

# motion

MACHINE TOOLS MAGAZINE

Improve technology ... reduce cost.



plastics for longer life®

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# motion plastics® for the machine tool industry



Your technical innovator and cost reducer:

## Lukas Czaja

Head of Industry Management Machine Tools  
Phone: +49 2203 9649-7722  
e-mail: lczaja@igus.net



Your technical innovator and cost reducer:

## Markus Kogelmann

Industry Manager Machine Tools  
Germany, Austria  
Phone: +49 8237 9529-736  
e-mail: mkogelmann@igus.net



Your technical innovator and cost reducer:

## Volker Beissel

Industry Manager Machine Tools  
Phone: +49 2203 9649-7041  
e-mail: vbeissel@igus.net

## Reduce process costs by 80% – worldwide

Machine tool manufacturers often have production locations around the world. In order to ensure globally consistent quality, uniform parts lists for their machines are important. However, manufacturers are sometimes forced to have different variants or delivery times for different locations. With 3,800 employees at 35 locations, igus® is always right at the heart of the machine tool, combining the benefits of global availability, fast delivery and global support. In China, for example, we have more than 400 employees and our own readychain® factory for customised harnessing. We will continue to expand capacities and move to a new factory in Shanghai in 2019. We can offer you the same service at other machine tool production hubs, such as Japan, Italy, Taiwan, Korea, India, Brazil and the USA.

Find new ways to optimise your assembly time, logistics effort and procurement process with turnkey igus® readychain® systems here:



igus.eu/machinetools

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Ready-to-install energy supply directly to the machine.



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Easy-to-assemble and swarf resistant.



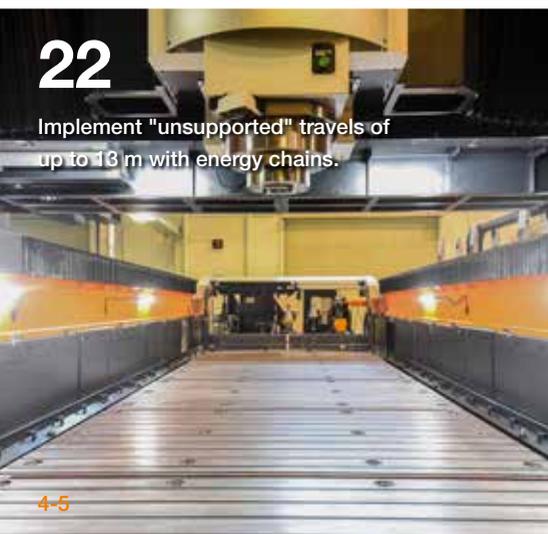
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The flexible igus® factory in Cologne.



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Implement "unsupported" travels of up to 13 m with energy chains.



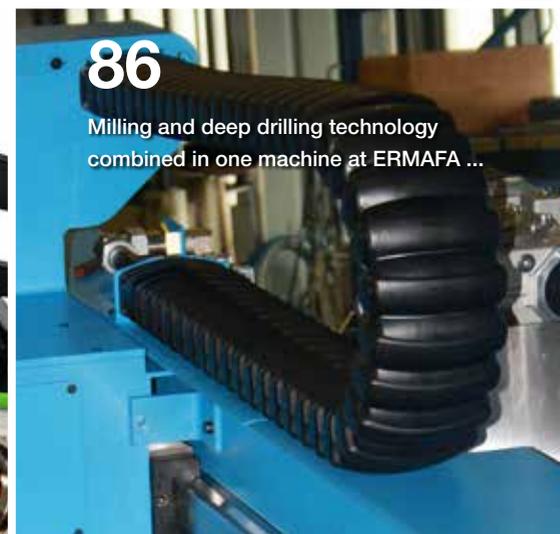
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Faster and more economical strain relief



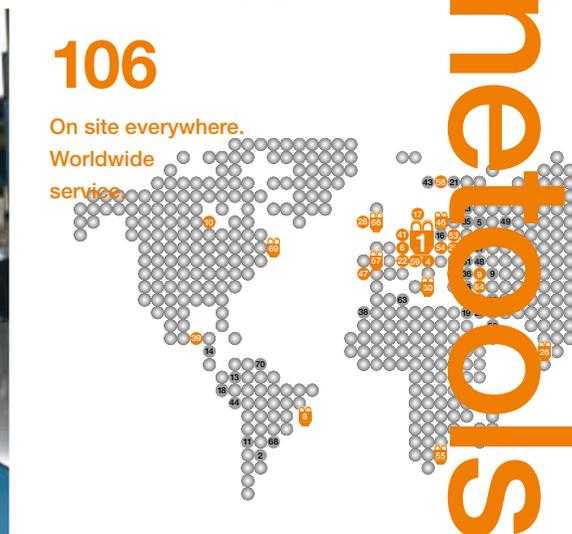
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Milling and deep drilling technology combined in one machine at ERMAFA ...



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On site everywhere. Worldwide service





# Minutes instead of days: Complete solution from igus® reduces assembly times of machining centres

day. Previously, two employees took one and half weeks for the work on the X axis of an AERO system and a further week for the energy supply of the Y and Z axes. In this way, Hartford is able to **cut out some work steps, reduce process cost** and, at the same time, **greatly improve productivity**. While rely on the tried-and-tested quality of the readychains® from igus®.



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**Thanks to ready-to-install readychain® systems from igus®, process costs can be lowered and errors reduced**

In its robotic machining centres, Taiwanese tool manufacturer Hartford uses **fully-assembled energy chain systems** from igus®. This cuts out many process steps for the manufacturer, reducing assembly time from several weeks to just half a day. Another benefit for Hartford is that, when it orders readychain® from igus®, it is **from a single source** and delivered onsite fully-tested for reliability and safety. igus® is the only supplier to develop energy chains as well as the cables that are designed specifically for use with them. These so-called '**ready-chains®**' can be pre-assembled to customers' requirements at **12 locations all over the world** and are then **delivered as ready-to-install products**.

igus® showed Hartford a solution for the **AERO-series** machining systems. The igus® energy chains enabled the Hartford engineers to significantly reduce the installation space. One reason for this is that all chainflex® cables on the machine have an **oil-resistant PUR outer jacket**. As additional protective hoses are superfluous because of this feature, the amount of space needed for the cables and therefore the size of the chains are reduced. The absence of these protective hoses reduces cost and helps ease maintenance too. In a process of close collaboration between igus® Taiwan and Hartford, a **3D drawing** of the readychain® with assembly frame was then created in order to simulate the assembly procedure. The benefit could be seen immediately: The first energy chain fitted with all electrical cables was **installed on the machine in an hour**. The **second chain** with hydraulic hoses was installed even faster, taking **just 40 minutes**.

**Work steps cut out for significantly greater productivity**

Normally, machine tool manufacturers try to avoid situations where too many different work steps have to be carried out on a system at the same time. A lot of manual work done by different employees does not automatically enhance efficiency; on the contrary, it increases the probability that errors can occur. By using **igus® readychains®**, all four e-chains® from igus® can be fully installed in half a



igus energy chains, including cables and mounting frame, are delivered to Hartford as fully-assembled readychains®.



Watch a video of the installation at Hartford here.



From left to right: Dexter Tzu, Lukas Czaja, William Wang (all igus®), Leo Chang (Hartford).



## Ready-to-install, industrially harnessed: [igus.eu/readychain](https://igus.eu/readychain)

Always the right harness for your application. Ready-to-fit readychain® e-chain system® configured and delivered in 3-8 days.

This is possible due to the large selection of energy chains for all kinds of motion; cables for e-chains® with 36-month guarantee complete with the relevant connectors. Reduce the number of suppliers and orders by 75%. Minimise machine downtimes. System guarantee - depending on the application.



- Basic**  
e-chain® with fitted cables - with strain relief in the system.
- Standard**  
e-chain® with cables and connectors
- Standard+**  
Pre-harnessed e-chainsystems® with sheet-metal parts
- Premium**  
Ready-to-install complete system with transport rack



The most common harnessing level in the machine tool industry:

### Premium

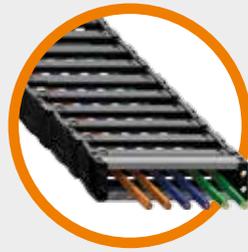
Ready-to-install complete system with transport rack

[igus.eu/readychain](https://igus.eu/readychain)



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# readychain<sup>®</sup> basic, standard, standard+ and premium: The productivity accelerators



readychain<sup>®</sup> basic:  
3 ... of 13  
readychain<sup>®</sup> benefits



readychain<sup>®</sup> standard:  
6 ... of 13  
readychain<sup>®</sup> benefits



readychain<sup>®</sup> standard+:  
9 ... of 13  
readychain<sup>®</sup> benefits



readychain<sup>®</sup> premium:  
13 ... of 13  
readychain<sup>®</sup> benefits

## 3 ... 6 ... 9 ... 13 ... readychain<sup>®</sup> benefits

Your benefits	BASIC	STANDARD	STANDARD+	PREMIUM
ONE supplier - combine suppliers	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Reduce assembly time	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Reduce failures	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
No electrical termination needed	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
100% digitally tested	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
No cable surplus	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Reduce interfaces	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Optimise points of connection / interfaces	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Ready-to-install multi-axis system	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Optimise your transport / assembly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
One single assembly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
One part number / product group	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Plug & play	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Your benefits at a glance	BASIC	STANDARD	STANDARD+	PREMIUM
Reduction of assembly time	■ ■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■ ■ ■
Reduction of logistics cost	■ ■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■ ■ ■
Procurement optimisation	■ ■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■ ■ ■	■ ■ ■ ■ ■



igs.eu/machines/tools

# The readychain® principle: All components from one source

## From e-chains® for all types of movement ...

Millions of igus® e-chains® are being reliably used world-wide. From small devices up to steelworks, from very simple linear applications up to the most complicated task - igus® offers thousands of options for all types of applications. igus® e-chains® are easy to assemble and achieve up to 80% time savings, e.g. when using the E4.1 series and the new LEAN separators.

[www.igus.eu/e-chains](http://www.igus.eu/e-chains)

## ... and chainflex® cables ...

With 1,354 cables from stock, we offer the largest range of cables specifically for the energy chain. Thanks to the industry's largest test laboratory with a floor area of 2,750m<sup>2</sup>, where among other things one million electrical measurements are conducted every year, we are the only supplier to give a 36-month guarantee\* on all chainflex® cables.

[www.igus.eu/chainflex](http://www.igus.eu/chainflex)

## ... up to harnessed systems

Ready-to-install energy supply systems are tailor-made for each customer, harnessed and delivered. The customers can dispense with their own storage space for e-chains®, cables and connectors, saving time and space for internal logistics and for assembly and installation of their energy supply system. The ready-made modules reduce process costs of our customers by up to 80% and accelerate throughput. Machine downtime and plant faults can also be minimised.

[www.igus.eu/readychain](http://www.igus.eu/readychain)

\* Guaranteed for 36 months or 10 million double strokes (up to 5 million double strokes for cables in the chainflex® M family). Whichever comes first. The number of double strokes depends on the type of installation and the cable quality. These are described in the current catalogue, in the data sheets and in the service life calculator at [www.igus.eu/chainflexlife](http://www.igus.eu/chainflexlife).



igus.eu/machinetools

## World record at Bihler: the fastest stamping and bending machine in the world

With a new drive concept to a world record: the fastest servo machine for stamping and bending moves and positions the individual units servo-electrically. Critical to the operation: the energy chains from igus®.

Bihler uses complete energy chain systems from igus® for supplying servo units.

With its RM-NC and GRM-NC machines, Otto Bihler Maschinenfabrik GmbH & Co. KG has developed the fastest stamping and bending servo machine in the world. Its key characteristic is a new drive and control concept for the moving tools. Energy is supplied in energy chains containing chainflex® cables from igus®, delivered as completely pre-harnessed, ready-to-install readychains®.



High accuracy  
and very fast: up  
to 300 precision  
parts per minute

The high-speed RM-NC and GRM-NC servo machines from Otto Bihler Maschinenfabrik turn out up to 300 precision parts per minute.

From the customer's point of view, they have the advantage that they are completely compatible with the widely used machines in the RM and GRM series. The user can make use of existing tools and then produce the desired quantity of stamped and folded parts in half the time. The retooling times are even reduced by a factor of ten. This means that output increases by more than 300 per cent in some cases. And the machines are significantly more flexible.

High accuracy and very fast: new drive and control concept.

Such gains in productivity can only be achieved with new design concepts. In the case of the Bihler machines, this means servo drive technology, sophisticated control technology plus intuitive operation. Once the position has been preset, the carriage units can be automatically moved along a circular path and exactly positioned in a radial and linear direction. A precision of 0.02 degrees is achieved when this is done. This ensures fast retooling without the replacement of cams as in the case of mechanical machines.



Made-to-measure energy chains protect the fail-safe cables.

Here, the E2/000 energy chain from igus® in combination with the chainflex® cables proves its worth. A closed version of the chain with an additional protective fabric hose is used in some places within the machine. This prevents stamping residues from getting into the chain. The energy chains in the upper and lower areas have zones with a reverse bend radius so that they can adapt themselves to any desired position and therefore save space.



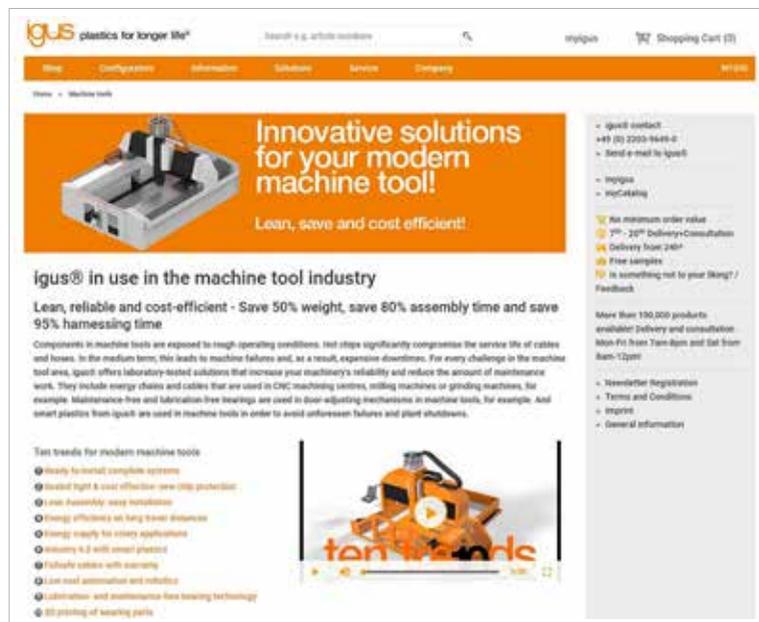
# Find more information, configure and order online: [igus.eu/machinetools](https://igus.eu/machinetools)

Visit our industry web pages for more information, products, application examples and useful online tools.

Quickly find and configure products and calculate service life - all online. With the help of our product finders, you can quickly find the right article and obtain an exact prediction of service life. All online tools also enable you to reduce process cost. igus® delivers from stock in 24-48 hours!

