motion

Solutions for machine tools.
Tech up ... Cost down

igus®.com

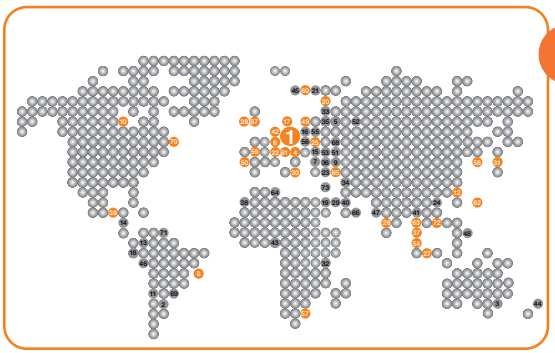
igus.com/machinetools

Smart, lean, modern – reduce costs and set new standards

Machine tools are the backbone of industrial progress and at the same time play a pioneering role.

For developing into a digitalized industry that is also sustainable, the company igus® is the right partner from planning to production. Experts with their know-how for moving machine parts are available to you worldwide.

With our global network of 35 branches and locally harnessed readychain® systems, we can reduce production times and process costs by up to 80%. When the machine is running, our smart plastics sensors and modules provide continuous information on the status of e-chains and cables and thus protect against unexpected machine failures. Maintenance intervals can also be planned more efficiently with these smart systems. When the machine has reached the end of its service life, igus® can take back the old plastic e-chains. We recycle them and return the recovered granules to production. With igus®, you not only use a machine component, you also get a partner.



igus® offices and distributors worldwide

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Contents

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Milling with micrometer accuracy with low-vibration energy supply

Vibration-free cables and hoses lead into moving column machines from DMG MORI. The DMF 200|8 has enlarged by 54 percent compared to its predecessor model and, despite its size, processes precisely and movably in the micrometer range. Five axes move simultaneously: three linear axes in XYZ direction with a feed rate of 50,000mm/min and an acceleration of 8m/s², an integrated slewing ring in the machine bed and the B-axis milling head with a pivoting range of +/- 120 degrees.

One of the challenges is to guide cables and hoses in such a way that vibration does not occur. Even slight vibration can cause the formation of ripples on the surface of the workpiece. The surface quality of the components is crucial especially in industries such as tool and mold making.

With the E4Q series of e-chains®, long unsupported travels are possible, virtually vibration-free.

The reason is that the lightweight feature has been reduced by another 10% than the previous E4.1 series. Shaped contours and integrated starting brakes in the stop-dog system of the chain links reduce noise and vibrations and ensure smooth start-up and braking of the energy supply system.

The e-chains® of the E4Q series are not only quiet and have low vibration, but also are durable and easy to maintain. Crucial is the tribologically optimized high-performance plastic that makes up the chain.
Even after years of use, the e-chain systems therefore show hardly any wear in the pin-bore connections of the chain links. Their service life can even be precisely determined using an online service life calculator.

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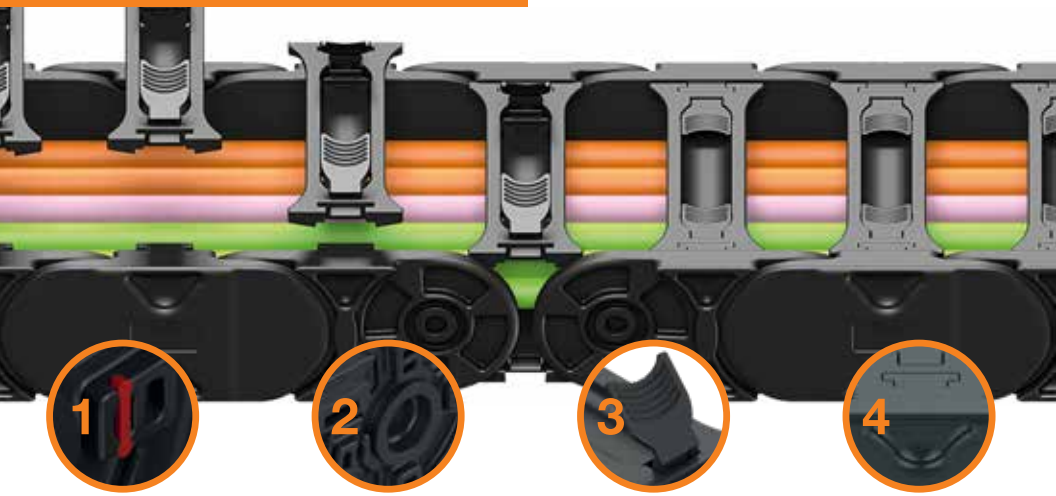
E4Q e-chains®: the new standard for machine tools

