbars and interior separation made of iglidur® J as an optimal gliding and friction partner for all cable jacket materials.

- ▲ Cleanroom-optimised design now with reduced inner height (other inner heights are being prepared)
- ▼ No static charge thanks to ESD side panels
- Tests in the internal igus® ISO 1 cleanroom laboratory
- No material contamination from particles
- 🔗 Push-pull force monitoring

Expert interview

Background of the C6 development



"Where did the idea of developing a new chain for cleanroom applications come from?"

Kira Weller: "We are a very dynamic company, so almost every week we look for new customer problems to solve. In the large and growing semiconductor market, and in battery production and microelectronics, our six-part energy chain series for cleanroom applications has already been very successful. Then there are our e-skin® and e-skin® flat products, which were developed specifically for this area. But requirements for individual applications are increasing, especially in the semiconductor industry, so we have very often offered special solutions."

"What were those special solutions?"

Weller: "Things like crossbars and separators made from our iglidur® J material, which reduces the abrasion from parts that come into contact with the cable, regardless of outer jacket material. We confirmed this result with many tests in our laboratory. Another special solution, one that customers often request, is electrostatically dissipative energy chains for use in ESD areas. We had already defined a standard product range for these areas, but most of the energy chains were not made for the highest cleanroom classes. So we developed a special solution made of ESD-compatible material for use with existing E6 chains. In a new generation of the six-part energy

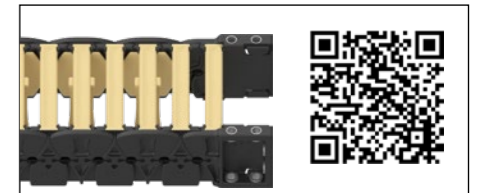
chain, we decided to make this special solution standard. The C6 has side links made of electrostatically dissipative ESD material. Its crossbars, side plates, and separators are made of iglidur® J."

"Were there any other items that you took into account during development?"

Weller: "Yes, we wanted deepen our experience from the previous series. So we decided on the E6.1 series inner and outer link principle. The advantage is that the energy chain has a very straight run. We have also adopted the E6-series crossbar design, which simplifies installation and gives the E6 its quiet operation and very long service life. The crossbars are completely new; our main focus here is on cable-friendliness and simple, tool-free installation."

"Since 2020, igus® has had its own cleanroom laboratory certified by Fraunhofer IPA. How much does this help you develop cleanroom products, especially the C6?"

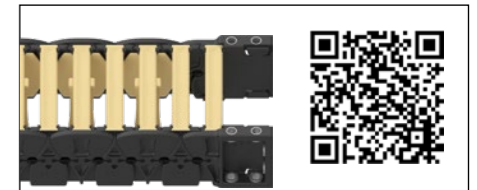
Weller: "Our cleanroom laboratory gave us important support. With every prototype change, we carried out particle tests directly and were able to identify and eliminate various particle sources. We can also take measurements over long periods of time and react quickly. The last change we made was to the number of crossbars in the outer radius. We decided on one crossbar in each chain link to make the C6 torsion-proof. If the chain is



C6.29

Highest cleanroom suitability, hardly any abrasion & high strength

Inner width	29mm
Bend radius	100mm



C6.53

Highest cleanroom suitability, hardly any abrasion & high strength

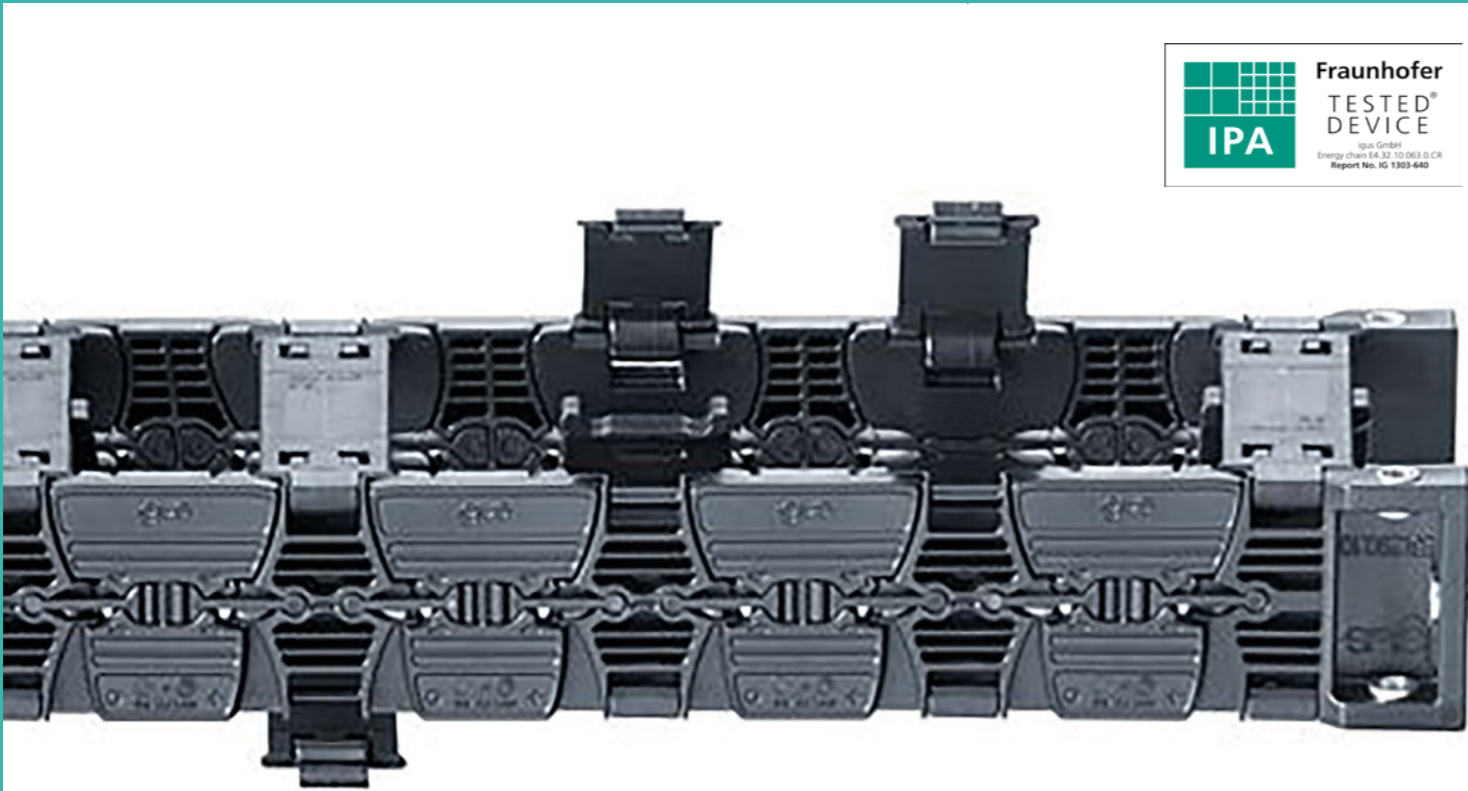
Inner width	53mm
Bend radius	172mm

not guided straight, there can be contact between the individual side links. Then it would no longer be safe to say that we do not generate any measurable particles, and given that cleanroom requirements may continue to increase, we decided on this extra security of doubling the number of crossbars."

Now the final question: What does C6 stand for?

Weller: "The C mainly stands for clean – for cleanroom-compatibility. 6 is the number of individual parts that make up an energy chain link. There are two side links, two crossbars, and two crossbars for a total of six. C6 also stands for the series name: Clean e-chain."

Quiet, clean, fast, and strong



Quiet operation at very high speeds

The E6.1 system is often the first choice when e-chains® are required for cleanrooms, extremely high dynamics, or low noise levels. Easy accessibility and high strength in this category specialise the E6.1 family for very demanding tasks.

- ▲ Extremely quiet operation thanks to the inner/outer-link design
- ▼ Less weight for the same inner height and unsupported length
- Cleanroom ISO 1 certification from the IPA Fraunhofer Institute
- change® standard material
- Push-pull force monitoring

High dynamics, quiet, lighter, easier to open



The interior of the E6.1 has been designed to be extremely cable-friendly to increase the service life of cables and hoses even more. The crossbars are very smooth and rounded as is the transition from e-chain® link to crossbar, and all markings have been moved outside of the e-chain® cross section.

Dynamic, quiet, light and cleanroom suitable - E6.1

The E6.1 series is a development of the E6 series. It incorporates all the advantages of the E6 such as strength, cleanroom-compatibility and low weight in addition to even quieter operation at higher maximum speeds. In addition, its accessibility to the interior and the assembly and handling have been improved.

igus® for cleanrooms – Suitability of the igus® E6.1 e-chains®

A special material reduces the already low e-chain® abrasion much further. In many applications where cumbersome special solutions are required, an e-chain® can thus be used. IPA tests confirm that standard e-chains® from igus® meet cleanroom requirements and have been "tested and found very good". e-chains® for cleanroom applications demand very high wear resistance of moving parts. e-chains®, for example, must be wear-resistant, in order to meet the normal requirements for such a sensitive environment.

Benefits

- Quiet – from a noise level of 32dB(A)
- About 30% less weight than the E6 system
- Highly dynamic
- Extremely low vibration
- Cleanroom-compatible due to principle of low-abrasion for connectors, without pin and bore connection

Typical application areas

- Semiconductor industry
- Studio technology and camera movements
- Printer/plotter industry
- For extremely high-acceleration applications

Attachment from any side: with KMA mounting brackets

Quiet from 32dB(A): small pitch for quiet, smooth running

Fast assembly: crossbars removable along the inner and outer radius

Dynamic: high speeds and accelerations

Long service life: low vibration, high tensile strength

IPA cleanroom Class 1: virtually no wear or abrasion

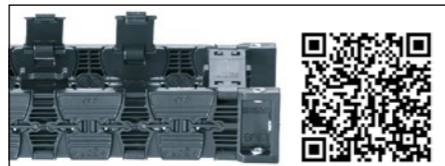
Modular design: can be easily lengthened and shortened

Series E61.29 special feature: crossbar openable along inner and outer radius, from both sides

Extremely low noise, vibration and abrasion, cleanroom suitable

E6.1 e-chain system®

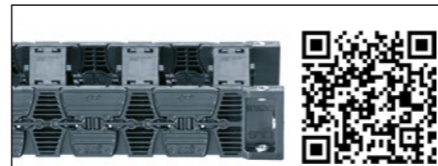
E6.1 e-chain®



E61.29

Openable along inner and outer radius, from both sides

Inner width **30 - 140mm**
Inner height **29mm**



EF61.29

Crossbars removable along the inner and outer radius

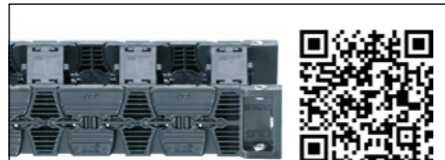
Inner width **30 - 140mm**
Inner height **29mm**



E61.35

Crossbars removable along the inner and outer radius

Inner width **30 - 140 mm**
Inner height **35mm**



E61.40

Crossbars removable along the inner and outer radius

Inner width **40 - 300mm**
Inner height **40mm**



E61.52

Crossbars removable along the inner and outer radius

Inner width **40 - 300mm**
Inner height **52mm**



E61.62

Crossbars removable along the inner and outer radius

Inner width **50 - 400mm**
Inner height **62mm**



E61.80

Crossbars removable along the inner and outer radius

Inner width **50 - 600mm**
Inner height **80mm**

e-chain® service life calculator

Simple calculation

e-chain® service life calculator

Calculate the service life of our e-chains® and get a 36-month guarantee certificate

e-chain® selection

E6.29.050.100.0 Inner width: mm Bend radius: mm

Application parameters

Movement type: Unsupported Gliding

Installation type: Supported lower run Unsupported lower r... On inclined plane

Travel: 2000mm Fill weight: 1.5kg/m Speed: 2m/s Acceleration:

Environmental conditions

Temperature: 20 °C Dirt: None Mechanical stress:

Service life

Part number: E6.29.050.100.0

Parameters: Installation type: Supported lower run (standard) Inner height: 29 mm Inner width: 50 mm Outer height: 35 mm Outer width: 66 mm Bend radius: 100 mm

Service life: 96,277,000 Double strokes (guaranteed) amounts to a total distance of 385,108 km (guaranteed)

64.40 EUR/m

[Request guarantee](#)

[Save information](#)

[View product details](#)

Alternative chains

Part number	Inner height [mm]	Inner width [mm]	Outer height [mm]	Outer width [mm]	Bend radius [mm]	Price [EUR/m]	Service life [double strokes]
R6.29.050.100.0	28	50	35	66	100	117.30	83,984,000
E61.29.050.100.0	29	50	35	64	100	59.80	72,195,000
E4.28.050.100.0	28	50	42	70	100	52.58	32,523,000
E4.32.05.100.0	32	50	54	73	100	60.66	32,523,000
R4.28.050.100.0	28	50	42	70	100	74.58	32,523,000
E4.31L.050.100.0	31	50	42	64	100	47.74	31,710,000
H4.32.05.100.0	32	50	54	73	100	55.26	31,710,000
R4.31L.050.100.0	31	50	42	64	100	70.40	31,710,000