**For any task - in any batch size.**

Different industries need different solutions. igus® offers customised support for specialised applications. For the machine tool industry, igus® has many years of experience and specialised experts that are ready to assist you.



igus.eu/machinetools

# Configure e-chains® online

igus plastics for longer life®

www.igus.eu/onlinetools

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Home > Online tools

## igus® online tools: simple online configuration

You are looking for a possibility to configure your product exactly the way you need it for your application? Our tools provide you with suitable equipment so that you can put together your desired product quickly and easily. Whether for e-chains®, chainflex® cables, iglidur® bearings, drylin® linear bearings and many other product areas – we offer you a wide range of reliable configuration and calculation tools. Reduce your process costs with our online tools and many other useful online services. Do you require support? We are happy to help you – feel free to call us.

Here you can find an overview of our online tools for ...

- » ... e-chains®
- » ... chainflex® cables
- » ... readychain® harnessed e-chainsystems®
- » ... iglidur® plain bearings and bar stock
- » ... igubal® spherical bearings
- » ... drylin® linear bearings, drive technology and lead screw units
- » ... xiros® polymer ball bearings
- » ... robotlink® joint kit for robots
- » ... Online tool apps

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mye-chain® : online tools

**Online tools**

More than 30 online tools help you to quickly find, configure and calculate the right product. No registration necessary. 3D CAD models are available for downloading at: [www.igus.eu/configurator](http://www.igus.eu/configurator)

## Milling without sagging

The linear robot machining centre KMC-G is designed for workpieces from the aviation and machine tool industry.



Large machining centre gantries are the speciality of machine tool builder Kao Ming in Taiwan. The long travels of up to 13 metres provide challenging requirements for the supply of energy and media.

At Kao Ming great emphasis is placed on a very strong basic machine design. The structural elements are made of Meehanite casting. On the travel axes, box guideways ensure maximum rigidity and damping.

The KMC-G series is one of the company's largest linear robot machining centres. The system is designed around a gantry i.e. the machining table with the workpiece remains stationary. The dimensions of these parts are getting larger. The first G-series plants had a travel distance of six metres in the X axis, and the current model series is already 13 metres. In order to be able to process different workpieces, this plant is equipped with a changing device for the machining tool so that milling heads with different machining angles can be used.

The machining centre is equipped with a changing device for the milling tool.



### The energy supply is the challenge.

The different axes increase the number of cables and hoses that are needed for energy, media and data and that have to be dynamically guided from the central control cabinet through the plant to the milling unit. The **special modular design** also increases the demands on the energy chain, since the travels are longer. In this system, additional modules can be inserted on the X axis. "For longer travels, no energy chain can be used without support. This is especially true when you consider the extra weight of the hoses and cables inside the chain," explains Kao Ming General Manager Tim Chang.

## igus® guidelok meets the highest requirements for energy supply



The pivoting roller holders allow the chain to run freely while supporting the upper run.

The **igus® guidelok system** matches the requirements almost perfectly. The special design of the **supporting rollers** ensures that the upper run of the chain can move smoothly and rapidly. Each roller can move out of the way when the chain radius moves past it. Thanks to this simple technical design, regular maintenance is unnecessary. Moreover, the design allows the option to have two opposite chains move within the same trough system. The travel distance can even **extend to 50 metres long**.



Impressive dimensions: the X axis of the KMC-G travels over 13 metres.



This energy chain keeps swarf out. The unique design means that no swarf can settle between the gliding surfaces of the upper and lower run of the energy chain.

## Tested at Gurutzpe in Spain: energy chain for travels up to 50 metres, unsupported



The Spanish mechanical engineering company **Tornos Gurutzpe S.A.**, based in Guipúzcoa, has delivered more than 5,000 machines within half a century. Its horizontal lathe, the "A-2000 4G CNC", is equipped with a novel energy chain solution for long unsupported travels in the swarf areas.

The buyers of the lathes all over the world place great emphasis on reliability and efficiency. The customers of Tornos Gurutzpe S.A. are mainly located in Europe, the USA, India and the oil-producing countries. Around 30 machines leave the Gurutzpe factory every year.

The philosophy of Gurutzpe is based on the durability of each component. "Even machines from us which are decades old are still being used productively by our customers," reports sales manager Oscar Anitua. The new "A-2000 4G CNC" horizontal lathe, a first model of which has been delivered to a customer in the wind energy sector, is fitted with two double-run "guidelok" energy chains from energy supply specialist igus® S.L., Barcelona. The two opposing energy chains have an unsupported connection to the carriage over a length of 13.5m.



# Swarf-, dirt-proof and strong: modern and resistant plastic instead of heavy steel

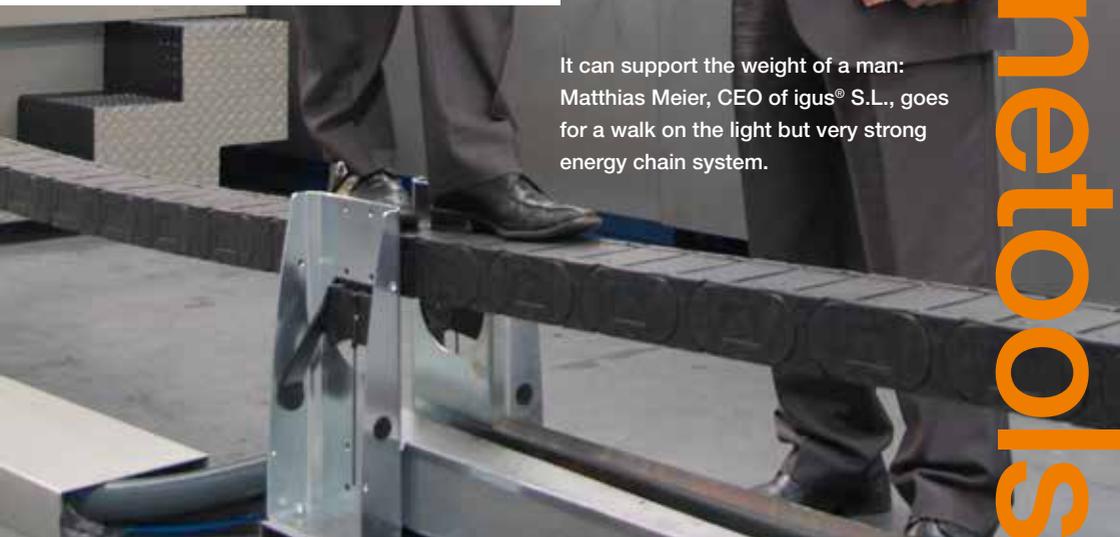
A new energy chain solution from igus® was specially developed for unsupported long travels up to 50m in swarf areas.

The guidelok system guides the upper run of the energy chain on pivoting roller holders that fold inwards inside the moving radius of the chain and thus ensure free travel at all times. Guided in a light trough channel, the energy chain initially travels past the roller holders. These then fold in and then after the radius, back out again. Then the upper run is supported again on the roller holders. Due to this novel design, no swarf can settle between the gliding surfaces of the upper and lower run of the energy chain.

If a customer is worried that the hot swarf produced during metalworking could eat through the plastic, they can reach for the soldering iron and applies it to the energy chain. "When the customers see that this has no effect on the energy chain either, they can have full confidence," says the electrical engineer. Market demand is increasingly tending towards very large and long lathes. "Gurutzpe has already built lathes with a length of 20m." As regards the important issue of energy supply, these distances are easily handled with the guidelok energy chain system.

Modern and resistant plastic instead of heavy steel. Joaquín Orbegozo, head of electrical engineering at Gurutzpe, is convinced of the advantages of the horizontal guidelok guidance system from igus®. "The energy chain is robust and torsionally stable, and functions reliably." The machine manufacturer points this out to its customers as well. "Sometimes people say, I would like to have this or that machine - but with an energy chain made of metal please." Then Joaquín Orbegozo presents the lighter but highly stable plastic energy chain, jumping up and down on it, demonstrating that it can carry the weight of a grown man easily.

It can support the weight of a man: Matthias Meier, CEO of igus® S.L., goes for a walk on the light but very strong energy chain system.

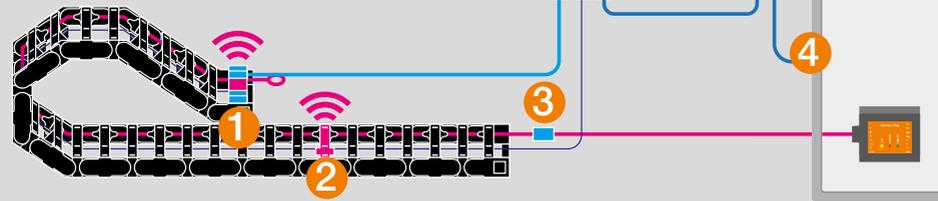




## smart plastics - enhance the fail-safety of your machine tool

igus® **smart plastics** increase the fail-safety of your machine tools. Intelligent products forecast the maintenance date ahead of time and can be integrated seamlessly into your processes (predictive maintenance).

The isense family of igus® products consists of various sensors and monitoring modules. They detect wear during ongoing operation and **issue an alarm** as soon as **repair or replacement** is necessary. Networking by means of the igus® Communication Module (jcom) enables direct integration into your company-wide IT infrastructure. This enables scenarios such as continuous monitoring or **automatic triggering of maintenance work**. An optional connection with the igus® data centre widens the options: individual lifetime optimisations and faster operational processes like automatic ordering of external maintenance teams or ordering of spare parts. These include maintenance commissioning or spare parts ordering. Thanks to smart plastics your equipment runs continuously and your maintenance costs go down.



- 1 Motion sensor with wireless transmission
- 2 Wear sensor with wireless transmission
- 3 Temperature sensor
- 4 Compact control and switching units
- 5 Communication module
- 6 Customer control and alarm function

- Reduce maintenance costs
- Eliminate unplanned downtime
- Long service life
- Increase equipment efficiency
- Detect anomalies quickly
- Reduce energy consumption

[www.igus.eu/industry4-0](http://www.igus.eu/industry4-0)



## smart plastics in use at an Austrian auto- motive supplier



igus.eu/machinetools

This engine factory is the biggest and most important engine factory of a large German car manufacturer.

On average, an engine comes off the assembly line every 14 seconds - in peak periods, more than 6,000 engines are produced every working day. This output can only be achieved with a high degree of automation using reliable components. This is why companies rely on smart plastics from igus® to avoid unforeseen failures and machine shutdowns.

With the help of a polymer wire (inside the energy chain) and a sensor unit, **isense EC.B modules** monitor the condition of the chain. In the event of a chain breakage, the machine is stopped automatically to prevent consequential damage.

**isense EC.W modules** have also been fitted. A sensor built into the crossbar signals advanced wear of the chain. The measurement of wear data means that a chain's remaining service life can be predicted and replacement can be planned at an early stage.

# Always the right solution for machine tools

igus® always offers the right products, for your application - guaranteed!

- Swarf-proof energy chains - no ingress of metal swarf into the stop-dogs or interior
- Closed energy tubes - large, small, oil-resistant
- Smooth and very quiet operation for clean machining and milling finishes
- 1,354 cost-effective chainflex® cables for moving applications
- Cables for extreme movements and radii of  $3.8 \times d$  and more, oil-resistant (UL-/EAC-/CTP-compliant)
- 36-month guarantee on all chainflex® cables\*
- Harnessed readychain® systems in 3 to 10 days
- 4,200 harnessed drive cables in accordance with 24 manufacturer standards
- Lubrication-free, maintenance-free and dirt-resistant plain and linear bearings



For example:

Reduce harnessing and assembly times by 80%, yet very swarf-proof: R4.1L

- Light and strong e-tube
- For use directly where swarf is produced
- Openable from both sides

[www.igus.eu/machinetools](http://www.igus.eu/machinetools)



\* Guaranteed for 36 months or 10 million double strokes (for cables of the chainflex® M family up to 5 million double strokes). Whichever comes first. The number of double strokes depends on the type of installation and the cable quality. This is described in the current catalogue, on the data sheets and in the service life calculator at [www.igus.eu/chainflexlife](http://www.igus.eu/chainflexlife).



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# Energy-efficient plastic energy chains reduce consumption by up to 57%

## Breakthrough in "green" production automation

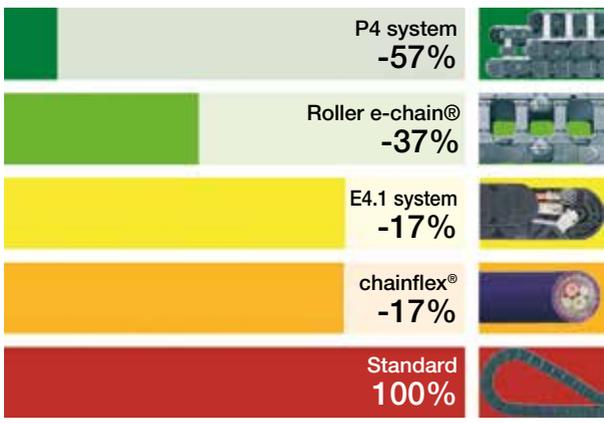
The P4 system helps to lower energy consumption dramatically as, when it is combined with chainflex® cables, the drive forces required to move the system can be reduced by as much as 57%. This is possible because the P4 e-chain® does not glide but instead rolls when moving.

This is only one of many options for designing more energy-efficient machinery with igus® products. For instance, igus® has been relying on "LEAN" energy chains, which are 30 percent lighter than dimensionally equivalent products while still being very tough. igus® lightweight solutions need less drive power, are more cost-efficient than standard products and offer increased energy efficiency by reducing energy consumption, and promote compact design by way of smaller drives. chainflex® cables also reduce the weight. Employing high-grade jacket and insulation materials can result in weight savings of 5 to 30 percent. This reduces the drive power needed by 17 percent. High-grade abrasion-resistant jacket materials facilitate particularly thin-walled extrusions, which results in weight savings of up to 18 percent. In addition, using high-grade materials for insulating materials enhances electrical performance with small electrical cross-sections. Weight reductions of up to 30 percent can be achieved this way.



e-chains® for "green" automation provide a wide range of savings potentials, e.g. for sheet-metal fabrication.

Energy-efficient e-chainsystem® P4 – rolling instead of gliding.