As the successor to the E4.1 e-chain®, which has been tried and tested for over 12 years, the new E4Q has a completely revised design.
With the aim of creating a new generation of the e-chain for machine tools, the service life could be further increased, weight saved, noise reduced and assembly simplified.

More information and online orders www.igus.com/E4Q



1. Optional noise damping
New concealed system for noise reduction. Can be retrofitted at any time. Rubber elements attached to the horizontal stops dampens the impact and reduces the noise of the already quiet e-chains®. **17dB(A) quieter** than 4040C series.

2. Higher strength
Two vertical and two horizontal stop-dogs per link provide more rigidity. This allows a greater unsupported length and higher fill weights. **20% stronger** compared to E4.1.

3. Crossbars (e-chains®)
Open and close the e-chain® easily without tools. Crossbars and shelves lock in the side section for even greater holding forces. The e-chain® can be filled in considerably less time. **40% faster** filling than E4.1.

4. Save weight
Due to new research, material is left out where it has no function for the e-chain®. This is used both inside, between the stop-dogs and outside. In the process, nature-inspired rounded shapes were used for the design. **10% less weight** than E4.1

Tool-free opening and closing.

Four stop-dogs for high strength in all installation types.

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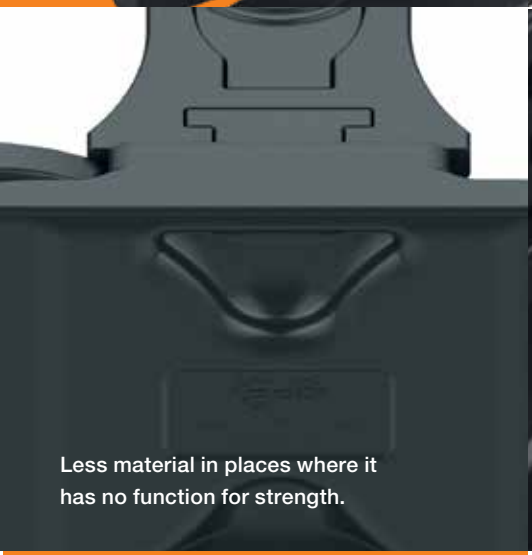


Less material in places where it has no function for strength.

Optional noise dampeners for even quieter operation.

Real-time condition monitoring with optional EC.W service life sensor.

Interior separation product range, also for complex division.

Turn days into minutes: igus' complete solutions reduce machining centers assembly times

Ready-to-install readychain® systems from igus® lowers process costs and reduce errors. In its robotic machining centers, Taiwanese tool manufacturer Hartford uses fully **assembled e-chain systems** from igus®. This makes it possible to cut out many work steps and thus reduce the assembly time from several weeks to a mere half a day. At the same time, customers can always rely on readychain® from igus® to receive a **safe solution from a single source.**

igus® is the only supplier to develop both e-chains and cables specially designed for this purpose, which reliably follow the continuous movements in the e-chains® from igus®. These so-called **readychains®** can be harnessed according to customer requirements at **12 locations all over the world** and **delivered worldwide.**

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

igus® presented Hartford with a solution for the systems of the **AERO series** units. The igus® e-chains enabled the Hartford engineers to significantly reduce the installation space. One reason is that all the chainflex® cables on this machine are equipped with an **oil-resistant PUR outer jacket**. Additional protective hoses can therefore be dispensed with, which reduces the space required for the cables and thus the size of the chains and also facilitates maintenance and, last but not least, reduces the costs due to the elimination of the protective hoses.