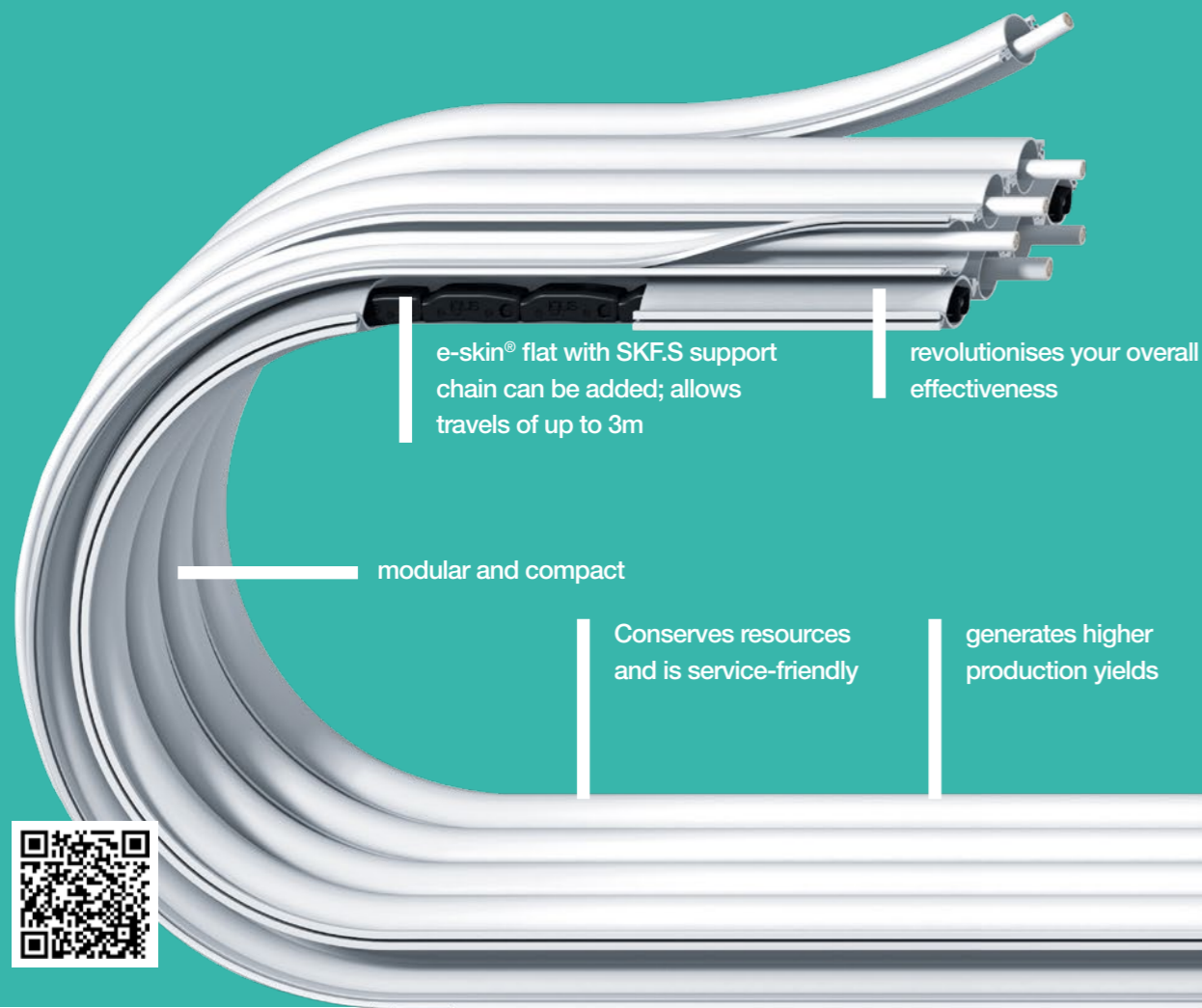
36-month guarantee of the calculated service life*

Our service life calculator gives you the energy chain's expected service life when you enter a few application parameters. You can also use the tool to create a guarantee certificate for up to 36 months (*The guarantee applies to the calculated service life, and not longer than 36 months).

igus.eu/service-life-calculator



Compact and modular: e-skin® flat with CFCLEAN



e-skin® flat with SKF.S support chain can be added; allows travels of up to 3m

revolutionises your overall effectiveness

modular and compact

Conserves resources and is service-friendly

generates higher production yields

clean-room



igus 36-month chainflex cable guarantee and service life calculator based on 2 billion test cycles per year



protected by highly abrasion-resistant heat-sealed film

has no outer jacket, so it is thin and lightweight

made for the e-skin® flat

great flexural strength thanks to very finely stranded special conductors

CFCLEAN CONTROL

CFCLEAN BUS

CFCLEAN DATA

CFCLEAN MOTOR

Revolutionises your overall effectiveness

e-skin® flat

The main advantage of the e-skin® flat is its modularity and easy maintenance. In contrast to commercially available solutions with firmly defined flat ribbon cables with welded stranded elements, the e-skin® flat energy chain system offers openable chamber systems. Flexible chainflex® CFCLEAN stranded elements (with or without connectors), support chains, hoses, etc., can now be replaced or added in just a few minutes.

- Highly efficient in the prototype phase
- Maximum availability due to easy replacement of defective elements
- Resource-efficient, as only individual elements are replaced when there is damage

igus.eu/e-skin-flat



Commercially available ribbon cables with permanently integrated cable elements: the entire system must be replaced if there is damage.

... made for the e-skin® flat chainflex® CFCLEAN

The e-skin® flat cable guide system combined with chainflex® CFCLEAN cables represents the systematic refinement of conventional PTFE trackless cables for cable guidance in flat-panel displays (FPDs) and semiconductors, microelectronic component production, and medical technology. The strengths of the PTFE ribbon cable have been enhanced and the weaknesses eliminated. The new e-skin® flat cable guide system is the result of this refinement.

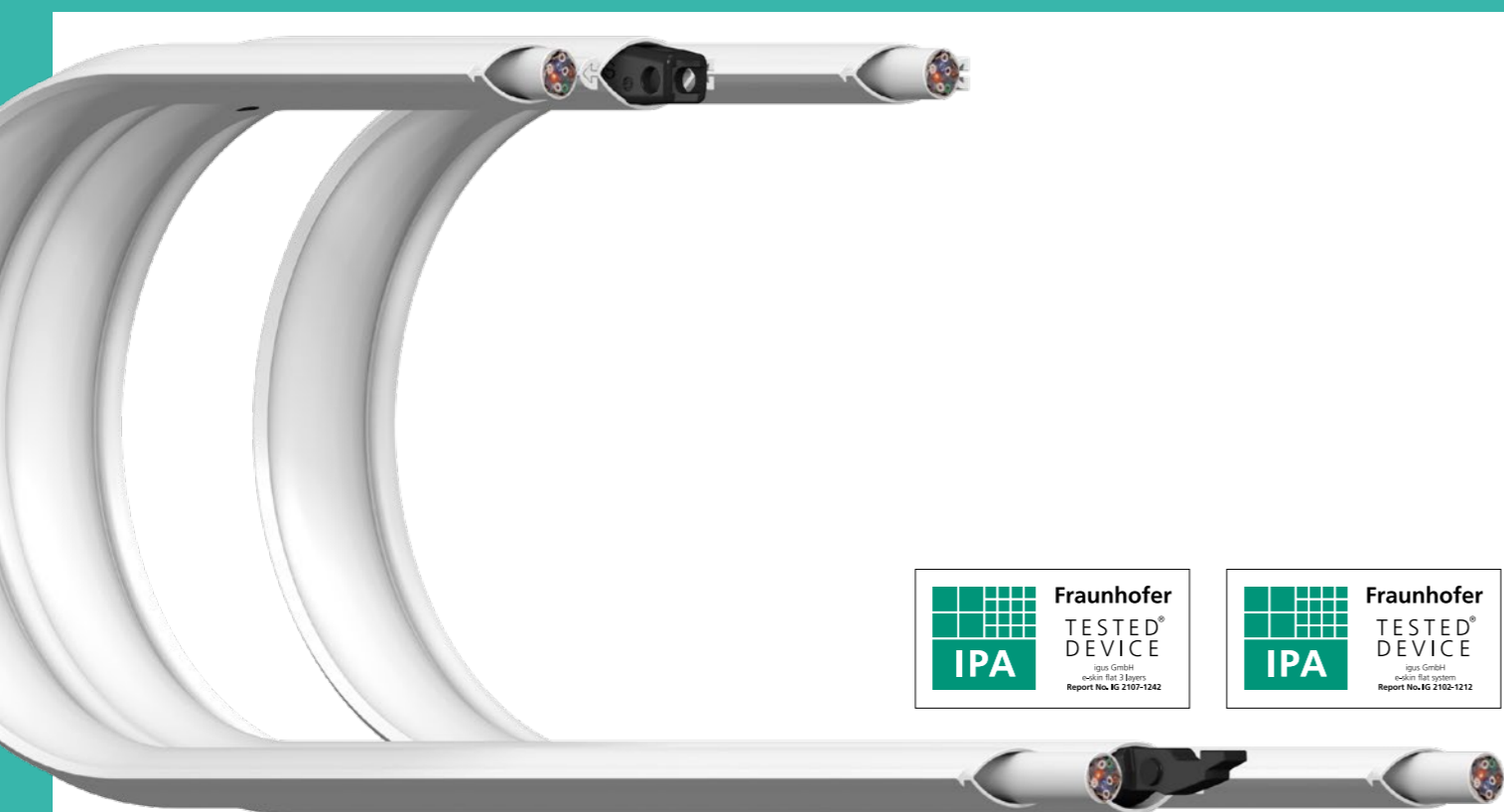
- Stiff cable jackets prevent system bending
- Low forces thanks to highly flexible stranded structure ... special conductors ... and no outer jacket
- CFCLEAN chainflex® adapted to the application with up to 21% less weight than conventional cables
- About 16% smaller diameter than standard cables with jacket
- No minimum length

- Conductor prototypes: finished in 48-72 hours
- All standard core/cross section combinations: data, bus, control, motor – available from stock, with a guarantee of up to 4 years

igus.eu/cfclean

e-skin® flat

Modular, flexible, and quiet



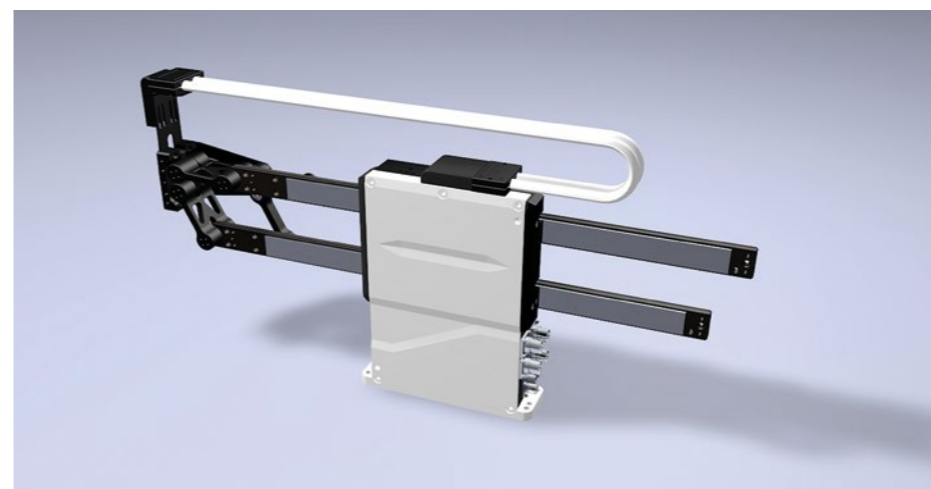
Modular principle for ISO Class 1 applications

The main advantage of the e-skin® flat is its modularity and easy maintenance. Unlike commercially available solutions with defined flat ribbon cables with welded stranded elements, the e-skin® flat energy chain system offers openable chamber systems. Flexible chainflex® CFCLEAN stranded elements (with or without connectors), support chains, hoses, etc. can now be replaced or added in just a few minutes.

- ▲ Single pods can be freely configured in different layers
- ▼ Openable for quick installation
- Fraunhofer IPA ISO 1 certificate, one and three layers
- Individual single pods can be replaced without replacing the entire system

SKF profiles

Modular and compact design



Weiss GmbH is specialised in the development and manufacture of components for automation technology and a leader in the field of rotary indexing tables and wanted to find a cable feed-through up to the middle of a tool that could hold two sensor cables and two hoses, each with a diameter of four millimetres. The solution: the clean e-skin® flat ribbon cable from igus®. Service life over 57 million double strokes.

Connectable profiles - e-skin® flat SKF

The cable guides for automation systems and robots in the manufacture of displays, semiconductors, and microelectronic components have to meet special particle-free requirements. In contrast to commercially available solutions using fixed flat ribbon cables with cables permanently welded inside, the e-skin® flat energy supply system offers an openable chamber design. Flexible braided cable elements (with or without connectors), e-skin® flat with support chains, hoses and so on, can now be changed or added in a few minutes.