## Reduce assembly time with the E4.1L(ean)

Time saving: separator tested in the igus® harnessing factory

### Harnessing

- LEAN interior separation vs. standard interior separation
- Time saving achieved by inserting the shelves: 50%
- Fast cable filling on several levels

[www.igus.eu/lean](http://www.igus.eu/lean)

## 50% time saving with new separators

New separators enable extremely fast cable filling on several levels. Cables can be easily fitted in several layers.



igus.eu/machineertools

# Reduce assembly time with the E4.1L(ean)

**Time saving: strain relief system tested in the igus® harnessing factory**

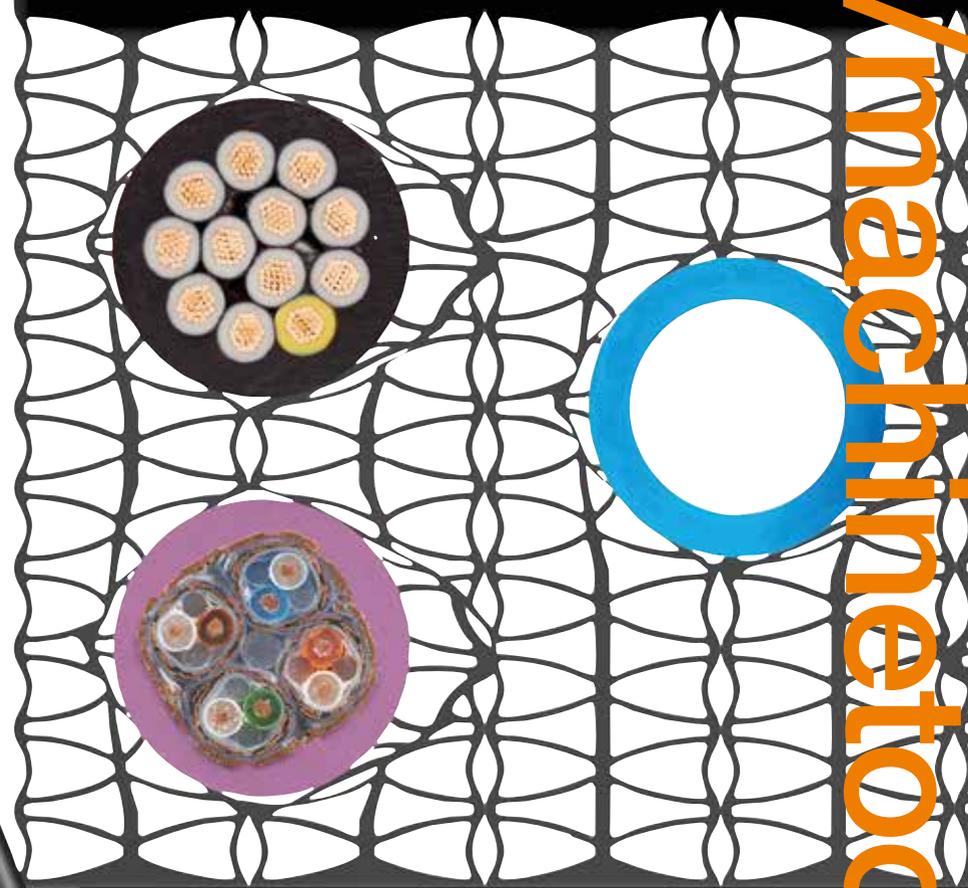
- LEAN strain relief CFU vs. chainfix CFX - 80% time saving
- New honeycomb strain relief block
- Quick and easy strain relief
- Honeycomb structure adapts to the cable
- Secure cable retention

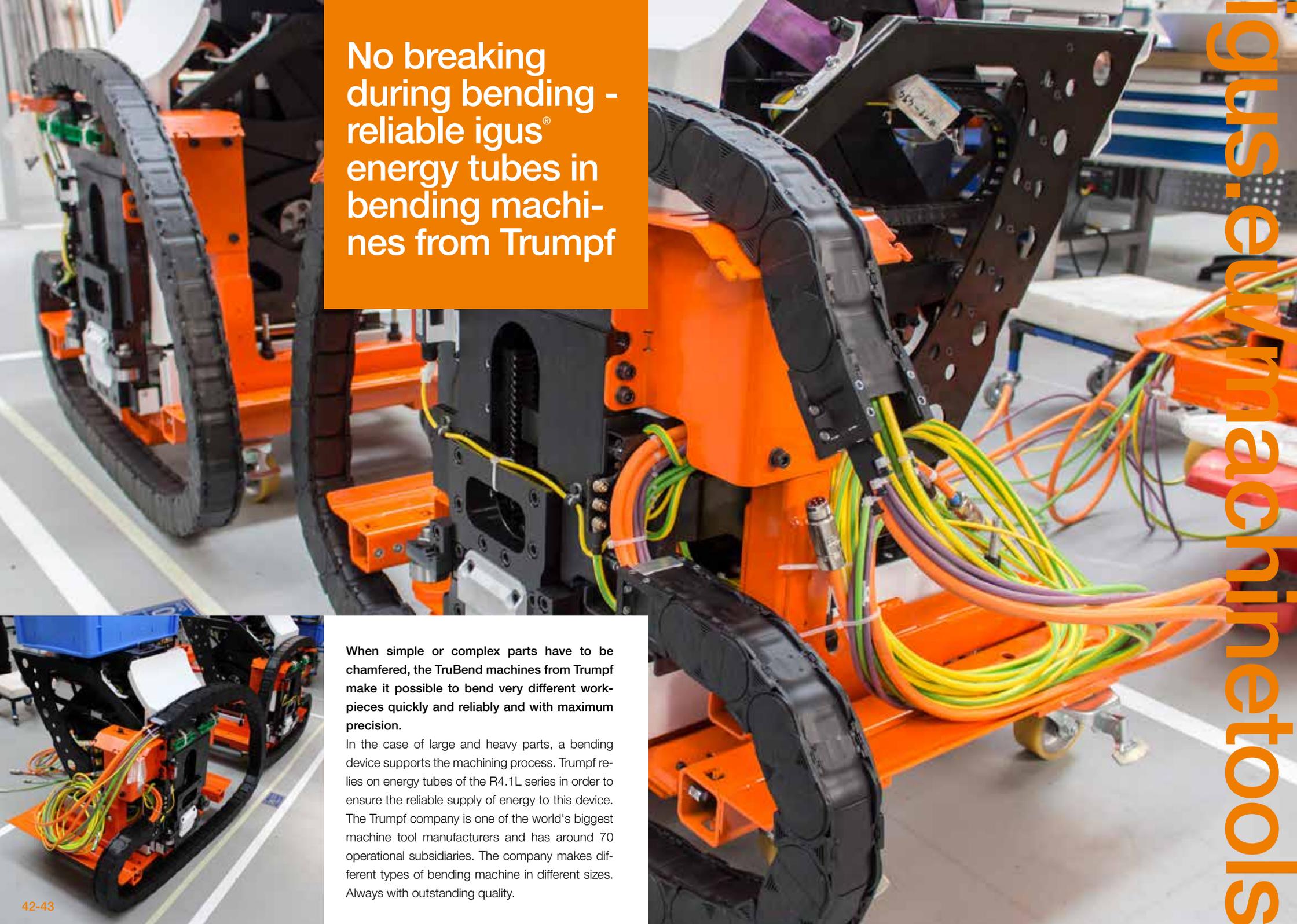
[www.igus.eu/E4.1L](http://www.igus.eu/E4.1L)



80% time saving with new honey-comb strain relief system

Innovative honeycomb structure. Strain relieve on cables extremely easily, quickly and flexibly.





No breaking  
during bending -  
reliable igus®  
energy tubes in  
bending machi-  
nes from Trumpf



When simple or complex parts have to be chamfered, the TruBend machines from Trumpf make it possible to bend very different workpieces quickly and reliably and with maximum precision.

In the case of large and heavy parts, a bending device supports the machining process. Trumpf relies on energy tubes of the R4.1L series in order to ensure the reliable supply of energy to this device. The Trumpf company is one of the world's biggest machine tool manufacturers and has around 70 operational subsidiaries. The company makes different types of bending machine in different sizes. Always with outstanding quality.



On the left: Volkmar Schmidt from Trumpf, on the right Elvis Kaufmann from igus®.

#### R4.1L – swarf-proof and sealed energy supply

"We originally developed the e-tubes so that we could offer a swarf-proof version of our e-chains® for use in moving applications in the direct environment of flying metal swarf or other small particles in the air", explains Elvis Kaufmann, technical sales consultant in the field for igus® Austria and responsible for Trumpf Maschinen Austria. "The cables on the inside are now reliably protected and moved." This is not the case at Trumpf but the machine tool manufacturer still prefers the closed version in order to give the machine a more discreet appearance.

## The swarf-proof and sealed R4.1L energy supply system



"We feel that it is visually more attractive if only one black tube can be seen instead of coloured cables or coloured dots on the outside of the chain", explains Volkmar Schmidt from Trumpf. Other important factors are not only the ease of assembly and the small bend radii of the energy chains but also the maximum filling volume combined with smallest possible exterior height. "I personally have worked for Trumpf for 25 years and cannot remember a time when we did not use igus® chains", says Volkmar Schmidt.



# chainflex® works - world's No. 1 in terms of service life guarantee

## Fail-safe cables for energy chains - with guarantee

- Avoids cable breakages and short circuits
- No corkscrew effects
- Minimal abrasion, for tough environments
- For the best EMC results and twistable movements, e.g. when connected to robots
- Reliable data transmission CAT5, CAT5e, CAT6, CAT6A, CAT7, Profinet, Profibus

[www.igus.eu/chainflex](http://www.igus.eu/chainflex)



## 36-month chainflex® guarantee

Avoid failures, guaranteed - more than 2 billion test strokes and 1.4 million electrical measurements per year. For almost 30 years, igus® has been carrying out tests in the industry's largest laboratory for moving cables and energy chains.



chainflex® cables  
supply KESSLER  
tools with energy  
and signals

What a Brembo brake is to a sports car drive or a Cohiba is to a cigar smoker is the same as what a KESSLER spindle is to the builder of machine tools.

The company in Bad Buchau has succeeded in achieving what many suppliers in the mechanical engineering sector strive for: the company's name has become a brand that stands for outstanding performance and quality and continues to be in worldwide demand, for example in the production factories of the automotive industry.

Permanent ability to move  
in all axes. For maximum  
possible reliability and  
precision.



## chainflex® guarantees maximum fail-safety of energy supply

**Great care in selection of the energy supply system.** The fact that KESSLER takes great care in selecting products for the supply of energy and signals to workpiece axes and rotary pivoting tables goes without saying. Florian Gehrmann, product manager for motor spindles & pivoting systems: "As the heads and axes are very compact, there does not remain very much space for the cables. This means that the cables, which are continuously and frequently being moved at short intervals, must be all the more wear-resistant." Resistance to cooling lubricants is yet another requirement.

### No problems for more than ten years.

KESSLER has been using chainflex® cables from igus® since 2003. No problems or failures have ever been reported to the responsible design engineers. This is why KESSLER always uses chainflex® cables - even in non-moving applications. Florian Gehrmann: "For us, what counts is fail-safety. Our customers expect high-performance systems with a very long service life. According to these criteria, all components - especially the ones for moving applications - have to be carefully selected."



Image left:  
If the housing of the pivoting spindle head is opened, the chainflex® cables can be seen.



## Compact design - 20% less installation space needed with the chainflex® CF29.D

### At 6.8 x d, the world's smallest bend radius for servo cables in e-chains®

The chainflex® CF29.D servo cable series is a further new chainflex® cable with a highly abrasion-resistant outer jacket made of TPE. This cable is suitable for temperatures down to -35°C as well as for extremely small bend radii of down to 6.8 x d. How does the customer benefit from this? A comparison with the previous tried-and-tested series shows that, if users choose a cable from the chainflex® CF27.D series (in this example, the CF27.25.15.02.01.D), an e-chain® of the E2/000 series with a chain radius of 125mm is needed so that the cable can be moved in accordance with the recommended bend radius. The total installation space required is therefore 250mm. If they use the electrically identical cable from the new chainflex® CF29.D series, users can choose an e-chain® with a chain radius of only 100mm, which means that the installation space needed is only 200mm. In the case of very restricted space, this avoids the necessity for design changes, as a result of which less effort is required and lower costs are incurred.



Quality connects: 36-month guarantee on igus® cables with Harting plug-in connectors. As of now, igus® offers harnessed chainflex® cables with original Harting plug-in connectors. A total of 112 different cables are available and can be purchased as finished readycables® cut to the required length, and there is no minimum order quantity.

250 mm

The 1:1 comparison shows that, due to use of the new series, a smaller radius of the e-chain® can be chosen, allowing you to build an even more compact machine.

200 mm

igus. e-chain. machine tools

# readycable® finder



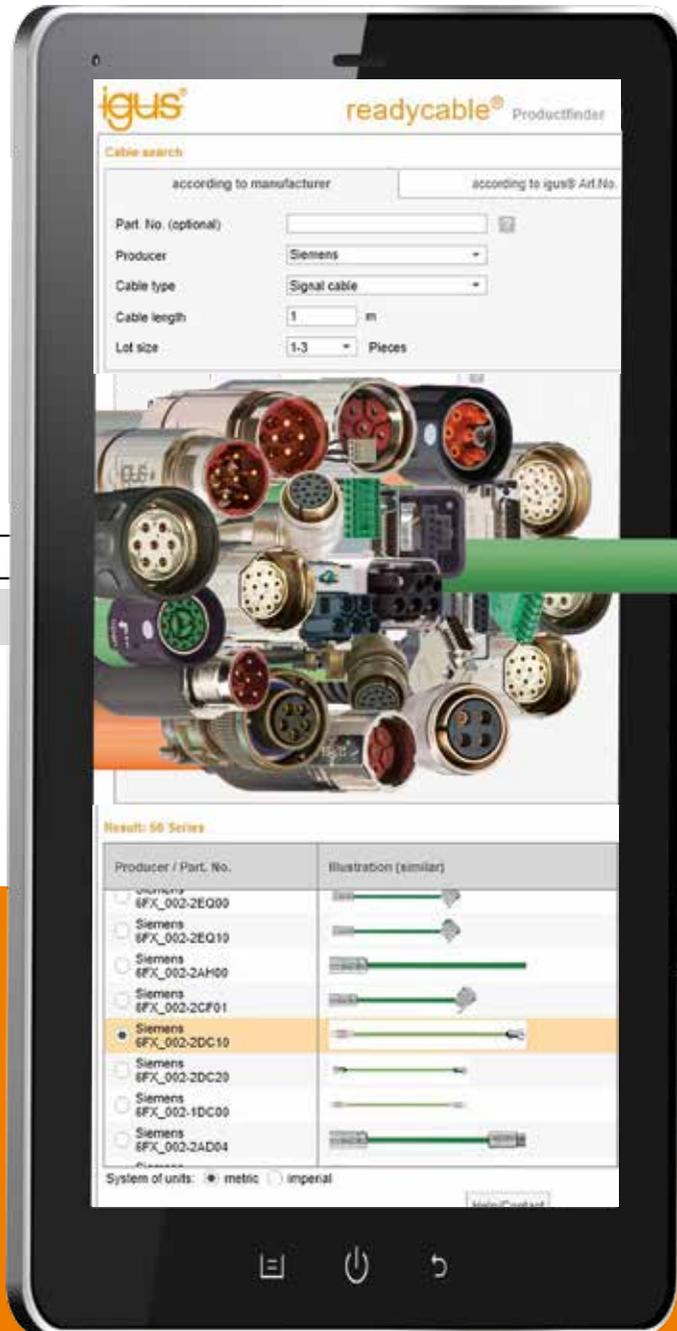
the most cost-effective drive cable

Easy searching      Service life



# Reduce throughput times ...

...with readycable®, ready-to-connect harnessed cables for use in energy chains. As manufacturer and harnesser, igus® provides everything from a single source, thus reducing throughput times and the number of suppliers.



# Harnessed cables with a guarantee - readycable®

The portfolio includes an extensive range of catalogue products

- 4,200 harnessed drive cables in accordance with 24 manufacturer standards: Allen Bradley, B&R, Baumüller, Beckhoff, Berger Lahr, Bosch-Rexroth, Control Techniques, Danaher Motion, ELAU / Schneider Electric, Fagor, Fanuc, Festo, Heidenhain, Jetter, Lenze, LinMot, LTI DRIVES, NUM, Omron, Parker, SEW, Siemens, Stöber
- Individually customised or serial production
- Numerous types of cable of different qualities, with different approvals and certificates of conformity
- Extensive quality checks and functional tests for all components

[www.igus.eu/readycable](http://www.igus.eu/readycable)

... that is guaranteed to



Simple!  
Universal angle adapter ibow® -  
for priceless flexibility.