In close cooperation between igus® Taiwan and Hartford, a **3D drawing** of the used readychain® with assembly frame was then created to simulate the assembly process. The benefit could be seen immediately: The first e-chain fitted with all electrical cables was installed on the machine **installed in an hour**. The **second chain** with hydraulic hoses in **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 day. Previously, two

igus.com/machinetools

More information and video about installation

Ready-to-install, industrially harnessed: igus.com/readychain

Always the right harness for your application! Ready-to-install readychain® e-chain system® configured and delivered in 3 to 8 days.
This is possible due to the large selection of e-chain® cable carriers for all kinds of motion; cables for e-chains® with up to a 36-month guarantee complete with the relevant connectors. Reduce the number of suppliers and orders by 75%. Minimize your machine downtime. 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-assembled e-chain systems® with sheet-metal parts

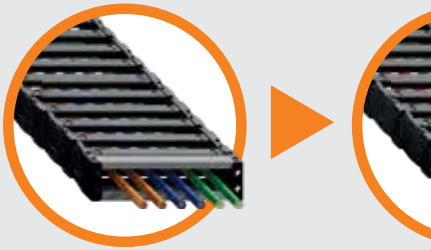
Premium
Ready-to-install complete system with transport rack

The most commonly used harnessing in the machine tool industry:
Premium ready-to-install complete system with transport rack

www.igus.com/readychain

igus.com/machinetools

readychain® basic, standard, standard+ and premium: The productivity accelerators



readychain® basic:
3 ... of 13
readychain® benefits

3 … 6 … 9 … 13 … readychain® benefits

Your benefits	BASIC	STANDARD	STANDARD+	PREMIUM
ONE supplier - combine suppliers	☑	☑	☑	☑
Reduce assembly time	☑	☑	☑	☑
Reduce failures	☑	☑	☑	☑
No electrical termination needed	■	☑	☑	☑
100% digitally tested	■	☑	☑	☑
No cable surplus	■	☑	☑	☑
Reduce interfaces	■	■	☑	☑
Optimise connection / interfaces	■	■	☑	☑
Ready-to-install multi-axis system	■	■	☑	☑
Optimize your transport / assembly	■	■	■	☑
One single assembly	■	■	■	☑
One part number / product group	■	■	■	☑
Plug & Play	■	■	■	☑

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

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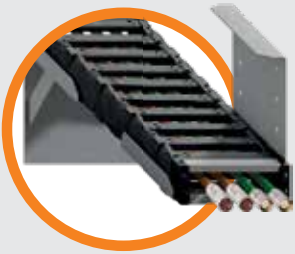
readychain® standard:
6 ... of 13
readychain® benefits



readychain® standard+:
9 ... of 13
readychain® benefits

readychain® premium:
13 ... of 13
readychain® benefits

Turn days into minutes: igus' complete solutions reduce machining centers assembly times

A fast-moving rotating energy supply system allows 540° rotation angles in a confined space - and wins the golden vector award

The MULTISPRINT series stands for a technological revolution in automatic turning. The fast, precise and varied production processes make the MULTISPRINT a machine with almost unlimited possibilities.

The heart of the machine is the spindle drum with six spindles, which consists of two rotation systems. In the outer system, there are the hoses, while 24 cables are guided in the inner circuit - 12 encoder cables and 12 servo cables each. It only takes 0.65 seconds for one of the 6 spindles to travel to the next position. For spindles to return to the starting position after machining has been completed in the 6 stations, the drum has to turn 300 degrees in reverse. For this, the unit, which weighs over 3 metric tons, only needs 1 second.

We use a rotary energy supply system that rotates along with the drum. These are custom-made systems for circular movements with e-chains, which are used in machine tools as well as construction machinery, among other things. The reverse bend radius enables movement of the e-chains in two directions. Rotation angle of up to 540° on one plane can be made possible here.

Each of the 6 installed linear chains accommodate 2 encoder and 2 servo cables. The e-chain systems® can be individually connected, easy to maintain and process. Finally, the chains and cables of the completely pre-assembled readychain® solution also make do with the relatively small installation space of the machine.

igus.com/machinetools

DMG Mori orders the e-chains® fully assembled as readychain® premium. The system delivered on a rack is prepared ready for installation, saving the customer days of assembly time.