Benefits

- Revolutionises your overall effectiveness
- Generates higher production yields
- Suitable for cleanrooms according to IPA cleanroom Class 1
- Openable or enclosed
- Modular, freely expandable, and compact

Typical application areas

- Cleanroom applications with compact installation spaces
- Short travels
- Display and semiconductor production
- LCD/LED panel production

IPA cleanroom Class 1: virtually no wear or abrasion

Modular structure: extendable by connecting additional profiles

Optional support e-chain®: SKF12C series for unsupported length and a defined bend radius

Mounting brackets: stackable and variable width with integrated strain relief

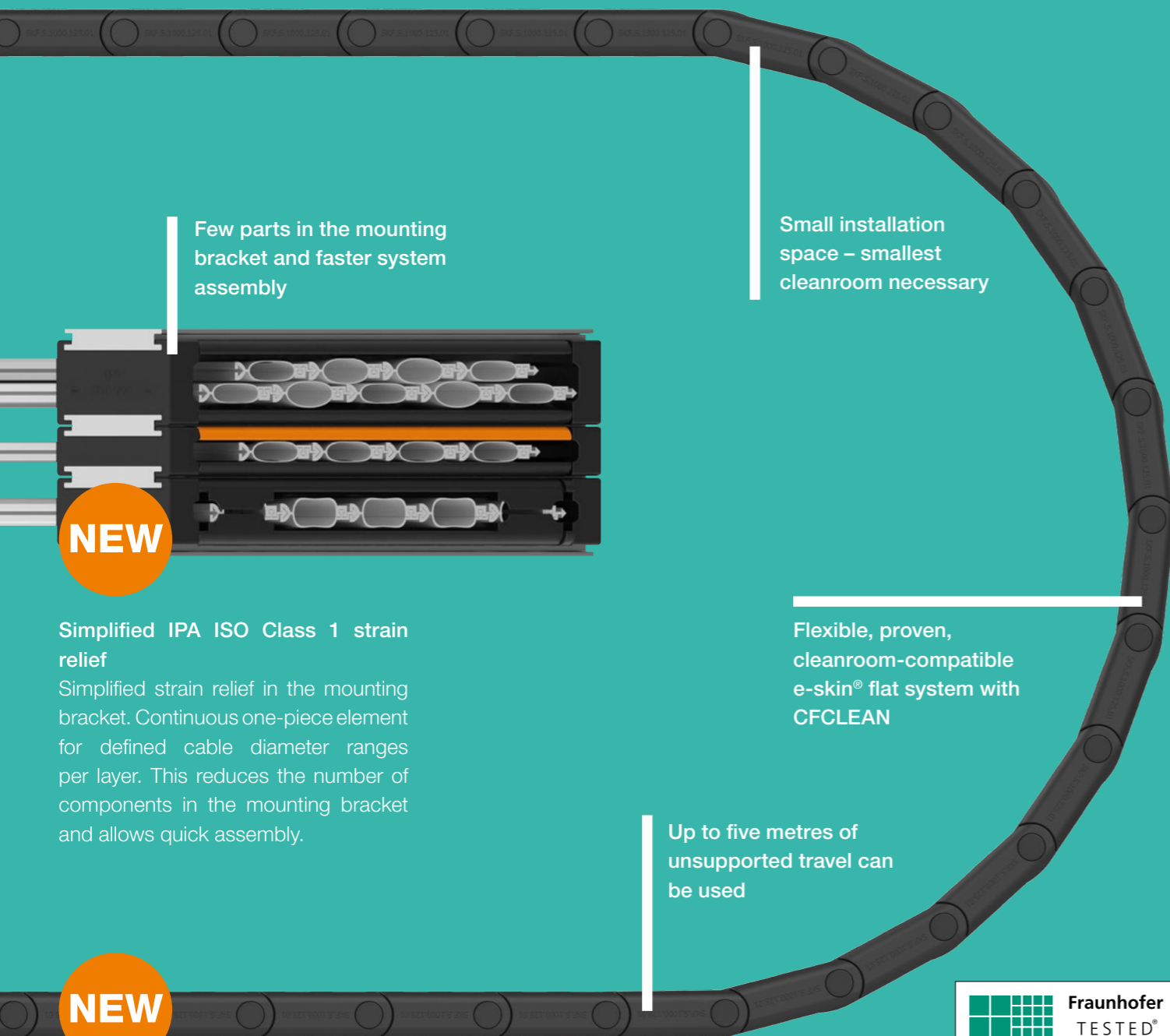
SKF.C fully enclosed: prevent particle ingress with closed cable chambers version

Flexible: can be shortened or widened

Revolutionise efficiency of the entire plant: specially matched chainflex® CFCLEAN braided structure



Next-level modularity



Few parts in the mounting bracket and faster system assembly

Small installation space – smallest cleanroom necessary

Flexible, proven, cleanroom-compatible e-skin[®] flat system with CFCLEAN

Up to five metres of unsupported travel can be used

NEW

Simplified IPA ISO Class 1 strain relief

Simplified strain relief in the mounting bracket. Continuous one-piece element for defined cable diameter ranges per layer. This reduces the number of components in the mounting bracket and allows quick assembly.

NEW

Up to 5m of travel with the e-skin[®] flat IPA ISO Class 1

The new e-skin[®] flat with support chain allows longer travel distances with the cleanroom-optimised e-skin[®]

flat system. The new larger e-skin[®] flat with support chain is guided in the POD SKF15C e-skin[®] flat and can be integrated into the existing connection element structure.



e-skin[®] flat in the first industry test of its kind

Highest cleanroom class after 60 million double strokes

Cleanroom-compatible energy chains from the e-skin[®] flat series still meet the highest Cleanroom Class even after 1.5 years of continuous use and 60 million double strokes. This result came from a test that is unprecedented in the industry. It was performed in a cleanroom laboratory set up by igus[®] in Cologne in cooperation with the Fraunhofer Institute for Manufacturing Engineering and Automation IPA, igus[®] development and certification partner for more than 17 years.

"The e-skin[®] flat cleanroom energy chain is ideal for robots and other automation systems in electronics production in such areas as semiconductors and display production," says Andreas Hermey, Development Manager for e-chain systems[®] at igus[®]. "It is so abrasion-resistant that contamination by airborne particles is no longer an issue." Until now, however, the intensity

of the high-performance plastic's particle abrasion after long, intensive use has been unclear. To determine its details, igus[®] launched a test setup that is unique in the industry so far. Part one of the experiment was conducted in igus's own laboratory. The energy chain moved in an environment with normal levels of dust and dirt for around 1.5 years, during which it performed 60 million double strokes.

The second part of the test took place in the clean room laboratory. The heart of the setup was three so-called laminar flow boxes equipped with high-performance filters that enable tests in uncontaminated air. The worn-out e-chain[®] was in motion three times (100 minutes each time) at different

speeds. Sensors detected particle concentration in the surrounding air. "Even after 60 million double strokes, our e-skin[®] flat e-chain[®] still qualified for the highest cleanroom class," says Hermey. "This finding gives cleanroom production facility operators additional confidence."



Kira Weller, e-chain[®] product manager (left); **Dominik Barten**, development engineer (middle); and **Andreas Hermey**, head of e-chain[®] research and development (right) explain what is special about these research opportunities



e-skin® flat

e-skin® flat




e-skin® flat SKF12C
Prevent particle ingress with closed cable chambers

Outer height	13mm
Inner height	12mm




e-skin® flat SKF12O
Easy to fill due to a special locking mechanism

Outer height	13mm
Inner height	12mm




e-skin® flat SKF15C
Prevent particle ingress with closed cable chambers



Outer height	16mm
Inner height	15mm




SKF.S support e-chain®
Can be combined with SKF12C series for unsupported length and a defined bend radius

Outer height	8mm
Inner height	8mm

CFCLEAN elements

CFCLEAN1
Control elements

- For extreme heavy duty applications
- PTFE film taped
- Highly abrasion-resistant

Bend radius e-skin® flat	70 x d
Temperature e-skin® flat	-10 °C/+80 °C




CFCLEAN2
Coax elements

- For extreme heavy duty applications
- PTFE film taped
- Highly abrasion-resistant



Bend radius e-skin® flat	70 x d
Temperature e-skin® flat	-10 °C/+80 °C




CFCLEAN3
Data elements

- For extreme heavy duty applications
- PTFE film taped
- Highly abrasion-resistant



Bend radius e-skin® flat	70 x d
Temperature e-skin® flat	-10 °C/+80 °C

CFCLEAN4
Measuring system elements

- For extreme heavy duty applications
- PTFE film taped
- Highly abrasion-resistant

Bend radius e-skin® flat	70 x d
Temperature e-skin® flat	-10 °C/+80 °C

CFCLEAN7
Motor elements

- For extreme heavy duty applications
- PTFE film taped
- Highly abrasion-resistant

Bend radius e-skin® flat	70 x d
Temperature e-skin® flat	-10 °C/+80 °C



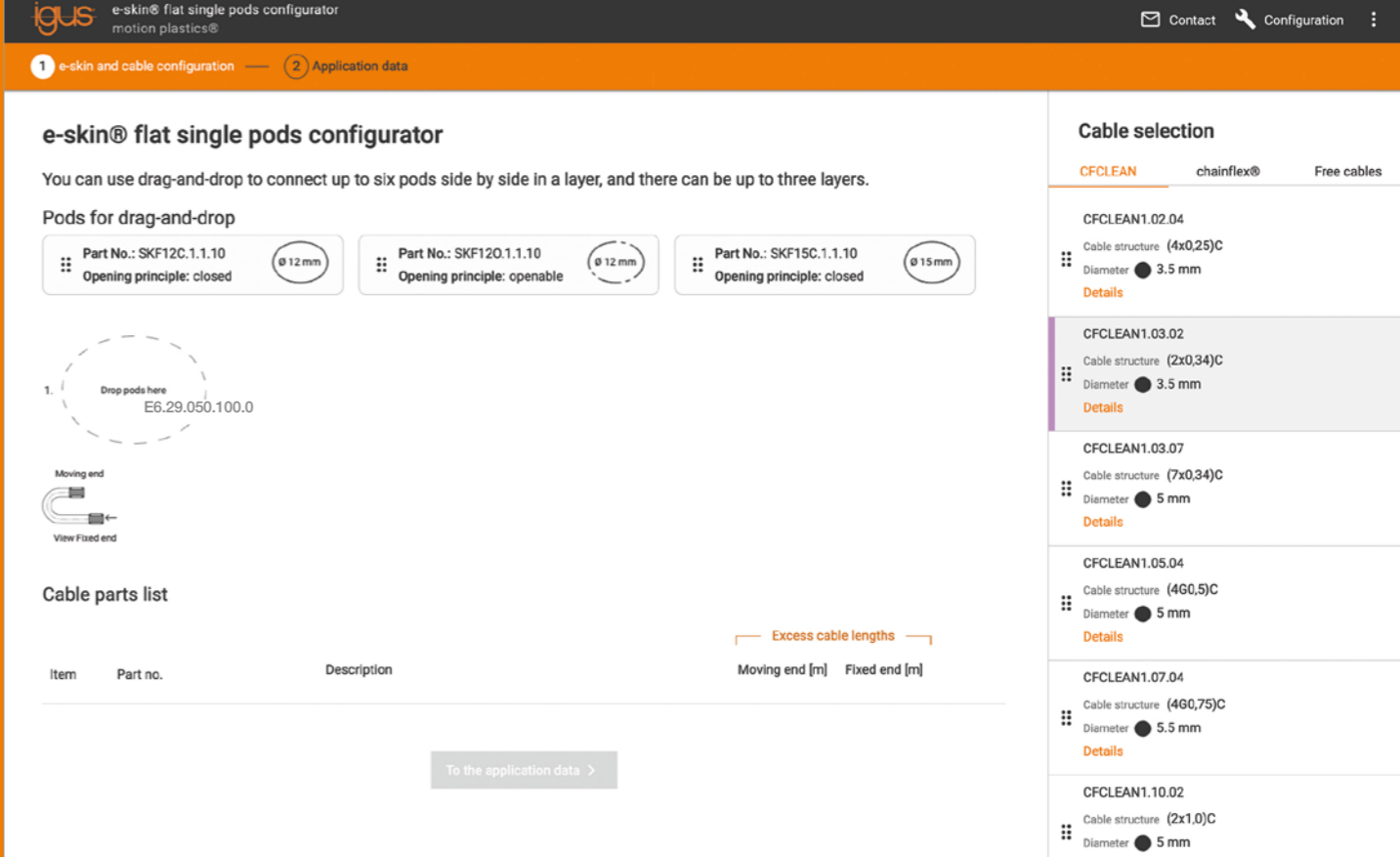

CFCLEAN8
Bus elements

- For extreme heavy duty applications
- PTFE film taped
- Highly abrasion-resistant

Bend radius e-skin® flat	70 x d
Temperature e-skin® flat	-10 °C/+80 °C

e-skin® flat configurator

Simple calculation



e-skin® flat single pods configurator

You can use drag-and-drop to connect up to six pods side by side in a layer, and there can be up to three layers.