[www.igus.eu/ibow](http://www.igus.eu/ibow)



Plug-in connectors and measuring system cable for large machining centres.



## Measuring system cables for large machining centres

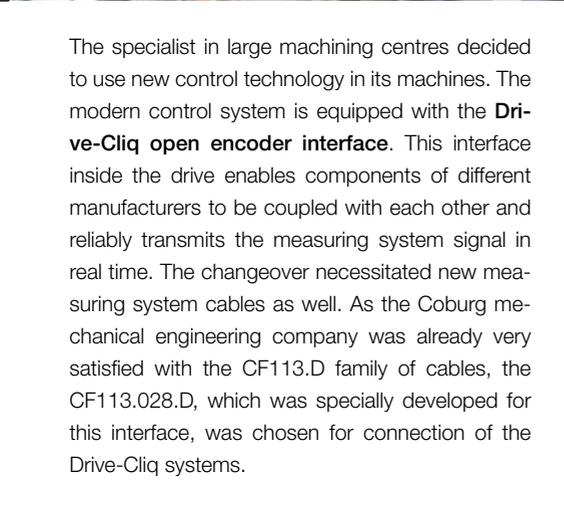
The machining of large components such as diesel engines, turbines, generators or ships' propellers means that machining centres are becoming bigger and bigger. This is also having an impact on machine tool technology itself. One builder of these complex machine relies on the latest generation of controls. For this control system, a special overall solution with a measuring system cable that continuously transfers signals reliably even over very large distances while ensuring a high degree of machine availability has been developed.

The specialist in large machining centres decided to use new control technology in its machines. The modern control system is equipped with the Drive-Cliq open encoder interface. This interface inside the drive enables components of different manufacturers to be coupled with each other and reliably transmits the measuring system signal in real time. The changeover necessitated new measuring system cables as well. As the Coburg mechanical engineering company was already very satisfied with the CF113.D family of cables, the CF113.028.D, which was specially developed for this interface, was chosen for connection of the Drive-Cliq systems.

The company WALDRICH COBURG GmbH is one of the world's leading mechanical engineering companies for large machine tools. "Extremely high quality standards and a consistent orientation to the customer are our fundamental guiding principles", says Dipl.-Ing. (TH), Thomas Bätz, Group Leader Electrical Design, in clarification. Horizontal and vertical milling machines, vertical lathes and grinding machines are produced at the production site in Coburg. "We see ourselves as a reliable partner of our customers around the world who have special requirements regarding complex technologies, levels of precision, metal cutting performance, workpiece dimensions and productivity."



From left to right: Andreas Muckes (igus® GmbH), Thomas Bätz, Thomas Bischoff (both from WALDRICH COBURG GmbH).



A large number of chainflex® cables are kept in stock in Coburg.

igus.eu/machinetools

# Pushing the rotary boundaries: rotary modules

Turning spindles by 720°, combination of rotary movement and torsion.

A machine tool manufacture had a problem, namely that a new order was received from a customer with the requirement that the pivoting angle of the spindle around the Z axis had to be increased from 360° to 720°. Previously, the problem involved in this 360° pivoting movement had been solved by twisting the cables over a length of approx. 1.5m in the Z-axis slide, but this was no longer possible for a rotation of 720°. Together with the customer, igus® developed a motor-driven solution with a Reverse Bend Radius (RBR). A big advantage of this solution is that the torsion cables function as "soft" elements. This avoids impacts and shocks on the milling spindle that can have an adverse effect on the milling result.

[www.igus.eu/MRM](http://www.igus.eu/MRM)

chainflex® CFROBOT cables for torsional motion in the e-chain®.



Technical data:  
Travel: 360°  
Speed: 300°/s  
Acceleration/deceleration: 600°/s<sup>2</sup>



Principle of RBR rotary movement.

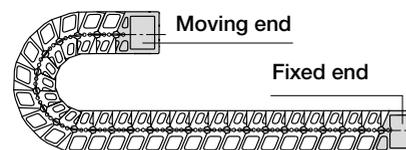
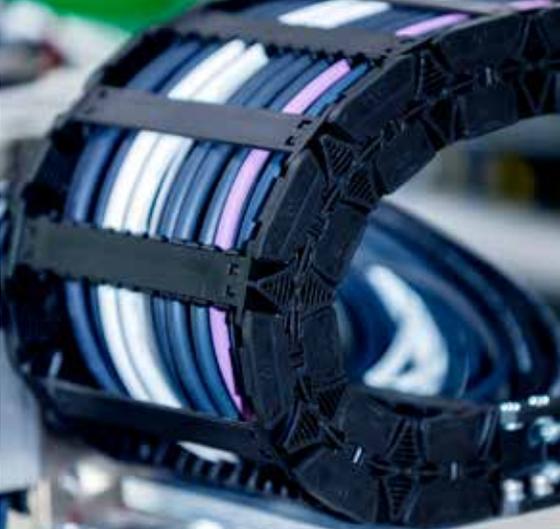


Test set-up of a large RBR system for an offshore application.

igus® WHITE PAPER  
**Influence of vibration on machine tools**  
**Vibration behaviour of energy chains**

**The problem**

The requirements regarding the **precision of machine tools** are growing continually. Their increasing automation entails specific challenges, whereby the influence of the **vibration behaviour** of machine components on the workpiece is an important factor on the cutting and milling result, among other things. The energy chains, the **"umbilical cord" of the modern machine tool**, are a possible source of vibration that can cause problems. As the technology used increases, the use of cables and hoses guided by energy chains also grows. During the operational movements, vibration occurs in the trough and at the moving end and can adversely affect the result of entire production process if they exceed a certain tolerance band. In international competition, the German machine tool industry in particular depends on **premium products** whose characteristic productivity and accuracy differentiate them from competitors' products. Factors that limit the performance of machine tools must be overcome with innovative technologies. Suppliers of quality machines used in tool manufacturing are therefore dependent on energy supply products that are characterised by **minimal vibration** and extremely **smooth operation**.



Cross section and front view of an energy chain with key vibration points, namely the moving end and the trough.

## Cutting and milling precision

Dynamic loads always generate types of vibration that can cause **displacement** of the tool and the workpiece **during machining**. This impairs metal cutting. Increasing deterioration of the cutting conditions of metal-cutting machine tools can lead to process instability. So-called **chatter vibration** occurs that leads to loss of quality in the machining result and to increased wear of machine components. Product defects as well as problems, up to and including production downtimes, are the consequence. As the materials that are used are increasingly of the type that are difficult to machine and, at the same time, the market demands better machining performance for the same size of machine, the use of **low vibration machine components** is more urgent than ever. Smoothly operating energy chains are therefore indispensable for the limitation of self-generated machine vibration.

## State of the art

Most energy chains that are currently being used have a pin/bore connection system. This standard feature guarantees that the chain links are securely connected to each other during movement. Due to the nature of this connection, the energy supply systems are robustly protected against bending stress, while demonstrating a high degree of tensile strength and mechanical load-bearing capacity. However, manufacturers still have to reckon with the **polygon effect**. While moving through the bend segment, the chain performs a turn that is not completely round. Unwinding of the links occurs. A circle, which is the ideal movement for the chain, becomes a polygon. This leads to **longitudinal and lateral shocks** that can cause vibration. However, improving the vibration behaviour of energy chains is the aim of every manufacturer. Different approaches to a solution for this problem are taken. Most makers of quality chains mainly rely on a small pitch of the links for low noise and smooth operation.

## Characteristics of the igus® energy chain technology

All igus® chains are very robust, low-vibration products and are therefore ideal for applications in machine tools. In the case of the e-chains® with a pin/bore connection system, igus® also adopts the small-parts approach as a design principle for smooth, low-noise operation. For especially challenging applications where a maximum reduction of vibration is the goal, igus® has also designed an innovative connecting component for the links in the framework of a high-end solution: **the elastic spring element made of high-performance plastic**. Instead of the conventional, relatively rigid connection consisting of pin and hole, the E3, E6 and E6.1 series of energy chains feature flexible connectivity, which reduces the polygon effect to a minimum when the chain unrolls. In this way, extremely low noise and almost vibration-free operation of the chain are possible. Very smooth, low-noise operation and simultaneously high rates of acceleration can be

achieved with the E6 energy chain. In **220 million test cycles** in the igus® technical centre, the design innovation was able to demonstrate its advantages and effectiveness. In a long-term test in 2008 with the E6.29 type of energy chain, the spring fasteners even underwent more than **400 million complete bending movements**. As an independent assessment by the University of Applied Science in Cologne showed, none of the fasteners used showed any visible or measurable damage.

The spring element also fits in with the modular approach to the energy chain structure. The side-links of the chains can be quickly attached or detached by inserting or removing the springs, the result being that the energy supply system can very easily be adapted to the individual requirements of the respective application, then filled with cables. The **chain is openable along the inner and outer radius**. A plastic hammer and a screwdriver are all that is needed to easily and quickly push the fasteners in or out by hand. The fact that interior separation can be organised in a variety of different ways through the use of separators and dividers, on the one hand, and full-width shelves and other shelves, on the other, enables a **specifically directed supply of power** and **fast cable filling**.

According to tests of the IP Fraunhofer Institute, the corrosion-resistant polymer material of the chain and springs is characterised by excellent abrasion resistance and low wear, whereby the chains and springs made with special material comply with the **highest quality standard for cleanrooms (ISO Class 1)**. The smoothness of operation is expressed in the low amount of noise that the E6 generates, whereby the measured sound pressure level of only **37dB(A)** is well below the levels of competing products, a fact which an assessment of TÜV Rheinland (Technical Inspectorate Rhineland) confirms. The chain becomes more elastic without any loss of tensile strength. Even highly dynamic applications with millions of reverse bends are possible, without the occurrence of faults or abrasion. All this is a guarantee of a very long service life. When used in combination with a linear motor whose drive is also designed for low-vibration operation, the vibration behaviour is reduced to a minimum, which is beneficial for the workpiece when finally produced.

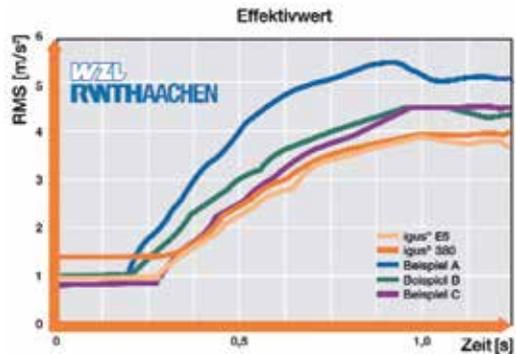


Elastic spring elements as vibration-dampening fasteners for chain links.

## Case study of "vibration behaviour": a scientific comparison of energy chains

A study carried out by the Laboratorium für Werkzeugmaschinen und Betriebslehre (WZL) of the RWTH Aachen was dedicated to a comparison of the vibration behaviour of five different energy chains. The two E6 energy chains from igus® and three comparable energy chains of other suppliers were examined. With inner widths of 100 to 105mm and inner heights of 42 to 52mm, all the chains were of the same size category. The test rig consisted of a base frame and a highly dynamic direct drive, which moved the carriages driven by a linear motor (feed force 14,000N) at four speeds (25m/min, 50m/min, 100m/min, 200m/min) and at two rates of acceleration (10m/s<sup>2</sup>, 20m/s<sup>2</sup>) over a travel of 800mm. The magnitude of the vibration was measured by means of acceleration sensors with a sampling frequency of 6,000 Hz that were fitted to the trough of the energy chains in each case. The data relating to the forward movement of the carriage were measured separately from the data for the reverse movement in order to avoid any mix-up of measured values due to the two directions of movement. The signals detected by the sensors were evaluated in the time range and the frequency range. In the time range, the RMS (Root Mean Square) value is a measurement of the vibration energy at the measuring point. The **RMS** (Root Mean Square) value, i.e. the root mean square of the **vibration energy** at the measurement point, is the lowest for the two igus® energy chains (source: RWTH Aachen).

In the case of all energy chains, the greatest vibration energy was at the trough in the direction of the z axis. The comparison test accordingly concentrated on these maximum vibration signals in the Z direction. The different acceleration rates of 10m/s<sup>2</sup> and 20m/s<sup>2</sup> had no significant



(Source: WZL RWTH Aachen)

The RMS value of the energy chain with the most vibration was even 40 percent worse at 5.6m/s<sup>2</sup>. At the moment, the E6 energy chain system is the energy chain solution with the lowest levels of noise and vibration.

influence on the vibration values of the energy chains. The results show that, compared to the other energy chains, the E6 energy chain has the **best properties** as regards **vibration behaviour** and **smooth operation**. This result applies to low and high speeds. On average, the measured vibration was 28 per cent lower than that of the other energy chains. The E6 type of chain had the maximum RMS value of approx. 4m/s<sup>2</sup>.

## Leadership of the market due to continuous product research and proximity to the customer

With its comprehensive range of 90,000 e-chains® products, igus® has acquired technical market leadership in this special area of energy supply. The company has almost 50 years of practical experience with energy chains. The first chain was delivered as early as 1971. In order to maintain its position, igus® relies on its permanent research and development activities. This is why it operates **the industry's largest test laboratory**. In an area of more than 2,750m<sup>2</sup>, 30 employees carry out **4,100 tests per year** on 65 test machines in the e-chains® laboratory alone. Technical innovations such as the elastic spring element are subjected to a test marathon consisting of tests under realistic conditions, whereby behaviour in respect of tensile forces, thrust forces, coefficients of friction, abrasion, external influences and vibration is examined. The more than **7,500 test results** obtained are recorded in an electronic database and are used for continuous product improvement. They are also available to the customer by means of online tools. The reason for this is that research and production at igus® are always customer-centred. Open cooperation guarantees the best possible result for both sides. With this in mind, igus® also cooperates with customers when it comes to design and assembly and, acting according to the slogan "igus® the-chain tries to find the most suitable system solution with and for each customer.



E6.1: the new generation of low-noise, smoothly operating energy chains with inner heights up to 80mm.

## Summary

The growing requirements for precision of machine tools call for technical innovations in the area of vibration reduction. Achieving smoother operation of energy supply systems in dynamic applications is an important component of a successful strategy. The avoidance of vibration by means of **machine components that have been optimised in terms of vibration** is the most cost-effective way of doing this. New solutions such as the elastic spring element as a fastener for the links of energy chains can make a decisive contribution towards achievement of the goal of "**low vibration machine tools**".

# Reliable energy supply systems promote long-term cooperation



ROMI, the market leader in the Brazilian machinery and equipment industry, is renowned worldwide for its high-tech products, and demands from its suppliers high technical performance, quality and solutions with the best price-performance ratio. The motion plastics® specialist igus® has been a reliable partner for 15 years.

Currently, Romi's portfolio is composed of various machine tools, such as turning centres, CNC lathes, conventional lathes, machining centres and milling machines. The customers come from the most diverse areas such as aviation

technology, agricultural machinery and automotive industry as well as consumer goods production.

ROMI has been relying on energy chain systems and chainflex® cables from igus® for almost all machine and plant lines, which have to withstand demanding movements, high accelerations and a high number of cycles, as well as exposure to shocks and friction on various surfaces.

With the new ROMI DCM 620-5X Hybrid Vertical Machining Centre, which was first presented in Brazil in 2017, the company aims to meet the constant demand of the Brazilian industry for solutions that increase productivity and efficiency. The plant combines machining operations and additive manufacturing (3D metallic printing) and allows the addition of various materials in complex profiles.

### Chains resist aggressive environments

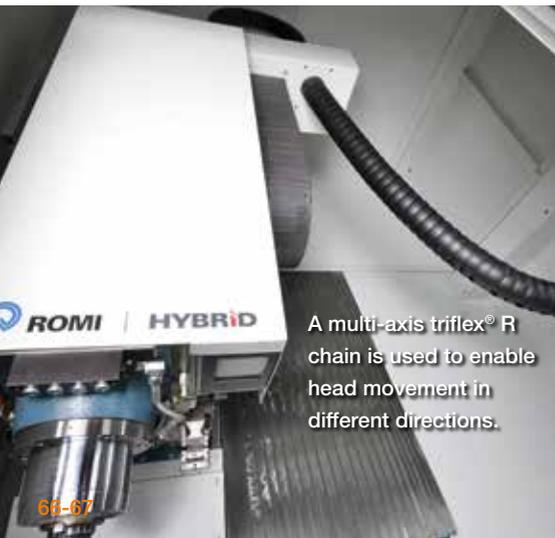
Two e-chains® from igus® are used in the machining and coating area of the plant. There they come into contact with oils and abrasive powders and are also exposed to high temperatures. The chains made of high-performance plastics always work reliably under these conditions and safely guide the chainflex® cables specifically designed for mobile applications.



DCM 620-5X  
HYBRID



Douglas Pedro de Alcântara, Product Development Manager - Machine-tools and the new ROMI DCM 620-5X Hybrid Vertical Machining Centre.



A multi-axis triflex® R chain is used to enable head movement in different directions.



In the **ROMI GL240 gantry loader**, igus® e-chain systems® also ensure reliable cable management. This application is an automation system for loading and unloading workpieces in ROMI machining centres. By using the gantry loader, **loading and unloading time** can be **reduced by up to 80%**, which means significantly increased production.

Due to the high travel speeds in combination with the limited installation space, the designers at ROMI needed an energy supply for this application that copes with these loads safely and reliably over a long period of time. "We are known

around the world for cutting-edge technology that characterises all our products," says Douglas Pedro de Alcântara, product development manager at ROMI. As a result, **e-chains®** from the **E2/000 series** from igus® are now being used in the gantry loaders. They have a high strength and crossbars openable on both sides. This makes it easier to insert or replace the cables, which considerably simplifies and shortens installation or maintenance.

The e-chains® from igus® are used on all axes in the latest generation of vertical machining centres, the ROMI D.



Thanks to ROMI's GL240 gantry loader, loading and unloading times at machining centres can be reduced by up to 80%.

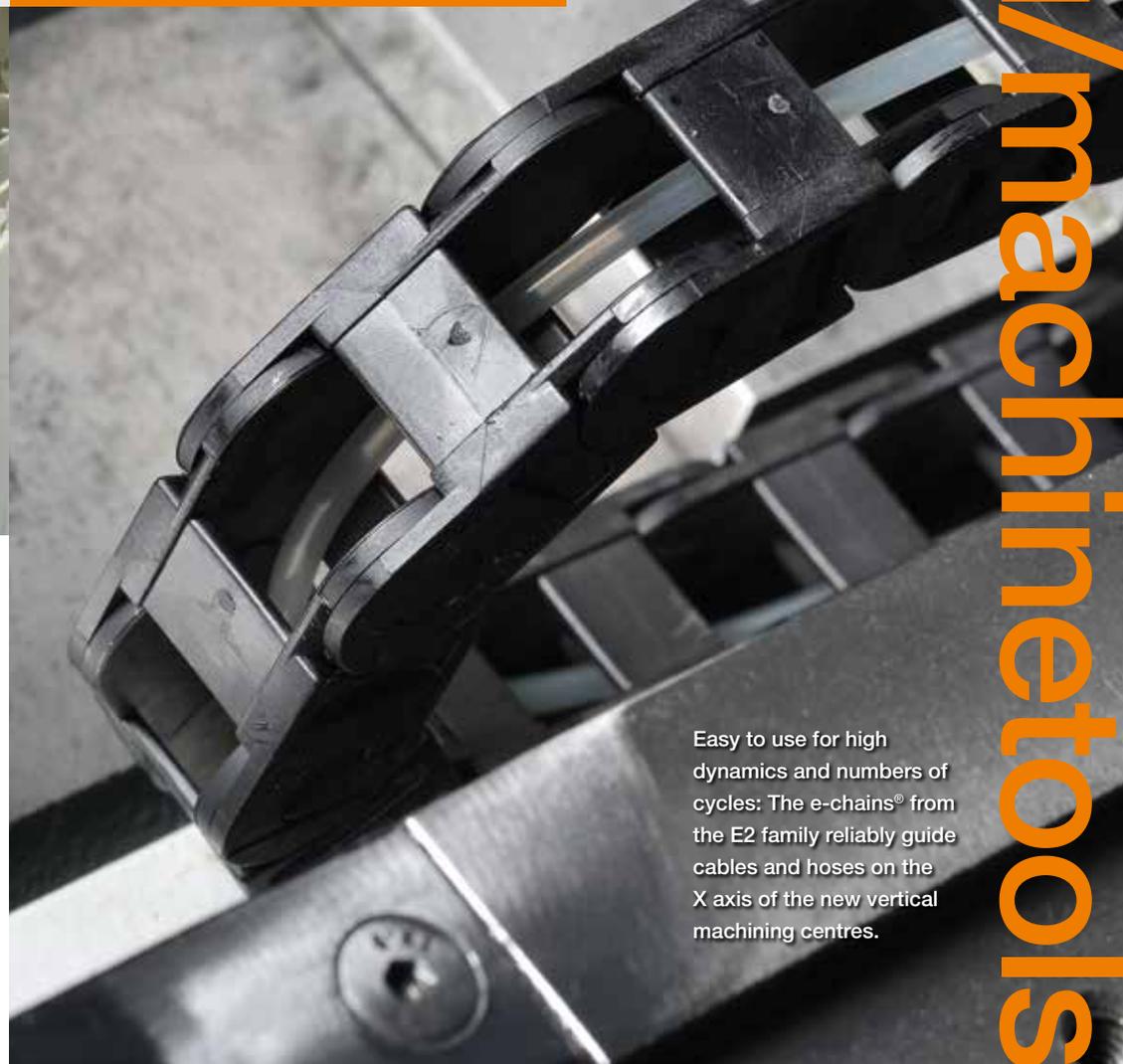
The e-chains® of the E2/000 series have crossbars openable on both sides, which makes assembly much easier.



The Brazilian machine tool manufacturer ROMI uses igus® energy chains in the **latest generation** of its vertical machining centres, **ROMI D**, as well. "The new generation of this product line has integrated new technologies that are even better aligned to the **specific needs** of customers," explains Douglas Pedro de Alcântara of ROMI. "The **precision** as well as the **robustness** and **durability** of the machines, continue to be recognised differentials of the Romi brand."

The **e-chains®** from igus® are also used here for the movement of the X, Y and Z axes. In the X and Y-axis of the systems, different energy chains of the **E2 family** guide cables and hoses. In addition, an **E4.1L series** chain is used on the Z axis. It combines strength and easy accessibility. The rounded edges of the crossbars and separators of the chain also ensure a long service life of hoses and cables. In addition, the crossbars can be easily opened, which significantly shortens the assembly time.

Easy to use for high dynamics and numbers of cycles: The e-chains® from the E2 family reliably guide cables and hoses on the X axis of the new vertical machining centres.



# Safe guidance for corrugated tubes parallel to an e-chain®

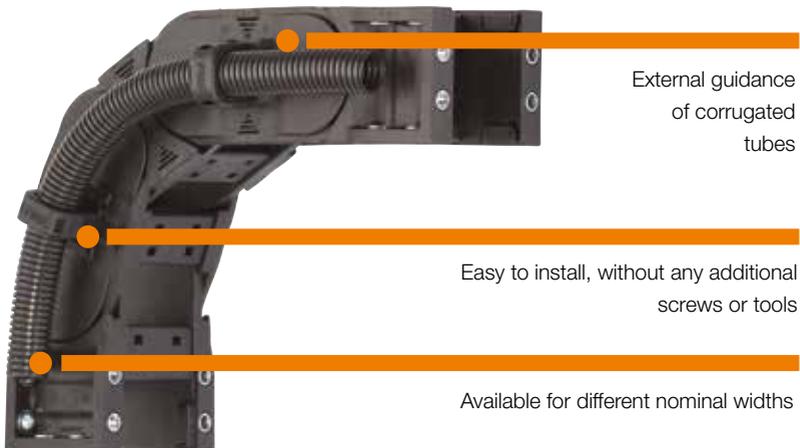
TUB is an addition to our E4 modular system. The side sections of the outer links have a clip feature that enables PMA clips to be easily clipped on. In this way, corrugated tubes can be routed parallel to an energy chain.

- Additional guidance for corrugated tubes
- Easy access to the corrugated tubes
- Quick replacement of the hoses is possible
- Save installation time and cost
- Easy to install, without any additional screws or tools
- For many E4.1/E4.1L series

## Typical areas of application:

General machine building, machine tools, laser cutting machines, where guiding must be done outside of the e-chain® cross section.

[www.igus.eu/E4-1](http://www.igus.eu/E4-1)



igus.eu/machinertools

# State-of-the-art technology in tough operating conditions



Messer Cutting Systems increases productivity by using igus® energy chains. Just like igus®, Messer Cutting Systems focuses on innovative technologies that satisfy the specific requirements of its customers. The machine components and systems which the company develops are used in a wide variety of industrial applications and are therefore chosen to achieve the maximum service life.

The **MultiTherm machine** allows plasma cutting (straight or bevelled), oxy fuel cutting with various torches, marking workpieces, or a combination of all these processes, with longitudinal units arranged side by side to ensure **high-quality cuts**. According to Messer, the key differentiator of the MultiTherm series is that "it is **nine times less expensive** than other conventional machines on the market, while having **nine times more output**". In terms of productivity, it is therefore setting new standards on the market.

The MultiTherm can **hold 11 cutting suspensions / torches** (10 installed in the front and one in the back). To accommodate the cables and hoses safely in a very limited space, special importance was placed on the energy supply system. Messer's technicians in Brazil worked closely with the team of the motion plastics® specialist igus® to develop a design in which the e-chains® were nested inside each other. This reduced the installation space and ensured safe guidance of the cables and hoses. Here, **e-chains®** from the **3500 series** with bend radii of 150mm and 250mm were used.



Assembly of a MultiTherm system at the Messer factory in Brazil. A total of eleven suspension mounts are used; igus® e-chains® were the best option for Messer in terms of safety when laying and operating the cables and hoses. To reduce installation space, the chains are nested inside each other.

An **autoglide system** ensures that the chains slide straight over each other. The special comb-like crossbars enable the chain to basically guide itself, which means there is no need for an additional guide trough.



In Messer's MultiTherm cutting machines, igus® 3500 series energy chains are used.

Image left: Messer's current flagship project is the MultiTherm machine, which meets the highest quality standards and increases productivity. In addition to cutting metal sheets, the machine cuts unalloyed strip steels to the specifications of manufacturers in the construction sector.

# Ethernet for my machine

Are you equipping your machine with a bus system or are you busy changing over to a new system?

If so, you will undoubtedly be confronted with one of the many Ethernet derivatives on the market. The choice here is overwhelming. This includes GigE and Sercos, Profinet is also popular and I prefer CAT5, CAT5e or even perhaps CAT6A. Or should I simply use an FOC solution?

Not to worry, here is some good news. Irrespective of which system you like, the cable technology is always similar from an electrical point of view. The **frequency** and the **amount of data** are always the decisive factors when it comes to the quality of the cables to be used. What is important in this context is that the cables are downward compatible. The easiest way to go about this is to base your choice on the cable categories that have been a fixed component of the definitions in standards for years.

As regards the cable, Profinet technology and Ethercat technology are very similar to each other as both are based on CAT5 as a precondition for their use. They are **different in terms of the cross section of the cores** and the **colours of the jacket and core insulation**. What is important when a cable is being chosen is that you also consider the mechanical properties such as **bend radius** and **the type of movement**. These are the parameters which ensure that data transmission is guaranteed for as long as possible. If a CAT5e cable, for example, has been chosen for chain movement whereby it is twisted, the data transmission properties change extremely quickly. This results in bus faults that often entail long searches for the problem. At this point, we would like to point out a big trap that can be fallen into and often becomes a very expensive affair. In the area of permanently laid cables, things are built to last, which in this case means using a cable of much too high a quality for a project where the cable is laid in a wall so that it does not have to be replaced at great cost when the quality is actually needed. As the cable does not age electrically and the **high-quality cable** is relatively inexpensive, this makes good sense. Unfortunately, this does not fully apply in cases where dynamic movements are involved. If a packaging machine was to be equipped with a camera today, for example, a GigE cable would probably be used, i.e. CAT5e. If the cable were to be replaced with a CAT6A cable, considerably higher costs would be incurred but the amount of work involved in changing the cable - should a GBit data volume actually be needed in the future - would be considerably less than that involved in the replacement of cables permanently installed in a building.

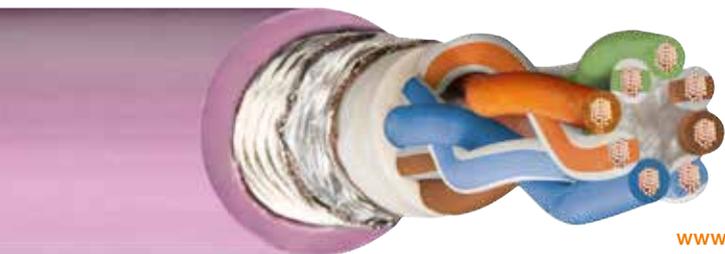
# For all data volumes and types of movement - 32 chainflex® Ethernet cables



From CAT5 to CAT7, we can supply you with exactly the Ethernet cable you need for your moving application. With that you can safely use Bus systems such as Ethernet/IP, Profinet, EtherCAT, Sercos and many other derivatives. The individual grading of the classes of cable means that there are opportunities for very large **savings** or for the cabling of your equipment in a way that meet the needs of the future.

We deliver on drums or in coils of your **required length** – of course, **without any cutting charges**. Upon request, we also harness your cable with suitable plug-in connectors. No minimum order quantity, with your custom dimensions and designs. **A new additions to the product range** are our **CFSPECIAL484.049** cable for the railway industry and the **CFBUS.LB** for especially small radii of 7.5 x d.

[www.igus.eu/Ethernet](http://www.igus.eu/Ethernet)



**Test 3089**  
CAT5e Ethernet cable tested successfully in an endurance test with 76 million strokes.

[www.igus.eu/chainflestest3089](http://www.igus.eu/chainflestest3089)

# Space-saving alternative to the servo cable in machine tools: PUR drive cable

Servo drives for machine tools are becoming bigger and bigger and more powerful as well. Accordingly, larger cable cross sections are needed to carry the high levels of energy supplied. The consequence: the servo cables used are becoming larger and larger, as a result of which the radius of the energy chain is becoming too big for the machine-tool installation space. The shielded single-core cable from igus® provides a solution to this: conceived as a servo drive cable, the **CF270.UL.D chainflex® single-core cable is considerably thinner** and, for this reason, is ideal for use in an energy chain that has a small radius and is used for a machine tool. High-quality and, at the same time, cost-effective single cores. The structure of the drive cable from igus® is simple but nevertheless complies with the igus® quality criteria for moving cables: **a braided conductor** consisting of fine conductor strands is shielded by flexible, fine-mesh copper wire braiding which provides around **80 per cent optical cover**. In this way, very good and long-lasting electromagnetic compatibility is ensured. In accordance with the requirements for use in energy chains, its outer jacket is made of a low-adhesion mixture on a PUR basis. As a result, it is **oil-resistant, resistant to scoring** and **halogen-free**, and can also be used for low-temperature applications. Due to its orange jacket colour and its approval according to UL and NFPA79.2012, it meets all the requirements of the machine tool industry.