Pods for drag-and-drop

- Part No.: SKF12C.1.1.1.10 (Opening principle: closed) Ø 12 mm
- Part No.: SKF12O.1.1.1.10 (Opening principle: openable) Ø 12 mm
- Part No.: SKF15C.1.1.1.10 (Opening principle: closed) Ø 15 mm

Cable selection

- CFCLEAN1.02.04: Cable structure (4x0,25)C, Diameter 3.5 mm
- CFCLEAN1.03.02: Cable structure (2x0,34)C, Diameter 3.5 mm
- CFCLEAN1.03.07: Cable structure (7x0,34)C, Diameter 5 mm
- CFCLEAN1.05.04: Cable structure (4G0,5)C, Diameter 5 mm
- CFCLEAN1.07.04: Cable structure (4G0,75)C, Diameter 5.5 mm
- CFCLEAN1.10.02: Cable structure (2x1,0)C, Diameter 5 mm

Get an e-skin® flat cable guidance system for cleanroom applications in just three steps

Our e-skin® flat online configurator lets you use drag-and-drop to quickly assemble your own ribbon cable and the cables it contains.

- 1 Open the e-skin® flat configurator.
- 2 Select pods and connect them, then select cables
- 3 Enter basic parameters and send your query

**igus.eu/
skf-configurator**



For ESD-sensitive cleanroom parts



Dissipative for cleanrooms

New black e-skin® flat in size SKF12 in openable and fully closed variants. Conductivity prevents electrostatic fields and abrupt discharges caused by e-skin® flat movement.

- ▲ No further shielding of ESD-sensitive parts necessary
- ▼ All e-skin® flat accessories can be used, including CFCLEAN
- Tests in the internal igus® ISO 1 cleanroom laboratory
- Small installation space – smallest cleanroom necessary Configure e-skin® flat energy supply systems online

For the highest level of safety and cleanliness in cleanrooms

Cologne, 13 September 2023 - igus® has added an ESD variant specifically for highly sensitive cleanrooms to its e-skin® flat series. The modular ribbon cable's new material prevents the chain from becoming electrostatically charged while ensuring that it generates no particles, even during very fast movements. The modular design with individual pods also allows quick energy supply system filling.

In addition to particle-free cleanrooms, electronics and semiconductor industry production requires electrostatically dissipative machine components. Even the smallest current surge from electrostatic charge can easily destroy the product. So igus® has added an ESD variant to its e-skin® flat series. The new black e-skin® flat is made of an electrostatically dissipative material. "The new material combines ESD approval, which is frequently required, with the e-skin® flat's proven low particle emissions. The chain produces almost no particles and dissipates electronic charges directly", says Kira Weller, e-chain® product manager at igus®. "The new e-skin® flat ESD gives us just the product our customers need to produce sensitive electronic components." The ribbon cable is used by such companies as Weiss, an automation specialist, in its high-speed HP70 pick & place unit, which is used in such applications as material handling in the medical and pharmaceutical industries. Weiss is enthusiastic about the advantages of

the e-skin® flat ESD. The igus® ribbon cable is much stronger and quieter and less susceptible to wear in quick movement than are classic corrugated hoses. The e-skin® flat also features a modular design, unlike laminated ribbon cables made of polytetrafluoroethylene (PTFE). In the igus® in-house cleanroom laboratory, developed with the Fraunhofer Institute, the new e-skin® flat has already proven itself in the highest cleanroom class.

Easy cable replacement

"Single pod" profiles ensure quick, easy e-skin® flat installation, so the energy supply system can be easily expanded. A zip-lock system allows easy cable replacement. "This is a big advantage over the widely-used PTFE ribbon cables, in which the stranded cores are welded in a continuous ribbon and cannot be separated. If a single core breaks, the entire system must be replaced. That takes time and money," says Weller. "For our e-skin® flat, we offer the CFCLEAN cable cores for transmitting energy, motor control, bus, and Ethernet signals. The user gets a ready-to-connect energy supply system directly from a single source." If long travels (up to five metres) are needed, a support chain can be integrated easily into the pods. Spacers, mounting brackets from the e-skin® flat series, and the smart i.Cee EC.S ultrasonic condition monitoring sensor are also compatible with the new ESD chain.



SKF12C.1.0.ESD*
Closed

Inner height	12mm
Outer height	13mm

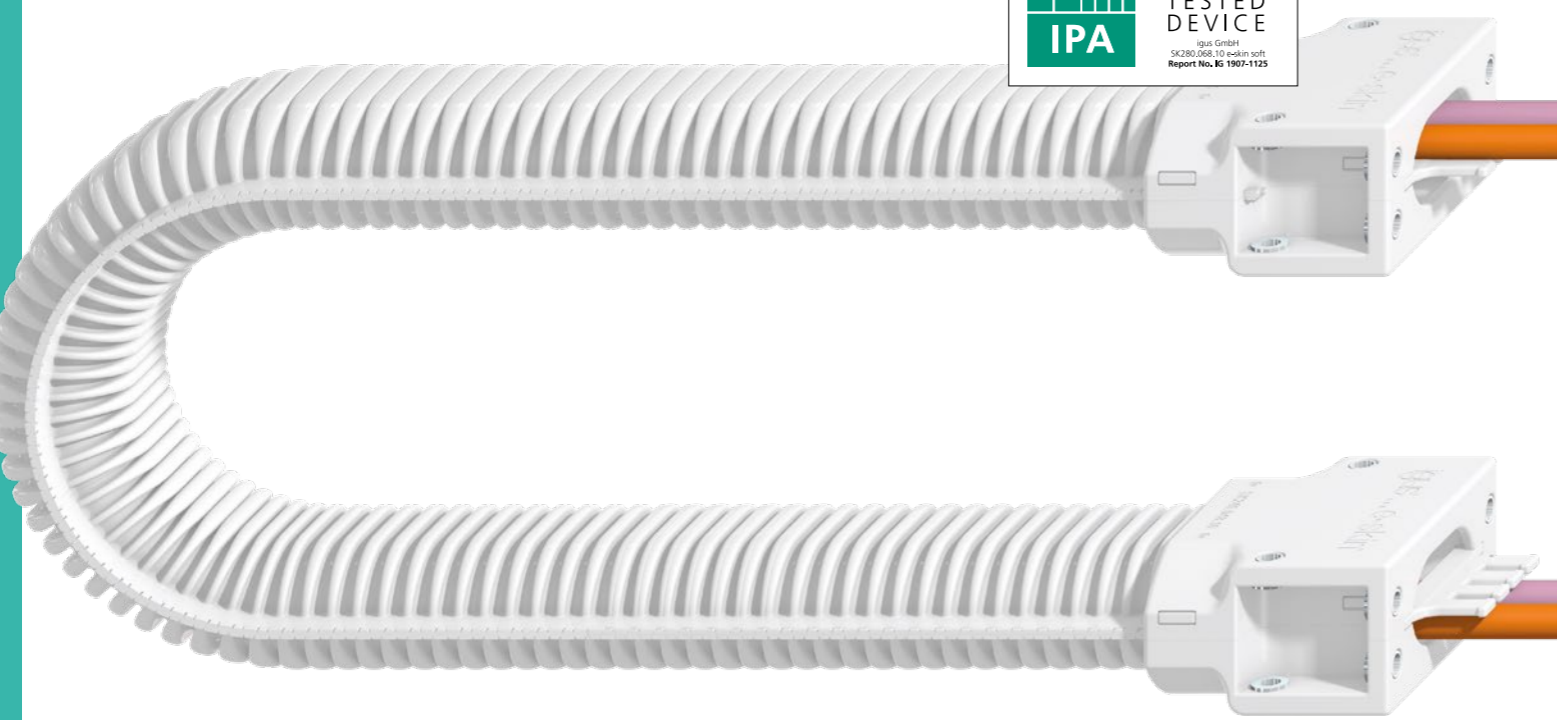


SKF12O.1.0.ESD*
Openable

Inner height	12mm
Outer height	13mm

*e-skin® flat with support chain for unsupported length and a defined bend radius optionally available (only in connection with SKF12C)

Highest cleanroom class



e-skin® corrugated tube cleanroom energy supply

The e-skin® is a hose consisting of an upper and lower shell that form a sealed tube when connected to each other. It is made of the igumid® SK polymer material developed specifically for this purpose. The simple reclosable opening mechanism allows easy maintenance and inspection of the installed cables. Operating temperature is +10°C/+50°C. The e-skin® has many advantages over conventional corrugated tubes and is available in three different versions.

- ▲ Self-supporting corrugated tube upper shell function for unsupported applications
- ▼ Small installation space thanks to the e-skin® soft's flexible material
- All variants (SK, SKS, and SKY) certified ISO Class 1 by Fraunhofer IPA
- No cleanroom contamination from production part particles

e-skin® corrugated tube for cleanrooms

Why the e-skin corrugated tube?

Typical application areas

- Cleanroom
- Fast, short, unsupported applications
- Hanging and standing applications
- Display and semiconductor production
- Pick & place applications
- Printer
- Medical technology
- All machines that use corrugated tubes



- 1 Cleanroom ISO class 1**
Virtually no wear or abrasion
- 2 Two-piece corrugated tube**
Consisting of upper and lower shell
- 3 Attachment from any side**
KMA mounting bracket with strain relief (optional)
- 4 Oval geometry:**
Prevents unintentional lateral movement
- 5 Fully enclosed:**
Protection against dust and water ingress
- 6 Reclosable opening mechanism**
Opening and closing with zipper function
- 7 Optional, vertical separation**
Consisting of individual separators and full-width shelves
- 8 Minimisation of abrasion**
With the new inner separation made of tribo-optimised iglidur material, the wear can be reduced by up to 80%

Attachment from any side:
KMA mounting brackets with strain relief

Two-piece corrugated tube:
upper and lower shell

IPA cleanroom Class 1:
virtually no wear or abrasion

Reclosable opening mechanism:
easy opening and closing with "zipper" function

Fully enclosed:
protection against dust and water ingress

Space-saving:
less installation space required

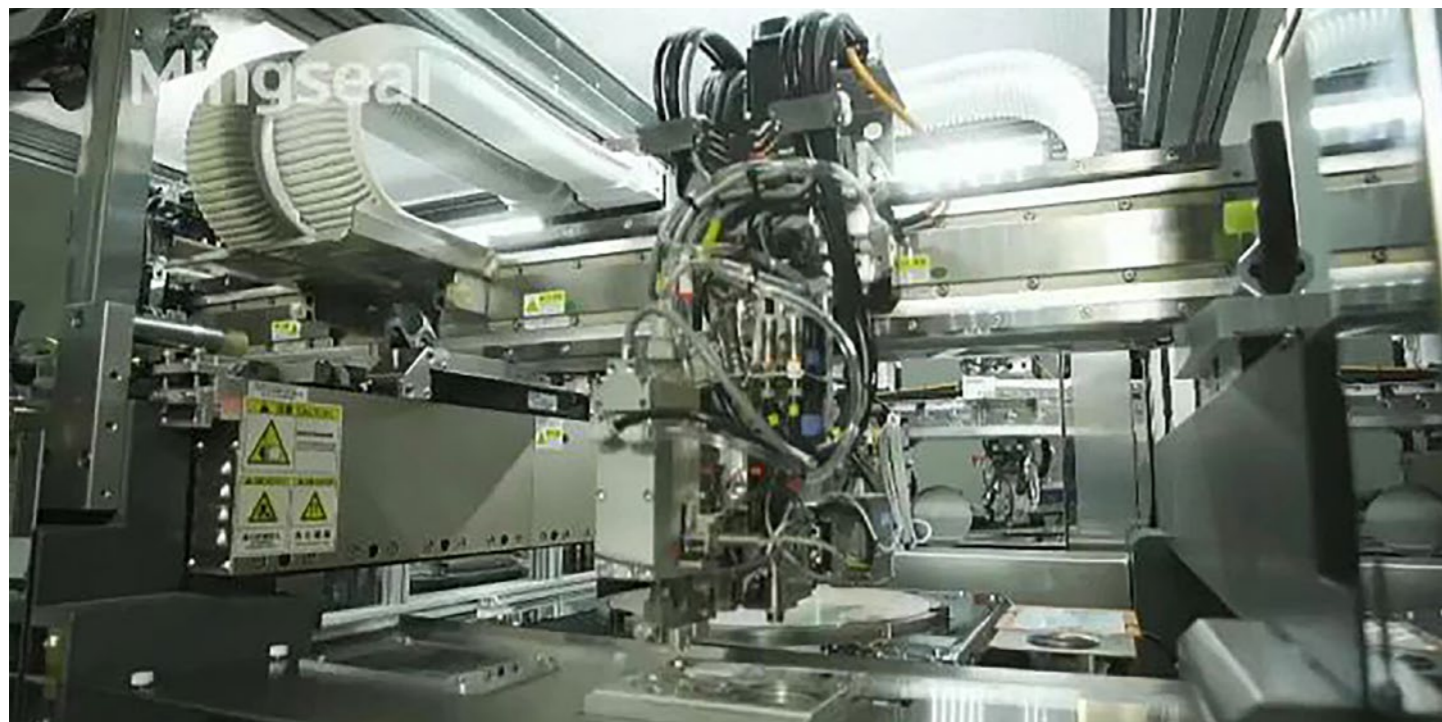
Cable-friendly:
with defined minimum bend radius

Strong:
prevents unintentional sideways movement

3 versions available:
e-skin® SK, SKS and SKY

Application example

e-skin® cleanroom chain in camera module adhesive dispenser



Mingseal uses our e-skin® corrugated tube in its camera module adhesive dispenser. It combines the engineers' openability, inherent rigidity, and compactness requirements with the highest cleanroom suitability according to ISO Class 1.