[www.igus.eu/CF270ULD](http://www.igus.eu/CF270ULD)



Conceived as a drive cable, the CF270.UL.D. chainflex® single core from igus® has an extremely flexible braided conductor made of fine stranded wires. The igus® single core is therefore substantially thinner than a servo cable and, as a result, is ideal for moving use in constricted machine-tool installation spaces.



## Different types of shield

The shield of a cable is used to prevent interference from the inside to the outside and vice-versa. Ideally, a metal tube would be used, but this will make a movement of the cable impossible. It is therefore necessary to find a compromise between swarf-tightness and good mobility. **chainflex® cables** for linear movements are made in such a way that the braided shield, which has an **optimised braid angle**, fits tightly around the stranded cores. In torsion cables, however, the shield wires must be able to slip and glide, whereby the shield is loosely placed around here. Movements in all directions are thus enabled and, at the same time, **reliable permanent EMC protection** is provided.



Thanks to the loosely wrapped around shield, movements in all directions are made possible.



Cables for linear movements: the shield is braided and fits tightly around the stranded cores.



Robot cable: in torsion cables, the shield is loosely wrapped around.

# The igus<sup>®</sup> machine tool specialists

## R2.1 e-tubes – cost-effective swarf protection

- Very easy to open, openable end caps
- Quiet operation due to integrated brakes
- High sealing
- Unsupported lengths longer than comparable R2 e-tubes
- High strength through double stop-dog system
- Cable-friendly due to smooth interior
- Integrated positional system 2.5mm

[www.igus.eu/R2-1](http://www.igus.eu/R2-1)



## R2.1 e-tubes

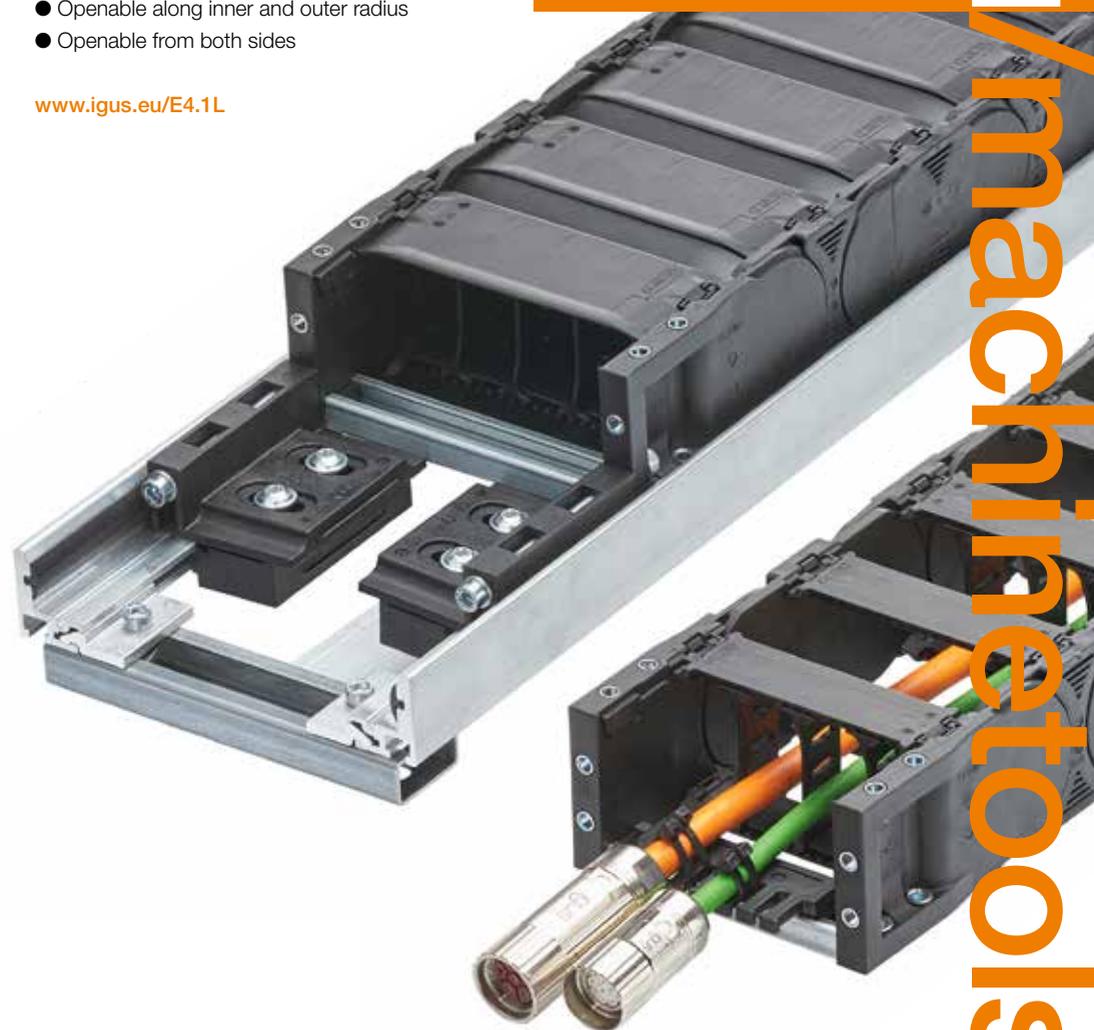
Cost-effective, robust e-tubes with an inner height of 26, 40, 48 or 75mm. Lids openable and removable from both sides. Very sealed design and strong double stop-dogs for high fill weights and unsupported lengths.



## E4.1L - high dynamics, light and cost-effective

- Less weight but still very strong
- Ideal ratio of internal and external dimensions with thinner outer links and optimised crossbar geometry
- 30% lighter and lower-priced than E4.1
- e-chains<sup>®</sup> and e-tubes along the inner and outer radius, openable on both sides
- Very tightly fitting lids, virtually no gaps or openings
- Openable along inner and outer radius
- Openable from both sides

[www.igus.eu/E4.1L](http://www.igus.eu/E4.1L)



## System E4.1L

All-rounder e-chains<sup>®</sup> and e-tubes for outstanding dynamic responsiveness. The E4.1L system is the ideal energy chain for mechanical engineering and applications of all kinds where there must be an optimum relationship between technical requirements and economic efficiency.

igus.eu/machinetools



Easy-to-assemble and swarf-resistant too

Lathe manufacturer FAT HACO chooses closed energy chains from igus®.

The **TUR 3MN heavy-duty lathe** from the Polish manufacturer FAT HACO can handle **workpieces** with lengths of up to **1,600 mm** and weighing up to **15,000 kg**. The headstock of the lathe has a modern compact design. The high-performance spindle ensures extreme precision and rigidity when heavy loads are being handled and ensures that the surface finish of machined workpieces is of a very high quality. In order to route the cables and hoses safely for the machine's energy and data transmission, FAT HACO relies on energy chains from igus®.

In addition to **TRC triflex® R** energy chains, which are capable of three-dimensional movement, closed **e-chains®** from the **R2 series** are used to protect the cables and lines inside against swarf and dirt. The lids on the energy chains can be opened and closed easily using a screwdriver. In addition to the high **reliability** and **long service life** of the chains, **ease of assembly** was the decisive factor for FAT HACO to favour energy chain systems from igus®. Now, all the metal chains have been replaced with plastic energy chains from igus®.



FAT HACO trusts in plastic energy chains from igus® for its CNC lathes. The closed design protects the cables inside against swarf and dirt.

Inside the energy chains, the machine tool manufacturer uses **chainflex® cables**, also from igus®. They were developed specially for moving applications in e-chains® to reliably withstand the stress of constant movement. This is guaranteed by igus®, which gives a **36-month guarantee** on all chainflex® cables. With the help of the online chainflex® service life calculator, users can quickly and easily calculate the exact service life for each application. This creates planning reliability with guaranteed service life.



## triflex® R – energy supply for 3D applications

- For applications involving multi-axis machine tools
- Defined torsion stop-dog
- Defined minimum bend radius
- Easy to lengthen and shorten
- Small bend radii and short pitch

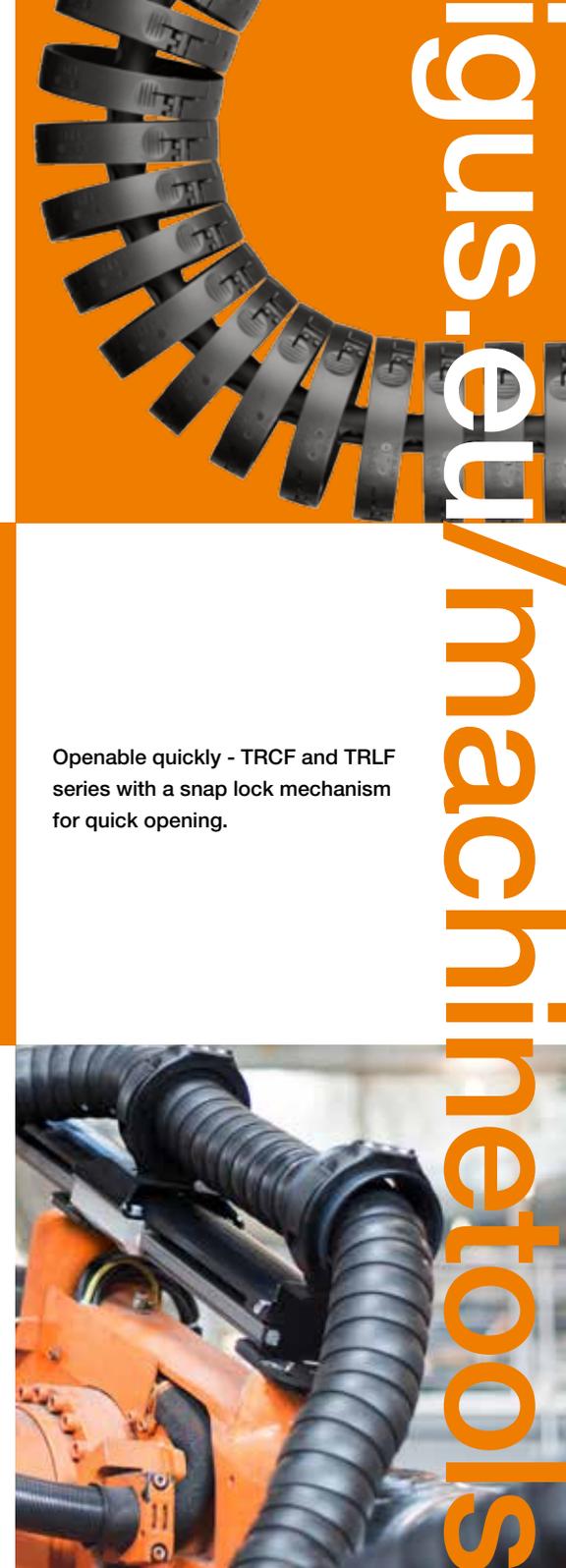
A robust, all-round bend radius stop-dog prevents cables and hoses from kinking.



Openable quickly - TRCF and TRLF series with a snap lock mechanism for quick opening.

Streamlined chain guidance - integrated spring rods generate a retraction force that prevents loop formation.

[www.igus.eu/triflexR](http://www.igus.eu/triflexR)



igus.eu/machinetools

AUERBACH X

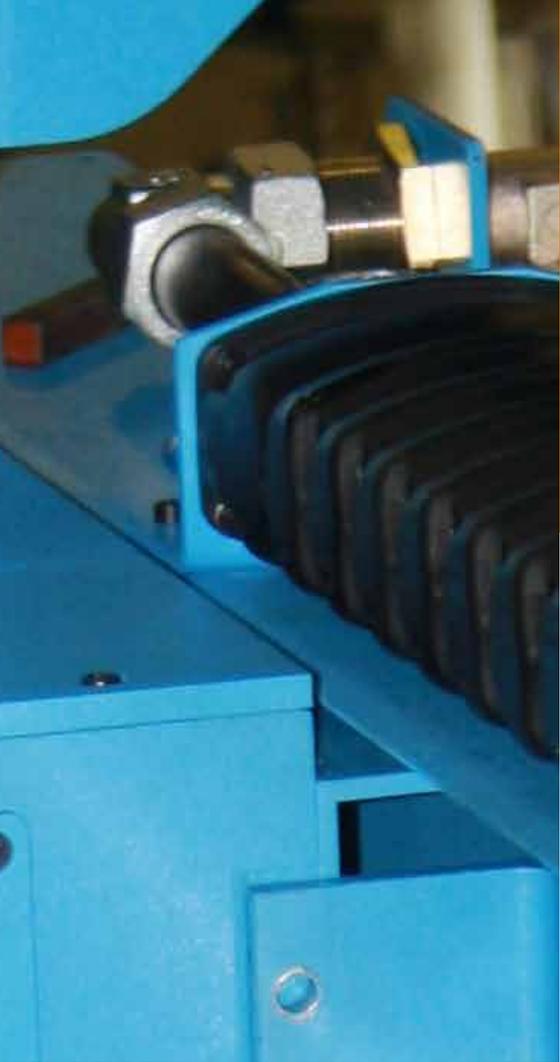
The universal combination machines from ERMAFA: milling and deep-drilling technology in one

**Swarf-proof energy-tube for combination machine used for milling and drilling.**

In this machine tool, extremely high requirements are placed on the energy supply system that delivers energy to the main tool. Dust, dirt and drilling oil from the outside result in extremely high levels of stress. From the inside, heavy hydraulic hoses are the main factors that affect stability. To ensure good performance data of the universal machine over the long term, the manufacturer uses an especially swarf-proof plastic energy tube for supply purposes. It protects and carries all cables and hoses.

In the case of ERMAFA's multifunctional "AX-TLF" type series, milling technology and deep-drilling technology are combined in one machine.





Able to withstand continuous exposure to dirt:  
RX energy tube from igus®

"Continuous exposure to dirt is the biggest challenge for the deep-drilling and milling machine", explains Thomas Gemeinhardt, managing director of **ERMAFA Sondermaschinen- und Anlagenbau GmbH, AUERBACH site**. "Another problem is that the performance requirements of the machine tools are increasing but the space on the inside remains the same." To reliably supply the main tool with energy, Auerbach uses the "RX", a new kind of energy tube from igus®, for its multifunctional "AX-TLF" type series for which milling technology and deep-drilling technology are combined in one machine. It is almost 100% swarf-proof and, even used continually, provides reliable cable protection.



Extremely swarf-proof "RX" energy tube

"Due to the enhanced milling performance, we had looked for an even more robust energy supply solution for a customer in the context of a retrofit with newly installed pressure hoses. It did not take us long to find what we wanted", says Thomas Gemeinhardt in retrospect. Since then, we have only used "RX" energy tubes from igus®, installation size 40, in the combined milling and deep-drilling machine. With their further improved standard swarf-proof characteristic, the new "RX" tubes have supplemented the "E2" and "E4" energy tubes since 2009.