Customer requirements:

Mingseal manufactures products for the 3C industry (Computer, Communication and Consumer Electronic). The main product is an adhesive dispenser for camera modules.

igus® E3 and E6 e-chains®, which are already suitable for ISO class 1 according to IPA, were previously used as energy supply systems. Nowadays, however, the market demands an even higher particle-free standard (and thus theoretically an even better ISO class) than before, especially for mobile phone camera modules.

The reason for this is the ever-increasing pixel counts of mobile phone cameras,

because if there is just one particle on these modules, the entire module is abandoned and the overall equipment effectiveness (OEE) as well as the yield of the plant drop enormously.

igus® solutions:

In the first step, the customer had to replace the energy chain with other products such as welded cleanroom ribbon cables. The disadvantages of this solution soon became apparent: on the one hand, it was not possible to open the welded ribbon cables to add or replace cables, and on the other hand, the cables broke very quickly because they had to support themselves. After only

half a year, the first defects appeared on these welded cables, which in turn led to the system coming to a standstill.

The igus® e-skin® cleanroom energy supply system won over the Mingseal engineers. The unique openable corrugated tube for cleanrooms, which consists of an upper and lower shell, combined the engineers' openability, inherent rigidity, and compactness requirements with the highest cleanroom suitability according to ISO Class 1. In future, the compact e-skin® SKS20 series will be installed in new machines.

Safe and abrasion-resistant guidance of cables in cleanrooms

e-skin® corrugated tube energy supply system

e-skin®
SK

SK 28
Two-piece corrugated tube for long unsupported lengths

Inner width	68mm
Inner height	28mm

SK 40
Two-piece corrugated tube for long unsupported lengths

Inner width	85mm
Inner height	38mm

e-skin®
soft SKS

SKS20
Two-piece corrugated tube with more elastic material and lower clearance height

Inner width	33mm
Inner height	20mm

SKS24
Two-piece corrugated tube with elastic material and lower clearance height

Inner width	48mm
Inner height	24mm

SKS28
Two-piece corrugated tube with more elastic material and lower clearance height

Inner width	68mm
Inner height	28mm

SKS40
Two-piece corrugated tube with more elastic material and lower clearance height

Inner width	85mm
Inner height	38mm

e-skin®
hybrid SKY

SKY28
Two-piece corrugated tube combines the advantages of e-skin® SK and e-skin® soft SKS

Inner width	68mm
Inner height	28mm

SKY40
Two-piece corrugated tube combines the advantages of e-skin® SK and e-skin® soft SKS

Inner width	85mm
Inner height	38mm

Clean SCARA Cable Solution



Fraunhofer
IPA TESTED DEVICE
 igus GmbH
 SKS20-TR-CSCS
 Report No. IG 2303-1401

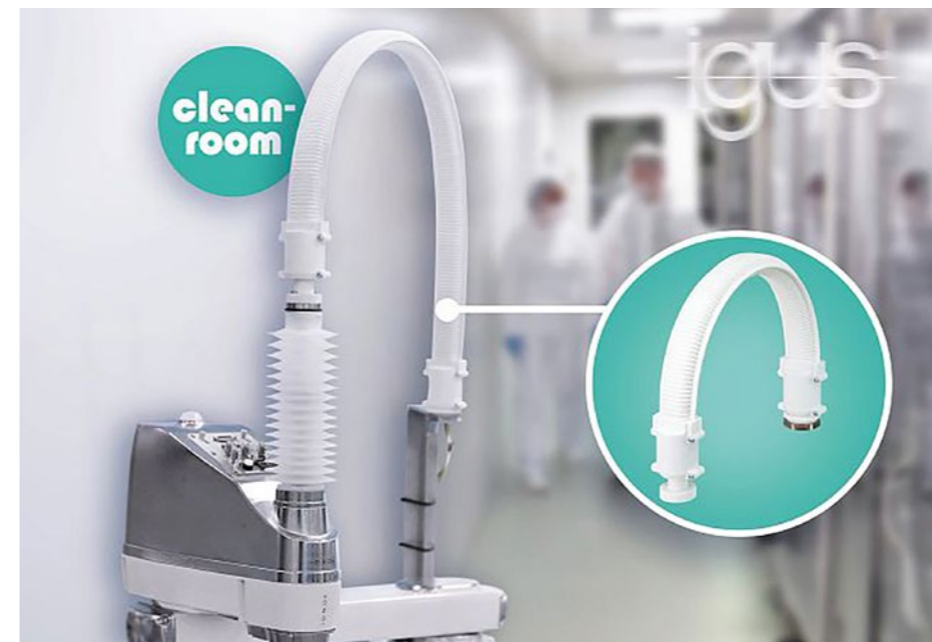
SCARA applications, IPA ISO Class 2

Based on the experience of the SCARA Cable Solution developed in 2020, a certified cleanroom variant is now available: the Clean SCARA Cable Solution. The optimised rotating mount connections allow up to ISO Class 2 (IPA-certified). In combination with the e-skin® design SKS20, which has been tried and tested in the highest cleanroom class, highly dynamic applications can also be implemented. The SKS20's proven zipper opening principle allows quick, easy cable filling. The new Clean SCARA Cable Solution is available in all known connections of the standard SCARA Cable Solution.

- ▲ Safe guidance of cables and hoses in cleanrooms, easy to retrofit
- ▼ High running performance and reduced downtime (all parts can be replaced individually)
- ISO Class 2 IPA certificate and more than 2,000,000 cycles in the igus® test laboratory
- Individual hoses and cables can be replaced

SCARA cable solution

Durable energy supply for SCARA robots

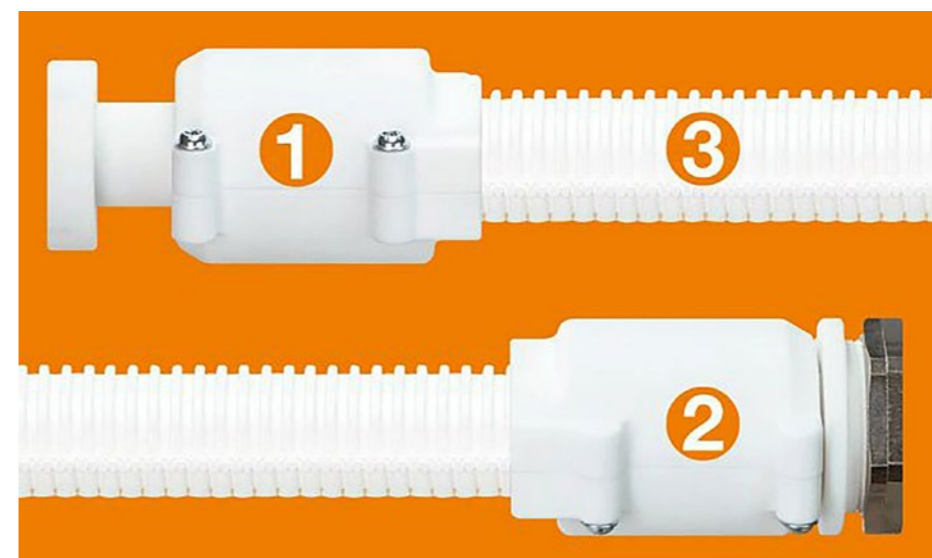


Modular system, easy to retrofit

Due to the excellent e-skin® cleanroom properties, the Clean SCARA Cable Solution immediately met the cleanroom requirements for ISO Class 2. This opens up new possibilities for using a SCARA robot in the cleanroom.

The Standard SCARA Cable Solution's rotating bearing function was adopted and adapted to the e-skin® energy supply system. The two SCARA Cable Solutions cannot therefore be combined.

The Clean SCARA Cable Solution consists of three elements that match the SCARA robot in question or are adapted to it:



- 1 Clean SCARA Cable Solution ball screw connection
- 2 Clean SCARA Cable Solution fixed end
- 3 e-skin® soft SKS20



Clean SCARA Cable Solution ball screw connection

Suitable for Epson, ABB IRB, Fanuc, Yaskawa, KUKA, and Denso

Diameter 16 - 25mm



Clean SCARA Cable Solution fixed end rotating/fixe

Thread M40

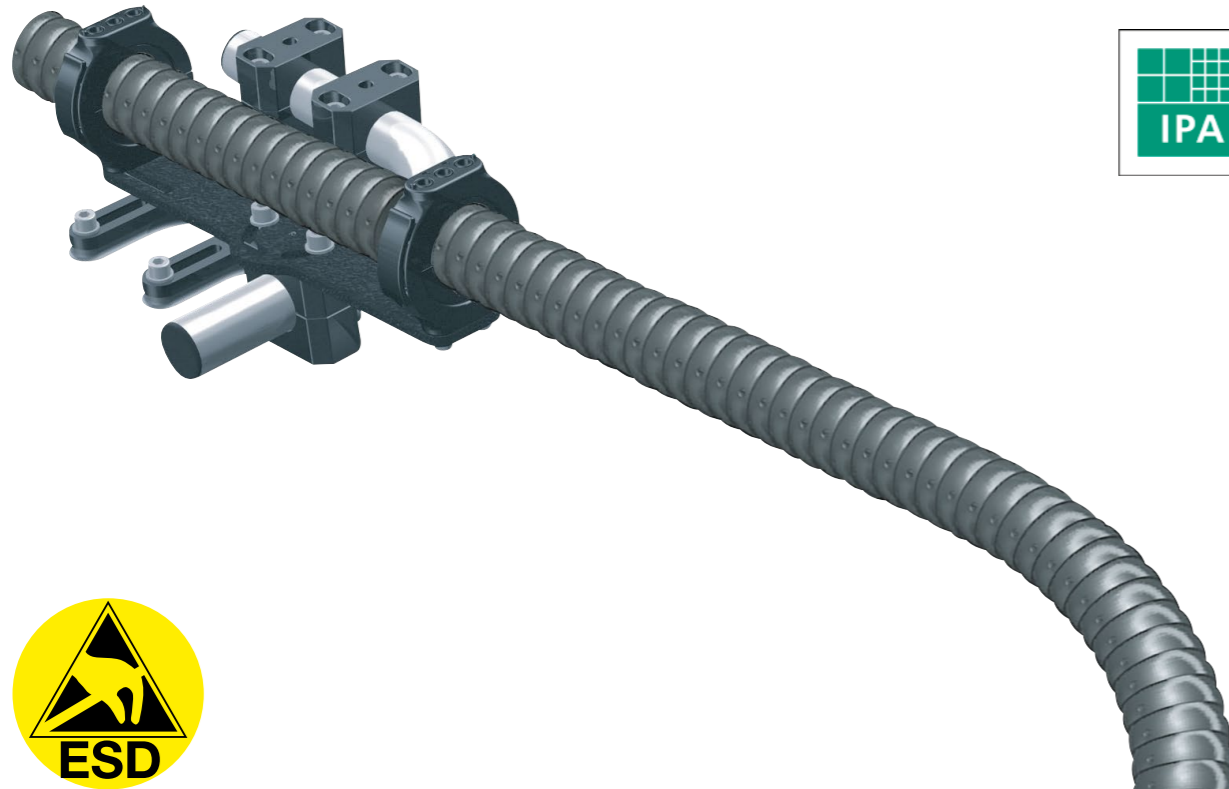


SKS20 e-skin® soft

Low clearance height, flexible filling with proven zipper opening principle

Inner width 33mm

For robots in dry cleanrooms



Robot energy supply system for dry-cleanroom applications

The triflex® energy chain TRC.40.058.0.ESD combined with the associated fibre-rod system represents the first energy supply for dry room applications that can move in three dimensions. In the context of the increasingly present electromobility, which has become an integral part of our everyday lives, requirements for the automated production of lithium-ion batteries have to evolve.

- ▲ Energy chain that is suitable for dry cleanrooms and can move in multiple axes
- ▼ Quick and simple assembly due to prefabricated modules
- Dry cleanroom ISO 4-5 certification from the Fraunhofer IPA
- Standard change® material; individual chain links can be replaced
Important contribution to e-mobility

Test report

TRC.40.058.0.ESD with fibre-rod module



Source: Roman Hickel, Fraunhofer IPA

The system was specifically designed for use on industrial robots to ensure a smooth and ideally contact-free production process. The integrated fibre glass rods serve to stabilise the energy chain up to the fifth axis and prevent contact between the industrial robot and the energy chain. The subsequent TRC energy chain enables the movements

to be followed precisely and thus offers a high degree of flexibility, which is particularly advantageous in dynamic areas of application. With thousands of successful applications in conditions other than cleanrooms, the system has been tried and tested in practice and stands for reliability and efficiency.

Test environment:

The system was tested in a dry cleanroom with a dew point of -40°C, which corresponds to a relative humidity of <1% at room temperature of 22°C and the cleanroom class ISO 3 with three different parameter sets:

Parameters	Cleanroom class (according to ISO 14644-1)
$v_1 = 0.5\text{m/s}; a_1 = 1.0\text{m/s}^2$	4
$v_2 = 1.0\text{m/s}; a_2 = 2.0\text{m/s}^2$	4
$v_3 = 2.0\text{m/s}; a_3 = 4.0\text{m/s}^2$	5
Result:	5

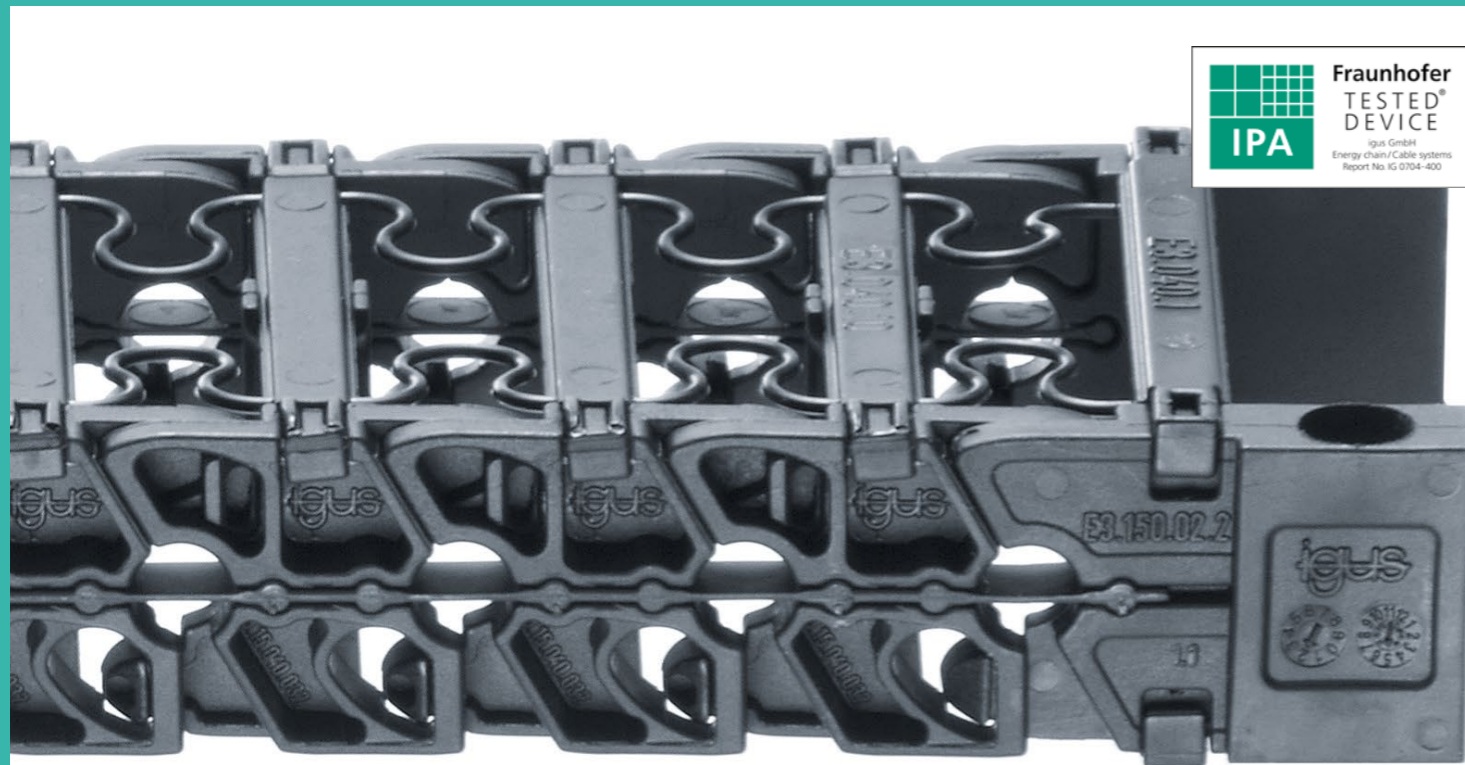
TRC.40.058.0.ESD
Closed triflex® energy chain in ESD

Size index	30-100mm
Bend radius	50-145mm

TRC.F.40.0800.1.0.ESD
TRC e-chain® reinforced with fibre glass rods

Size index	30-100mm
Bend radius	50-145mm
Length	300-2,000mm

Dynamic for cleanrooms

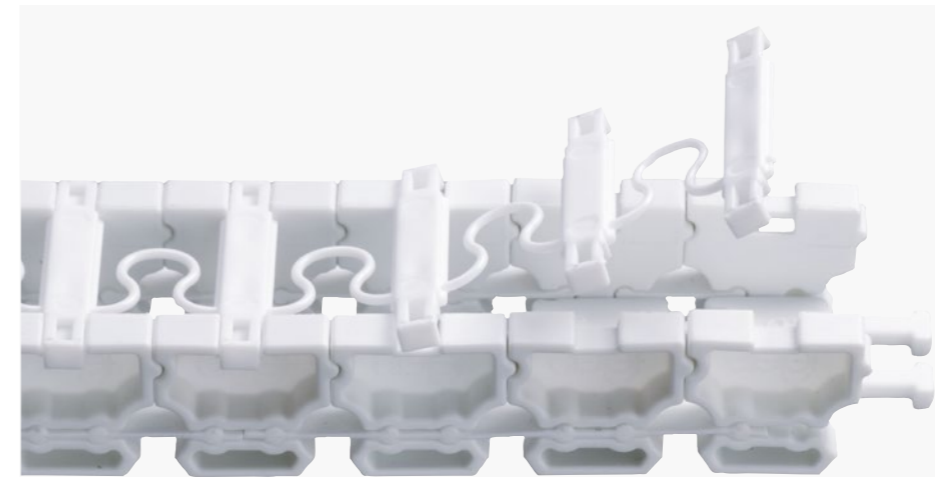


Extremely low noise for extremely small installation spaces

E3 combines small pitch, smooth running, low noise, stability, easy assembly and low cost. The spring connector element replaces the pin and bore and avoids relative movement between the joints. This means virtually no wear or abrasion (cleanroom). To reduce production and assembly costs, the spring connector is on a segment of ten e-chain® links.

- ▲ Low vibration at high speeds and accelerations
- ▼ Quick installation thanks to the crossbar band
- Cleanroom Class ISO 1, Fraunhofer IPA certified
- change® standard material

Modular system with high economic efficiency



E3 e-chains® in optional white colour; ideal for cleanroom and medical applications, available upon request

Benefits

- At high speeds and accelerations
- For lightning-fast opening and easy closing
- Quiet: 38dB(A)1 – small pitch for low-vibration operation
- Suitable for cleanrooms according to IPA cleanroom Class 1

Typical application areas

- Semi-conductor manufacturing and handling
- Pick and place robots
- Optics
- Material handling technology
- Measuring technology
- Printers and plotters
- Cleanroom environments
- General mechanical engineering

Three-part e-chain®



E3.10 e-chain®

Crossbars on a strip - zip-open along the outer radius

Inner height	10mm
Inner width	20 - 60mm



E3.15 e-chain®

Crossbars on a strip - zip-open along the outer radius

Inner height	15mm
Inner width	20 - 60mm



E3.22 e-chain®

Crossbars on a strip - zip-open along the outer radius

Inner height	22mm
Inner width	20 - 60mm

Fast assembly: zip-open along the outer radius

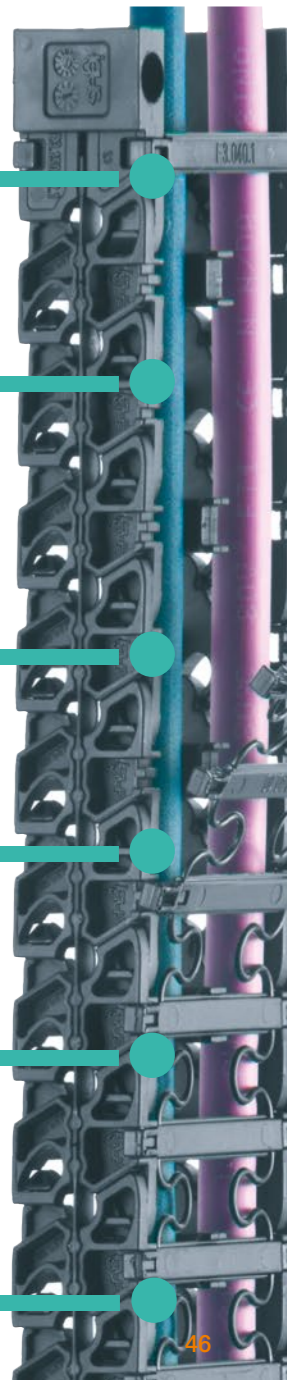
Dynamic: high speeds and accelerations

Modular design: Crossbars, interior separation, and crossbar all in one band

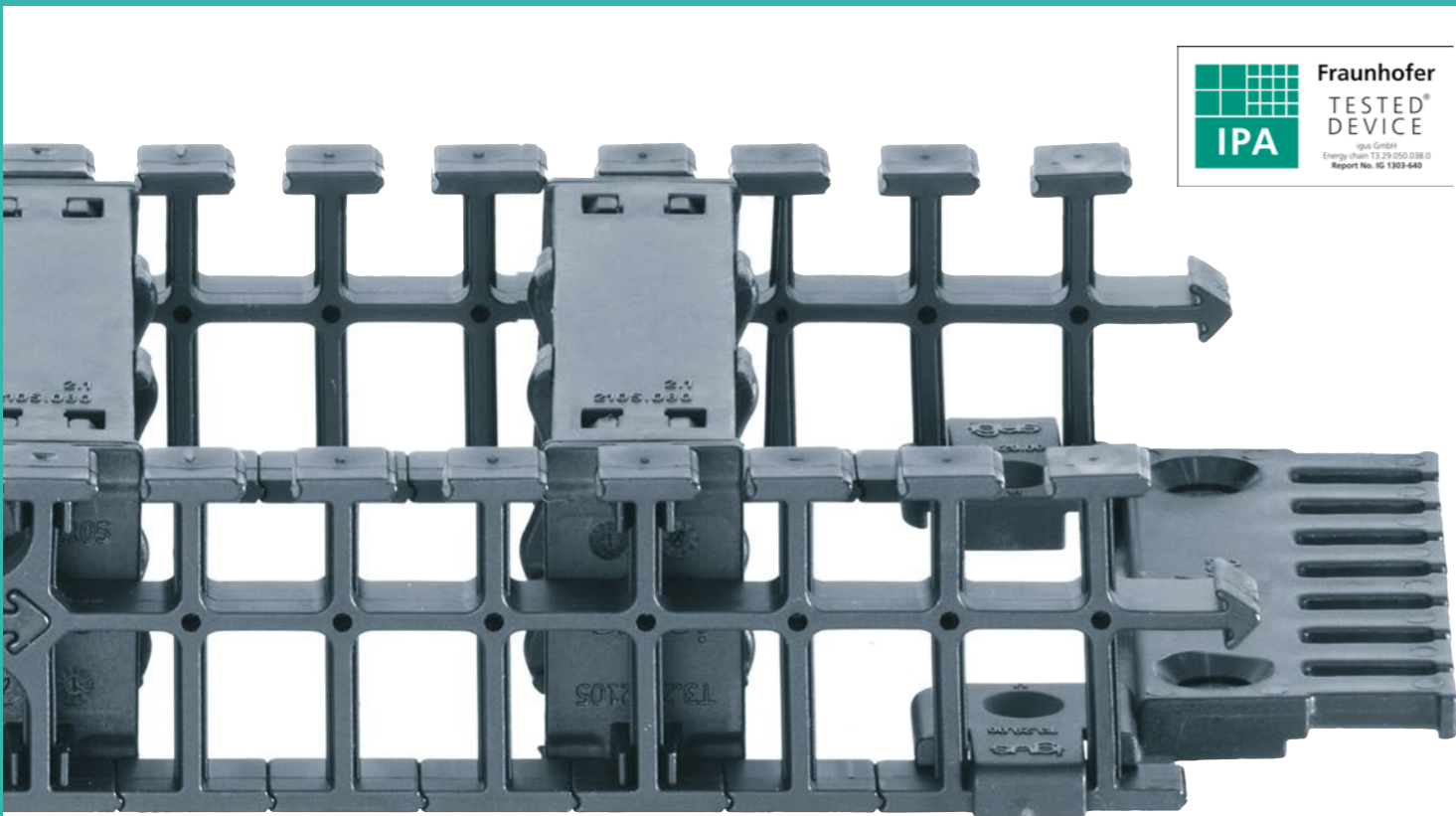
High strength: for unsupported applications

Quick assembly: openable along the outer radius

Modular design: can be easily lengthened and shortened



Smooth-operating "T-band"



Lightweight, highly flexible and low-vibration

The T3 system combines low noise operation, simple assembly and economy. The side bands, which snap together, replace a conventional pin and bore connection and prevent relative movements between the joints giving extremely low wear. This means virtually no wear or abrasion (cleanroom). The novel geometrical shape of the t-band, means that hardly any polygon effect is generated in operation. The t-band therefore rolls in a very smooth arc, giving extremely low vibration and noise. In order to reduce the manufacturing and installation costs, the t-band is made in a segment of 8 links. Due to its low mass, the igus® t-band, is suitable for applications with low fill weights and short strokes, combined with high speeds and accelerations.