# The easy way to open and close machine guard doors with igus® drylin® linear guide systems

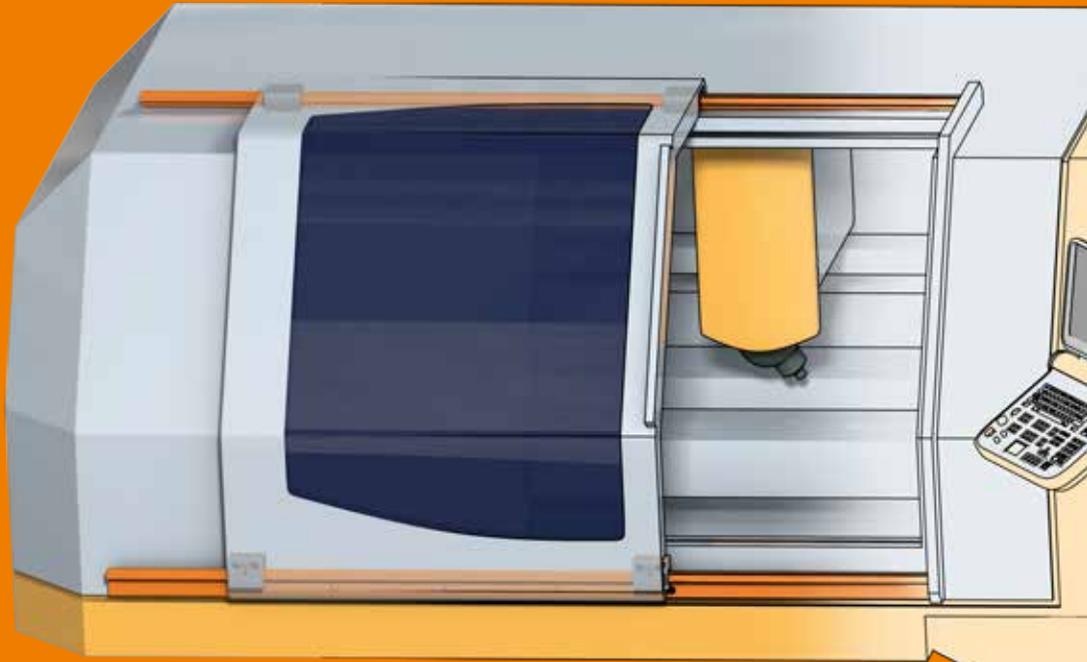
**The drylin® W linear system for maximum design freedom.**  
 drylin® W linear guides are a cost-effective, pre-assembled system. The design allows extremely high flexibility in the construction and installation due to the use of individual or double rails. Hard-anodised aluminium is used as rail material and provides the best friction and wear results. With its dry running lubrication-free operation, the linear guide system is extremely resistant to dirt; the cleanliness also makes the system suitable for cleanroom and hygiene applications.

- Easy installation, maintenance-free
- Resistant to dirt due to dry operation
- Lightweight and quiet
- Manually adjustable bearing clearance (optional)
- Available in stainless steel (optional)

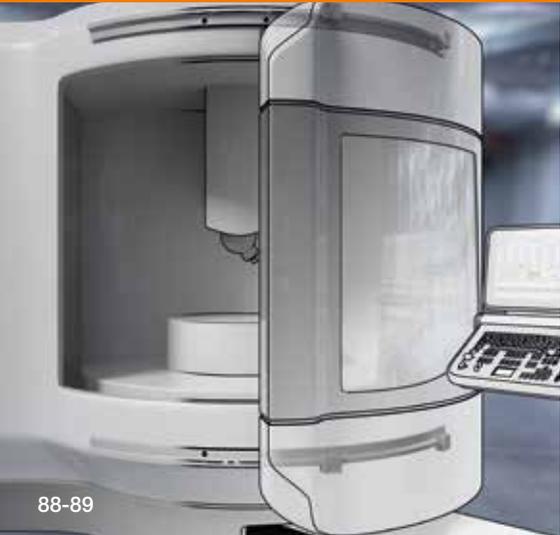
[www.igus.eu/drylinW-hybrid](http://www.igus.eu/drylinW-hybrid)



**drylin® W hybrid roller bearings: low driving forces due to the combination of rolling and sliding.**



For the drylin® W product range, igus® supplies customised curved rails with matching carriages.





## Challenging application at IMA Klessmann: energy AND bus signals in one moving cable

Hybrid cables from igus® in challenging drilling machine applications.

Up to fifty servo axes in a small space, high dynamics, high demands on service life and small bend radii: can one-cable technology function under these adverse conditions? **IMA Klessmann** did not just try it out but thoroughly tested it together with igus®. Result: The hybrid cables of the chainflex® product range are tried and tested and are used in the new flexible IMAGIC flex drilling systems.

60 metres a minute: this is the speed at which **IMA Klessmann's** woodworking machines operate. This applies to numerous processes in the fully automated flow production of residential, office, kitchen and bathroom furniture - for example for edge processing with sawing, chamfering and/or gluing.

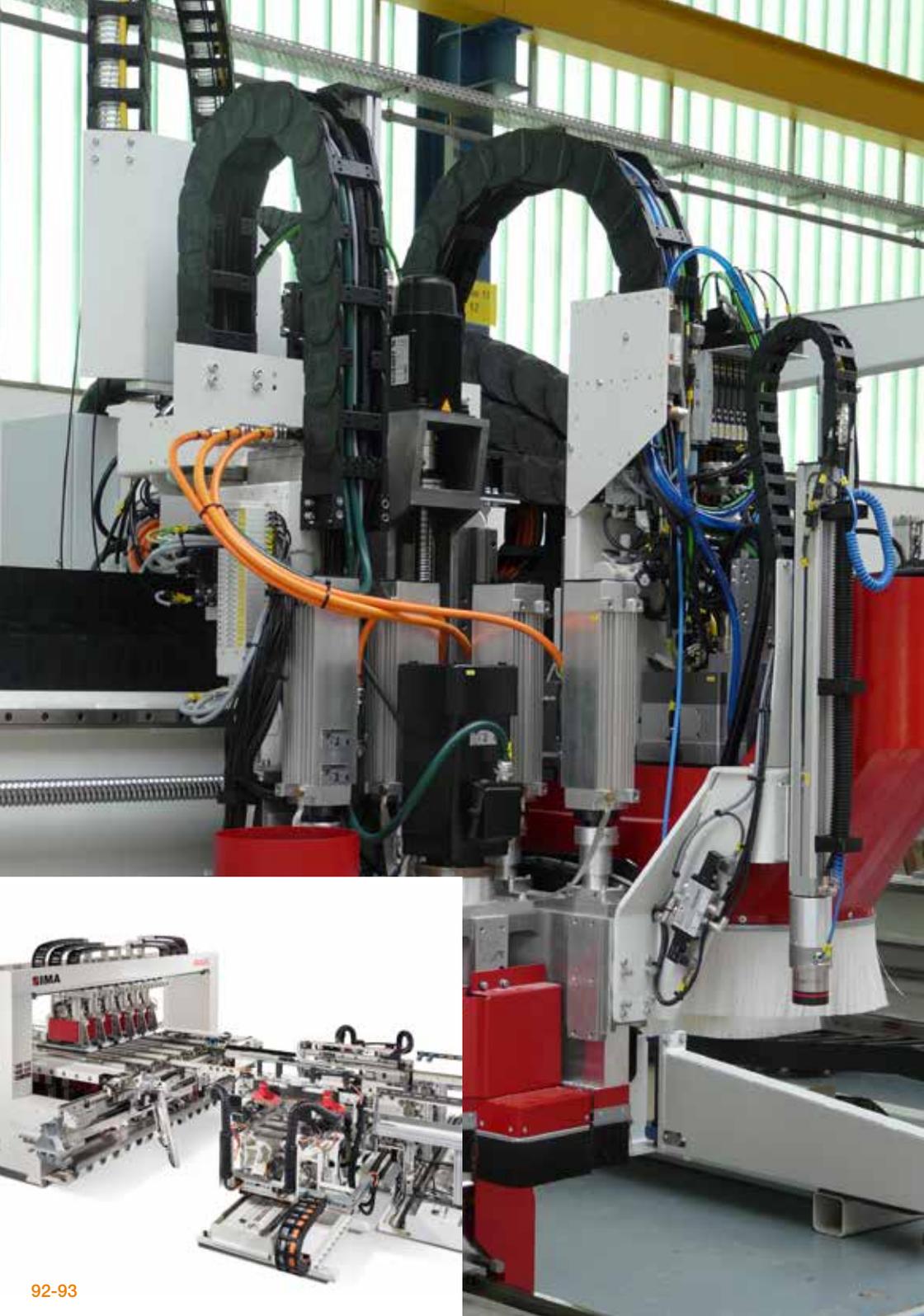
Good guidance: Energy chains, delivered as ready-chain® products, undertake the orderly supply of energy and signals to the individual axes of the IMAGIC flex.



For drives of up to fifty servo axes within a small space



igus.eu/machinetools



## Flexible drilling at high speed

However, this speed also dictates the material processing rate of the drilling stations that have been integrated into the machinery. They have to drill at high speed, even if the components are manufactured according to specific orders and have different drilling patterns.

**IMA Klessmann** developed the flexible IMAGIC flex drilling system precisely for this purpose. It offers the user real added value in production. The individually controllable drilling spindles enable horizontal and vertical drilling as well as dowelling, and promise minimum set-up times even for complex drilling patterns - and at a remarkably high speed.

**All in one: encoder cable integrated into servo cable.** One of the highlights of the new automation system is the innovative energy and signal supply system. The new one-cable technology combines the power and feedback system in the same servo cable. This greatly reduces the cost of materials and the time needed for commissioning.

## chainflex<sup>®</sup> hybrid cables



The chainflex<sup>®</sup> hybrid cables have a built-in bus element - and they have been designed for a long service life in highly dynamic applications.

CF220.UL.H

# igus® robolink® modular system for low-cost robotics

**robolink®  
RL-DCi**  
Complete module with 5  
degrees of freedom and inte-  
grated control system

**€5,492**

The new robolink® modular system for robotics makes it possible to automate manual work steps quickly, easily and cost-effectively at any time.

Articulated arms in various lengths and sizes are available. The number of lubrication-free joints used ranges from two to six, and the robot can be equipped with various tools (e.g. grippers, suction cup, camera, etc.) as desired.

robolink® robot components are characterised by their modularity. As a modular system, a robot arm can be configured as desired and therefore economically, and moreover it is also possible to obtain ready-to-use complete systems.

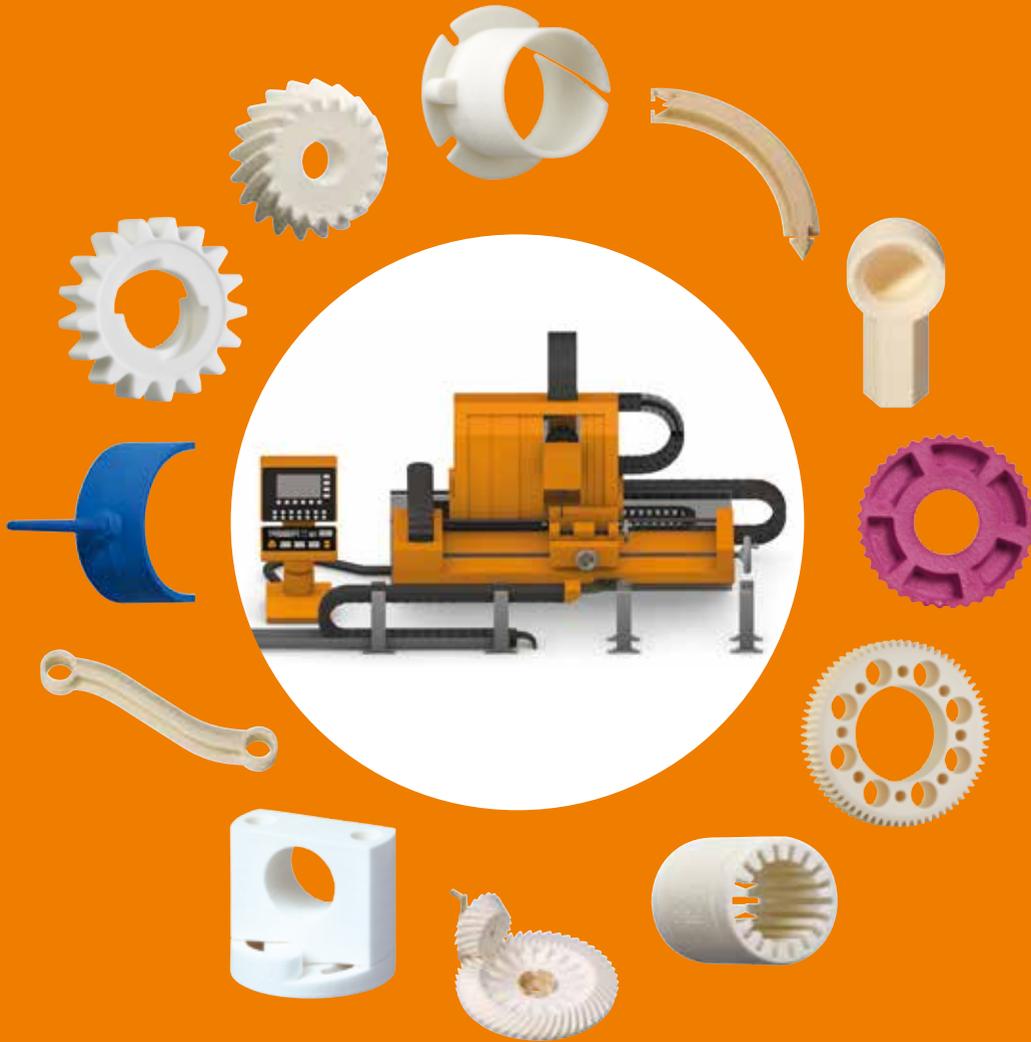
[www.igus.eu/robolink](http://www.igus.eu/robolink)

robolink® removes components from a machine tool. robolink® articulated arms are suitable for difficult-to-access, hazardous work areas and for use where the environment is wet. In an application of a Chinese machine tool manufacturer, a robolink® D is being used under exactly these conditions. In a very small space, the robot joint with a pneumatic suction gripper removes half shells of mobile phones from a machine.



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# Prototypes, very small batches, special purpose machinery



# 3D printing service - for customised parts made from high-performance plastics

## In two simple steps 3D-printed component - with instant price.

We print your customised component, using lubrication-free, abrasion-resistant iglidur® high-performance plastics.

Upload your drawing in the STEP (STP) format, check the 360° view and select a filament. We ship your desired product - depending on the complexity - from 24 hours.

## Tested strength when compared to machined and injection-moulded parts.

3D print materials from igus® are robust and composed of wear-resistant materials made of iglidur® high-performance plastics, which are especially suited for moving applications. They guarantee a long service life as well as a high abrasion resistance of custom-made parts.



igus® online 3D printing service: easy, fast, transparent



# Research and development: more than 15,000 tests annually - in the igus® laboratory

**Better products for less – a key element is the industry's largest test lab. 2,750 m<sup>2</sup> lab, more than 15,000 tests and 2 billion test strokes per year.**

**The industry's largest test lab** conducts more than two billion test cycles per year on a total of 107 test rigs. Extensive test databases are created in the process and even tests for individual customers are possible upon request.