- ▲ Almost no polygon effect, making it very quiet and low-vibration
- ▼ Lightweight energy chain
- ISO Class 2, Fraunhofer IPA certified
- change® standard material

Quiet, low-abrasion energy supply systems



Benefits

- Very light e-chain®
- At high accelerations and speeds
- Almost no polygon effect
- Small bend radii and extremely small installation spaces
- Quick, easy filling and assembly
- A quiet 33dB(A)1 – small pitch for quiet, low-vibration operation

Typical application areas

- Printers and plotters
- Cleanroom use
- Semiconductor production and machining
- Optics
- Measuring technology
- Pick and place machines

Durable energy supply systems for electronics production positioning systems

To safely guide the drive, measuring system, and compressed air lines, readychain® systems are used in this Jenaer Antriebstechnik GmbH positioning unit 24 hours a day, seven days a week. Two very quiet energy chains from the

E6 product range are used on the Y-axis on a length of about 2m, and a highly flexible energy chain from the T3 product range is used on the Z-axis on a length of almost 400mm. Both systems are suitable for production under cleanroom conditions, which also apply during circuit boards exposure and mean that almost no abrasion residue can be generated.

Universal: mounting plates and strain relief option

Low noise 33dB(A)1: small pitch for low noise, smooth running

Modular design: t-band in one segment of 8 e-chain® links

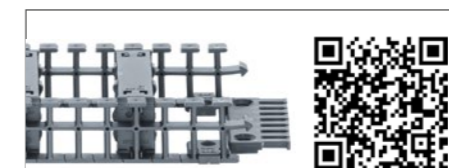
Modular: easy to lengthen and shorten at any point

Easy to use: clip-on interior separation clips

Dynamic: high speeds and accelerations

Efficient: lightweight

T-shaped band e-chains®

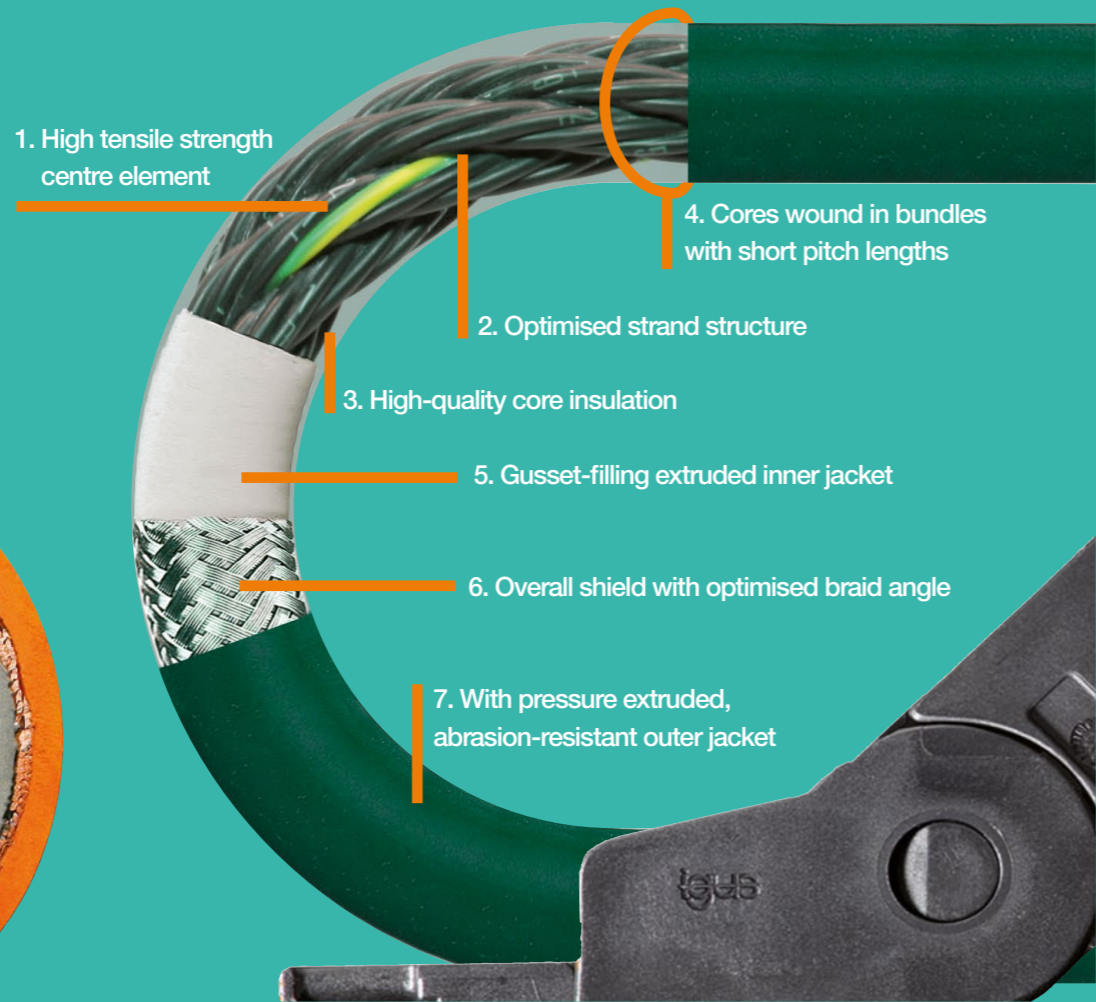


T3.29 e-chain®

Crossbars removable along the inner and outer radius

Inner height	29mm
Inner width	30 - 140mm

chainflex® cables for moving applications



1,350 chainflex® types ...



- Control cables**
- Bend radii down to 4 x d
 - Shielded or unshielded
 - Jacket materials: PVC, PUR, TPE



- Motor cables**
- Shielded and unshielded
 - For the most extreme applications
 - Jacket materials: PVC, PUR, TPE



- Fibre Optic Cables**
- Bend radius up to 5xd
 - Plastic fibre and glass fibre
 - Jacket materials: PVC, PUR, TPE



- Bus cables**
- Profibus, Profinet, CAN-Bus, Ethernet, CAT7, USB
 - Jacket materials: PVC, PUR, TPE
 - UL and NFPA79 certification



- Special cables**
- High tensile strength cables
 - Approval for railway technology
 - Special conductor materials



- Servo and hybrid cables**
- Abrasion-optimised
 - Seven quality levels
 - Jacket materials: PVC, PUR



- Measuring system cables**
- For high dynamics
 - For 22 drive manufacturers
 - Jacket materials: PVC, PUR, TPE



- Data cables**
- For travels up to 400m
 - Optimised shields with high coverage
 - Jacket materials: PVC, PUR, TPE



- Twistable cables**
- ± 180° at 5 million/m
 - UL and CSA
 - Jacket materials: PUR, TPE
 - 88 catalogue products from stock

chainflex® design tricks

chainflex® cables are unique

All a customer needs from an energy supply system is that it works. But this means that all sub-components, including the cables inside the system, must be completely reliable. This is just where problems arose in the early 1980s. In extreme cases, failures caused by "corkscrews" and core ruptures brought production to a complete standstill, resulting in high costs.

igus® was the first company to develop entire e-chain systems®. chainflex® cables and e-chains® are tested in combination and optimised. Design principles based on improved expertise and exhaustive testing since 1989 help prevent machine downtime all over the world.



Katharina Wielpütz
Product Manager chainflex®

Tested and certified

chainflex® designates special cables for e-chain systems®

Complex applications with high speeds and cycle and acceleration rates, and those that operate in adverse ambient conditions, require reliable cables for energy supply. They must have EMC safety and comply with standards and guidelines such as UL, CSA, and VDE. They must function reliably with Profibus, Profinet, or Ethernet. And our customers expect a consistent response to a wide

variety of movement types because they need the same electrical specifications in both long linear chains and small torsional movements. Our mission is to ensure all of this non-stop and globally.



* Four years or up to ten million double strokes (five million for cables of the chainflex® M family), whichever is first

Control cables




CF9

- For extreme heavy duty applications
- Oil and bio-oil-resistant
- Low-temperature-flexible

Jacket	TPE
Bend radius e-chain®	5 x d
Temperature e-chain®	-35°C/+100°C






CF10

- For extreme heavy duty applications
- Oil and bio-oil-resistant
- Low-temperature-flexible

Jacket	TPE
Bend radius e-chain®	5 x d
Temperature e-chain®	-35°C/+100°C



Fibre Optic Cables

CFL G.LB

- Graded glass-fibre cable for heaviest duty applications
- Non-metallic


Jacket	TPE
Bend radius e-chain®	5 x d
Temperature e-chain®	-35°C/+80°C

CFL G.G

- Glass-fibre optic cable for very heavy-duty applications
- Oil and bio-oil-resistant

Jacket	TPE
Bend radius e-chain®	10 x d
Temperature e-chain®	-40°C/+80°C




CF98.PLUS

- For extreme heavy duty applications
- Oil and bio-oil-resistant
- Low-temperature-flexible

Jacket	TPE
Bend radius e-chain®	3 x d
Temperature e-chain®	-35°C/+90°C






CF99.PLUS

- For extreme heavy duty applications
- Oil and bio-oil-resistant
- Low-temperature-flexible

Jacket	TPE
Bend radius e-chain®	3 x d
Temperature e-chain®	-35°C/+90°C

Data cables

Measuring system cables

CF11.D

- For extreme heavy duty applications
- Oil and bio-oil-resistant
- PVC and halogen-free

Jacket	TPE
Bend radius e-chain®	6.8 x d
Temperature e-chain®	-35°C/+90°C


Servo cables




CF12

- For extreme heavy duty applications
- Double-shielded
- Oil and bio-oil-resistant

Jacket	TPE
Bend radius e-chain®	10 x d
Temperature e-chain®	-35°C/+100°C




CF298

- For extreme heavy duty applications
- Oil and bio-oil-resistant
- PVC and halogen-free



Jacket	TPE
Bend radius e-chain®	4xd
Temperature e-chain®	-35°C/+90°C




CF299

- For extreme heavy duty applications
- Oil and bio-oil-resistant
- PVC and halogen-free

Jacket	TPE
Bend radius e-chain®	4xd
Temperature e-chain®	-35°C/+90°C






CF29.D

- For extreme heavy duty applications
- Oil and bio-oil-resistant
- PVC and halogen-free

Jacket	TPE
Bend radius e-chain®	6.8 x d
Temperature e-chain®	-35°C/+100°C

Motor cables






CF37.D

- For extreme heavy duty applications
- Oil and bio-oil-resistant
- PVC and halogen-free

Jacket	TPE
Bend radius e-chain®	7.5 x d
Temperature e-chain®	-35°C/+90°C



Bus cables

CFBUS.LB

- For extreme heavy duty applications
- Oil and bio-oil-resistant
- Low-temperature-flexible

Jacket	TPE
Bend radius e-chain®	7.5 x d
Temperature e-chain®	-35°C/+70°C

CF38

- For extreme heavy duty applications
- Oil and bio-oil-resistant
- PVC and halogen-free

Jacket	TPE
Bend radius e-chain®	7.5 x d
Temperature e-chain®	-35°C/+90°C



Spindle cables/ single cores




CF330.D

- For extreme heavy duty applications
- Oil and bio-oil-resistant
- PVC and halogen-free

Jacket	TPE
Bend radius e-chain®	7.5 x d
Temperature e-chain®	-35 °C/+90 °C






CF340

- For extreme heavy duty applications
- Oil and bio-oil-resistant
- PVC and halogen-free

Jacket	TPE
Bend radius e-chain®	7.5 x d
Temperature e-chain®	-35 °C/+90 °C

Twistable cables

CFROBOT5

- For torsion applications
- Oil and bio-oil-resistant
- UV-resistant

Jacket	TPE
Bend radius e-chain®	10 x d
Temperature e-chain®	-35 °C/+80 °C

Special cables

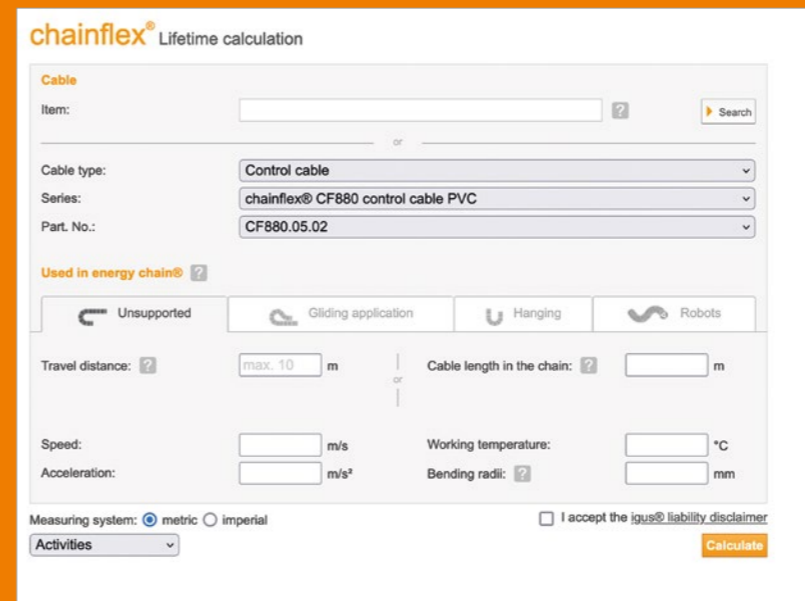



CFFLAT

- Single-core flat cable
- For extreme heavy duty applications
- Oil and bio-oil-resistant

Jacket	TPE
Bend radius e-chain®	5 x d
Temperature e-chain®	-35 °C/+90 °C

Simple calculation



chainflex® Lifetime calculation

Item: Search

Cable type:

Series:

Part. No.:

Used in energy chain® ?

Unsupported Gliding application Hanging Robots

Travel distance: m or Cable length in the chain: m

Speed: m/s Working temperature: °C

Acceleration: m/s² Bending radii: mm

Measuring system: metric imperial I accept the igus® liability disclaimer

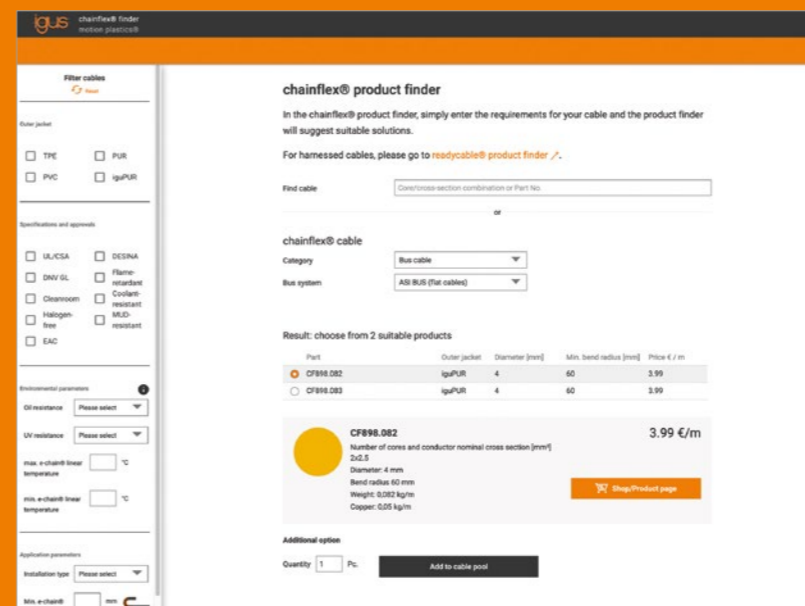
Activities: Calculate

With the chainflex® service life calculator, you can quickly and easily calculate the expected service life of chainflex® cables specifically for your application. The unique chainflex® guarantee is extended to 4 years with immediate effect.

igus.eu/chainflexlife



Easy to find



chainflex® product finder

In the chainflex® product finder, simply enter the requirements for your cable and the product finder will suggest suitable solutions.

For harnessed cables, please go to [readycable® product finder](#).

Find cable:

or

chainflex® cable

Category:

Bus system:

Result: choose from 2 suitable products

Part	Outer jacket	Diameter (mm)	Min. bend radius (mm)	Price €/m
<input checked="" type="radio"/> CF880.082	igUPUR	4	60	3.99
<input type="radio"/> CF880.083	igUPUR	4	60	3.99

CF880.082 3.99 €/m

Number of cores and conductor nominal cross section (mm²): 2x2.5

Diameter: 4 mm

Bend radius: 60 mm

Weight: 0.082 kg/m

Copper: 0.08 kg/m

Additional option

Quantity: Pcs. Add to cable pool

Find and compare cables

Find the right chainflex® cable for your e-chain® application in just a few clicks. A filter function for cleanroom suitability is now available as well.

igus.eu/quickcable



e-chains® for low ISO classes

e-chain® E2/000



E2/000 Series 1500

crossbars openable along the outer radius, from both sides

Inner width	15 - 125mm
Bend radius	035 - 180mm
ISO Class	2



2500 series

crossbars openable along the outer radius, from both sides

Inner width	25 - 125mm
Bend radius	055 - 250mm
ISO Class	3

e-chain® E4.1



E4.32

e-chains® with crossbars every link. The all-rounder – including for particularly demanding applications

Inner width	50 - 400mm
Bend radius	063 - 300mm
ISO Class	5

e-chain® E14



E14.3.038.0

Press the cable in along the outer radius

Inner width	38mm
Bend radius	38mm
ISO Class	2

Tough, low-noise, modular.

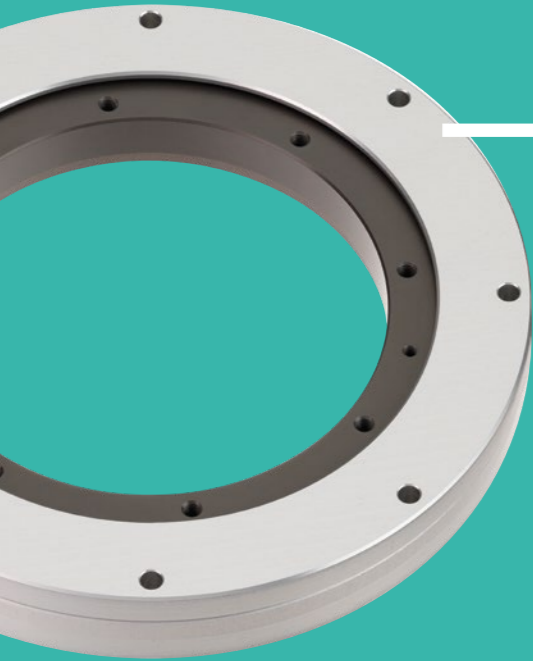


E4Q – the next generation of easy-to-assemble igus® e-chains®

Easy opening and closing, without tools. The latest E4Q e-chains® generation combines proven design features of the 12-year old, robust E4.1 e-chains® standard with new bionic design elements and a novel opening mechanism. This gives the E4Q an even longer service life and significantly improved ease of installation.



Bearing technology cleanroom solutions



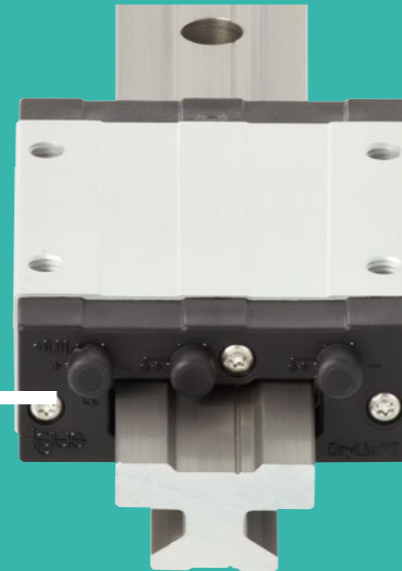
Tested and proven by the
Fraunhofer Institute
(ISO14644-1 Class 3 / 4)

Tested and proven by
the Fraunhofer Institute:
(DIN EN ISO 14644-1, Class 6)



Tested and proven by the
Fraunhofer Institute:
(DIN EN ISO 14644-1, Class 6)

Tested and verified by the
Fraunhofer Institute
(DIN EN ISO 14644-1, Class 5)



Cleanrooms have special requirements of machines and equipment and of their components. If you are looking for plain bearings for cleanroom-compatible devices, you most likely know about cleanroom specifications. This article is not so much about definitions and

general requirements, but about the specifications that are relevant for plain bearings, and about which plain bearings meet these requirements and how.



Bearing technology

Plain bearings for the cleanroom – how clean are they?



The problem with all cleanroom devices: particles wind up in places besides where abrasion took place

Cleanrooms qualify primarily based on one requirement: they contain only certain amounts of airborne particles of a certain size. And this is the big challenge. Complex ventilation systems and elaborate safety precautions keep out as many existing particles as possible. But what about particles that are generated in the cleanroom? Relative movement of surfaces creates abrasion residue when there is sufficiently high mechanical stress or sufficiently low abrasion resistance.

These particles don't have to resemble the residue left behind by an eraser after an extensive modifications to a text. The amount and shape of the abrasion residue depend very much on the material and the condition of the surfaces being used. It also depends on the type of movement and the forces that act during that movement.

Which plain bearings are suitable for the cleanroom?

Plain bearings serve to minimise the abrasion wear that inevitably occurs during relative movement and, above all, to allow abrasion to proceed in a controlled form. On the one hand, movement is to be optimised and as controlled as possible. On the other, the bearing needs to last as long as possible.

Both factors favour use in cleanrooms. The less the abrasion residue generated, the fewer the particles that are released. But the difficulty that arises as early as plain bearing selection – when equipment for the cleanroom is being designed – is determining which abrasion particles will be "generated" and how many. This information is essential to determining the cleanroom class for which the components, or the devices and machines made from them, are suitable.

As mentioned above, the number and properties of the particles depends on several parameters. What material are moving parts made of? What surface finish, hardness, and shape do sliding surfaces have? How fast, at what frequency, and in what way do surfaces move relative to each other? What is the ambient temperature? All these factors individually and in combination have different effects on the size and amount of abrasion residue. It is theoretically impossible to determine the interactions of all parameters in advance.

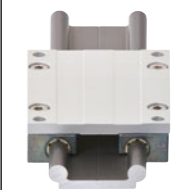
Cleanroom classifications can therefore be assigned only to complete assemblies in which these parameters are limited to specific combinations and application scenarios. So plain bearings sold as individual components can have no cleanroom classification.



iglidur® PRT-04-100-CR

Low wear and emissions

Inner Ø	100mm
Outer Ø	160mm



drylin® W profile guides

Fully assembled linear carriages with iglidur® J liner

Installation size/shaft Ø	6-25mm
Shaft material	Aluminium



drylin® N low-profile guides

Guide carriage made of iglidur® J, suitable for aluminium design profiles

Rail width	17-80mm
Rail height	6-12mm

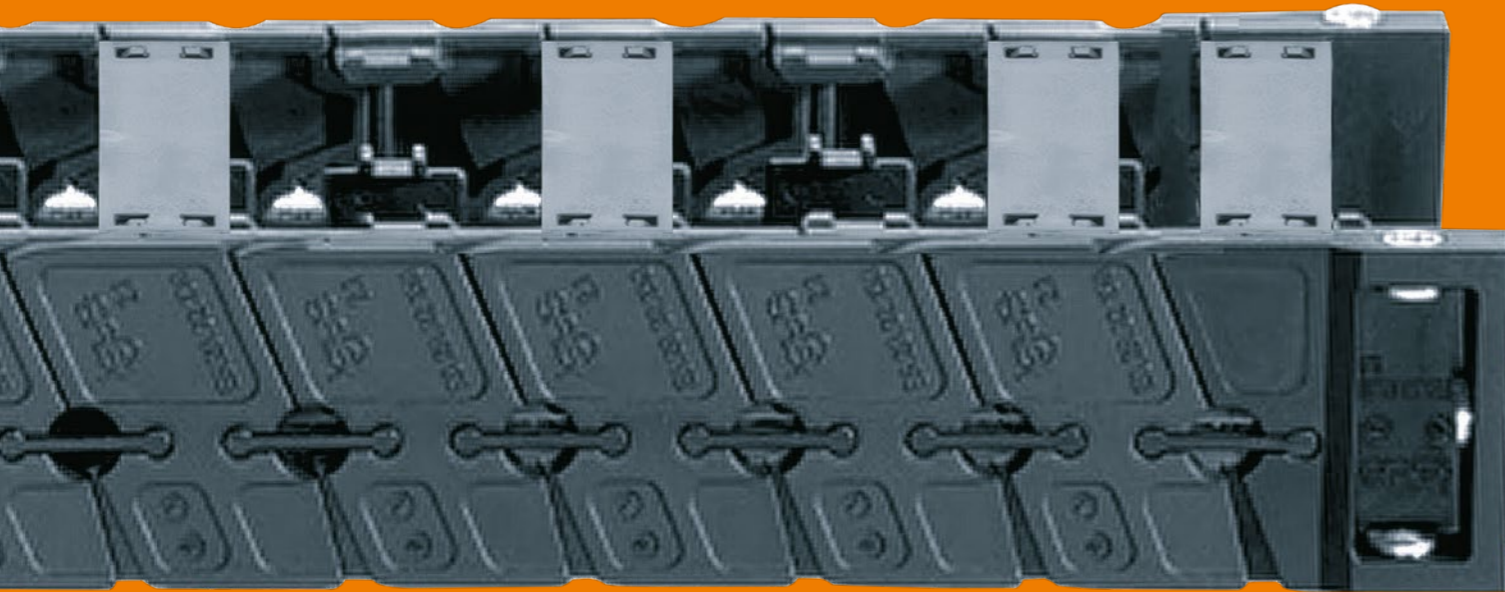


drylin® T rail guides

Linear carriage dimensionally identical to recirculating ball bearing guides

System width	17-90mm
System height	8-42mm

For dry rooms and cleanrooms



E6.29 – The first e-chain® for IPA ISO Class 4 dry cleanrooms

The proven E6.29 series with its standard inner width is now certified by Fraunhofer IPA for use in dry cleanrooms (ISO Cleanroom Class 4).



Overview

Material selection for cleanrooms

Material	Densit [g/cm³]	Colour	Moisture content at saturation after storage at 50% room humidity [% weight]	Fire class	Min. application temperature [°C]	Max. long-term application temperature [°C]	Max. short-term application temperature [°C]	Resistance areas
igidur® J	1.49	yellow	0.3	HB	-50	90	120	Insulating
igidur® P	1.58	black	0.2	HB	-40	130	200	Insulating
igidur® P210	1.40	yellow	0.3	HB	-40	100	160	Insulating
igidur® H1	1.53	cream	0.1	V-0	-40	200	240	Insulating
igidur® X	1.44	black	0.1	V-0	-100	250	315	Conductive
igidur® F2	1.52	black	0.2	HB	-40	120	165	ESD
igidur® H370	1.66	grey	0.1	V-0	-40	200	240	Conductive

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Published by igus® GmbH, Germany
MAT0075622.20 11/2023

Subject to technical alterations.

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