**The igus® GmbH quality policy** is based on the objective of identifying and meeting customer needs, and of always being a professional partner and reliable supplier. igus® has therefore committed itself to the manufacture of products of the highest possible quality standard and to the consistent development of innovative solutions. One vision has been driving us for more than 50 years - **motion plastics®**: innovative moving parts made of plastic. Our core technology is based on tribo-polymers - high-performance plastics whose friction and wear properties we always strive to improve. The technology has made us into a world-wide leader for developing and manufacturing energy supply systems and plastic plain bearings.



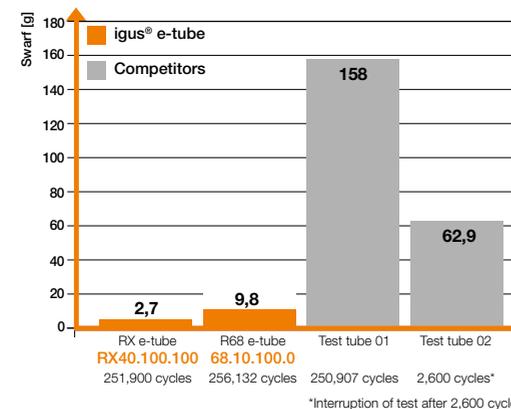
## Tested ...

### Outstanding swarf-tightness in realistic ambient conditions

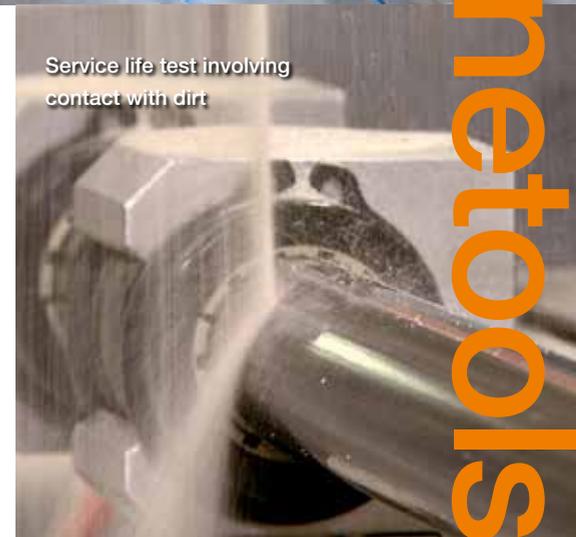
Swarf penetration test - various types of tube were exposed to a defined quantity of swarf. After 251,900 cycles, only 2.7g of swarf were found in the interior of the RX tube.

We test for you as well in relation to specific industries and applications - talk to us!

[www.igus.eu/test](http://www.igus.eu/test)

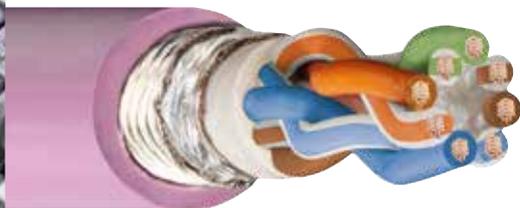


Service life test involving contact with dirt





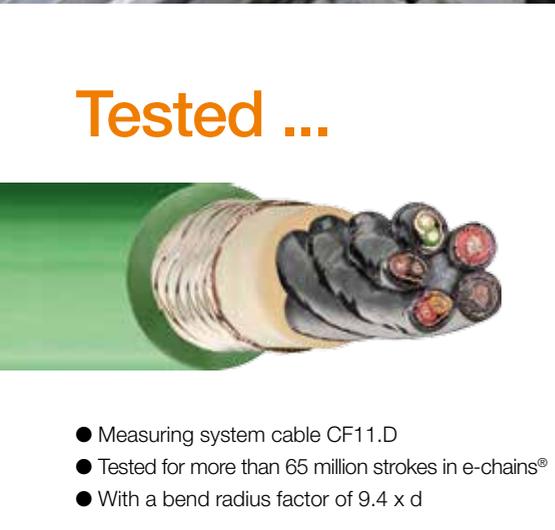
## Tested ...



- Ethernet bus cable Cat 5e, CFBUS.045
- Tested for more than 76 million strokes in e-chains®
- With a bend radius factor of 9.4 x d



## Extensive test database



## Tested ...

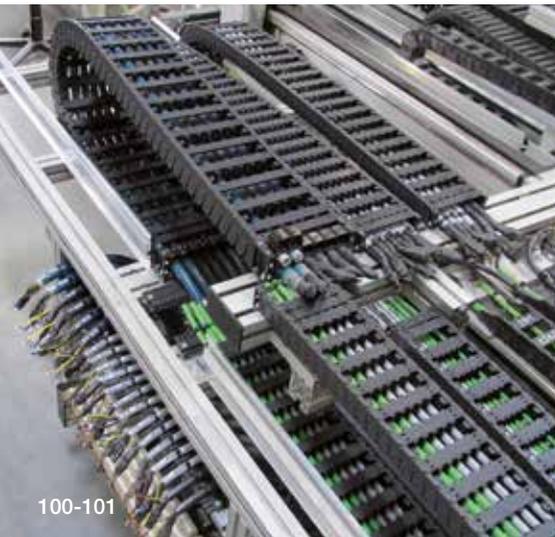
- Measuring system cable CF11.D
- Tested for more than 65 million strokes in e-chains®
- With a bend radius factor of 9.4 x d



## Tested ...



- All-round e-chain® system E4.1
- Test for service life and wear
- Test with e-chains® and chainflex® cables



## Tested ...

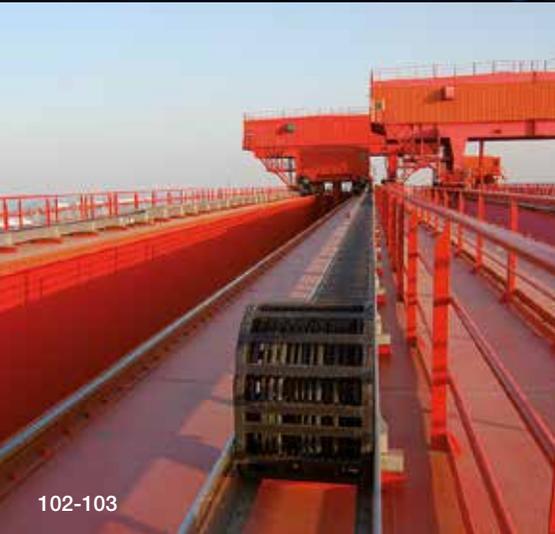


- twisterband with chainflex® cables
- Test for torsion and twisting
- Rotate up to 7,000°



From more than 15,000 tests per year was created, what is probably the world's largest test database. This database gives us the ability to always select the right product for your specific application. Individual tests for your industry are also possible.

[www.igus.eu/test](http://www.igus.eu/test)

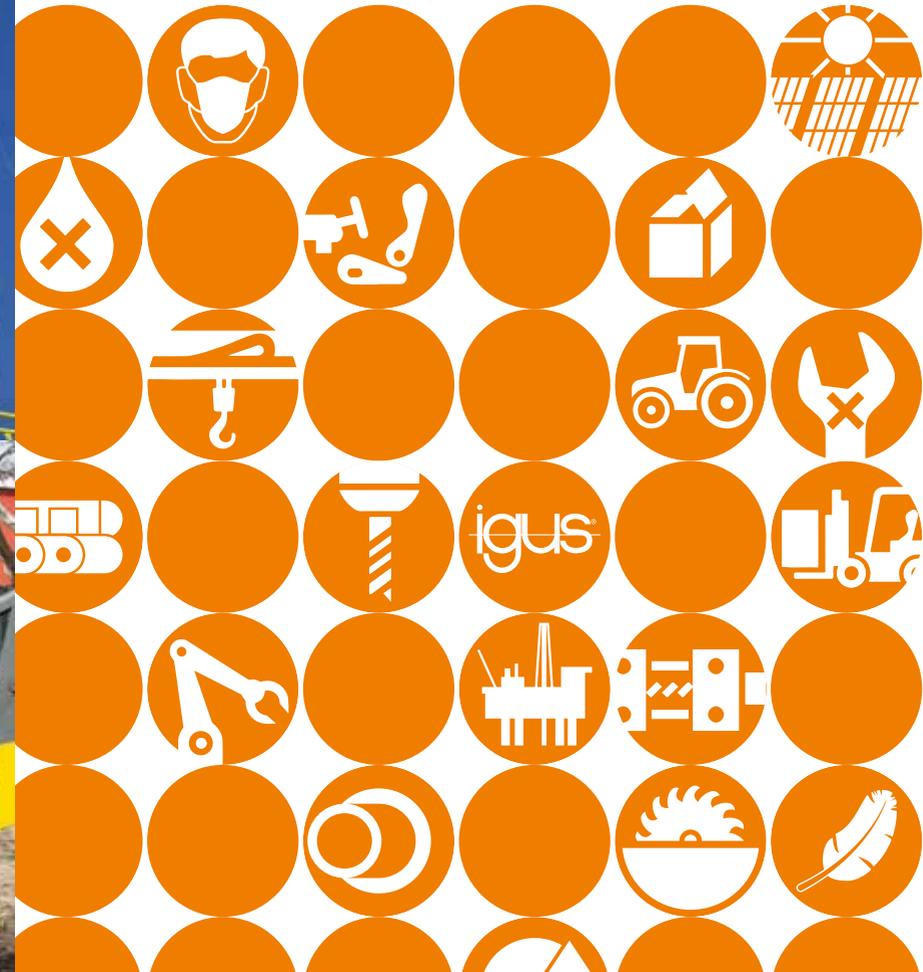


# Always the right solution for more than 60 branches of industry: [www.igus.eu/industry](http://www.igus.eu/industry)

## igus® motion plastics® solutions for almost any industry.

Different industries need different solutions. From mechanical engineering, automotive assembly or medical technology, to the robotics industry - igus® offers customised solutions for specific applications. igus® possesses many years of experience in most branches of industry and has competent specialists that can be contacted when necessary.

[www.igus.eu/industry](http://www.igus.eu/industry)



igus.eu/machinetools

**From a garage in Cologne to the global market with ideas and tribo-polymers.**

What began in 1964 in a garage in Cologne with a single injection moulding machine and confidence in the potential of polymer materials grew to be a globally active enterprise in 54 years.

Today, 3,800 employees come up with new ideas daily, while making high-quality products, ensuring streamlined processes, guaranteeing short delivery times and, above all, maintaining close proximity to the customer. igus® dispatches around 5,500 deliveries every day. To ensure speedy service and individual consulting, 14 storage and assembly centres around the world are available to customers.

Lots of room for innovation - the flexible igus® factory



igus.eu/machinetools

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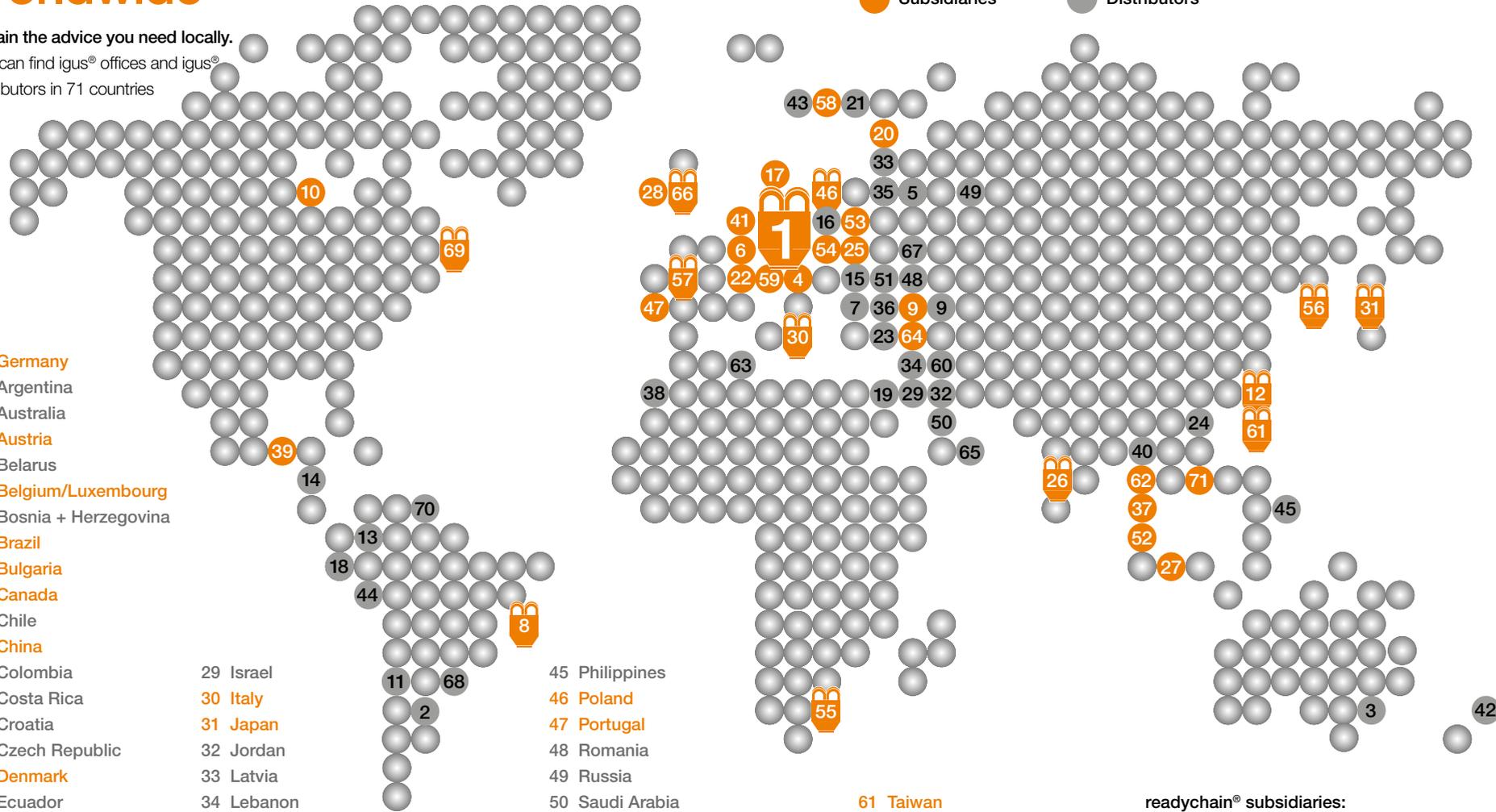
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- 35 Lithuania
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- 37 Malaysia
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- 39 Mexico
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- 41 Netherlands
- 42 New Zealand
- 43 Norway
- 44 Peru

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- 46 Poland
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Quickly find and configure products and calculate service life - all online. With the help of our product finders, you can quickly find the right article and obtain an exact prediction of service life. All online tools also enable you to reduce process cost. igus® delivers from stock in 24-48 hours!



**Always the right solution for machine tools.**

igus® is certified in accordance with ISO 9001:2015 and IATF 16949:2016 in the field of energy supply systems, cables and harnessing, as well as plastic bearings.

igus® GmbH  
Spicher Str. 1 a  
D-51147 Cologne  
Phone +49 2203 9649-800  
info@igus.de  
www.igus.eu

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