The rotating energy supply system in DMG Mori's multi-spindle lathe won the 2020 golden vector. Find out more about the vector award at:

www.igus.com/vector

More information and video on the installation

Configure e-chains® online

igus.com/machinetools

Online tools for e-chains®

Find the right chain type in the product filter, configure the chain with filling, calculate the guaranteed service life, download the CAD file of your individual configuration.
This, and more, is possible with our digital e-chain® helpers. Free of charge and without registration.

www.igus.com/info/onlinetools

Milling without sagging

Large machining center gantries are the specialty of machine tool builder Kao Ming in Taiwan. The long travel lengths of up to 13 meters 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 centers. 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. If the first G-series plants had a travel distance of six meters in the **x-axis** the current model series already has **13 meters**. 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 gantry machining center KMC-G is designed for workpieces from the aviation and machine tool industry.

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

igus.com/machinetools

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 switch cabinet through the plant to the milling unit. The **special modular design** also increases the demands on the e-chain, since the travels are longer. In this system, additional modules can be inserted on the X axis. "For longer travels, no e-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 **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 meters** long.

igus.com/machinetools

guidelok horizontal for long travels, unsupported in chip areas

In machine tools on long travels, when the e-chain® has to be used in a sliding manner, metallic chips is often a problem.

The e-chain system® guidelok horizontal is a cost-effective solution, unsupported up to 50 meters. It has a lower cost than most steel chains or gliding systems

Design principle: The system guides the upper run of the e-chain on pivoting roller holders, which can fold in the moving radius of the e-chain and guarantee an unobstructed travel.

1. Enormous increase of unsupported lengths for e-chains
2. Chips cannot get stuck between the sliding surfaces of the lower and upper run
3. Intelligent upper run guide with pivoting roller brackets
4. Modular system with few parts (also possible without lateral trough)

www.igus.com/info/guidelok

The e-chain® is guided in the trough channel, pushing back the spring loaded roller supports with its radius ...

... roller supports pivot in and out again after the radius ...

... the upper run then lays on the roller support.

Tested at Gurutzpe in Spain: e-chain for travels up to 50 meters, unsupported

The Spanish machine manufacturer Tornos Gurutzpe S.A., based in Guipúzcoa, has delivered well over 5,000 machines within half a century. Its latest horizontal lathe, the "A-2000 4G CNC", is equipped with a novel e-chain solution for long, unsupported travels in the chip 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" e-chains® from the energy supply specialist igus® S.L., Barcelona. The two reverse e-chains have an unsupported connection to the carriage over a length of 13.5m.

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

igus.com/machinetools

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

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

The guidelok system guides the upper run of the e-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 e-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 chips can settle between the gliding surfaces of the upper and lower run of the e-chain.

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 e-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 very strong plastic e-chain, jumping up and down on it, demonstrating that it can carry the weight of a grown man easily.

igus.com/machinetools

smart plastics in use at an Austrian automotive supplier

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 reliable components and a high degree of automation. Companies therefore rely on smart plastics igus® to avoid unforeseen failures and machine shutdowns.

With the help of a polymer wire (inside the e-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 subsequent damage.

The **isense EC.W modules** have also been fitted. A sensor built into the crossbar signals advanced chain wear. 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.

igus.com/machinetools

Smart sensors in Güdel linear robots:
Automation expert Güdel Group AG also relies on smart plastics in its linear robots. The travel axes for the efficient handling of workpieces weighing tons are used in tightly synchronized industries such as the automotive industry or goods logistics. In order to offer their customers a high level of planning reliability, sensors on the e-chains continuously measure movement, temperature and wear. An evaluation of the data suggests maintenance measures to the customer, who can use them to plan and avoid expensive downtimes.

Application video

i.Sense condition monitoring for e-chains

Smart plastics avoid plant downtimes

If the energy supply system fails and/or a cable breaks, the whole machine often stops. Since a system failure or an unplanned machine downtime are among industry's most significant cost burdens, we have developed smart plastics. These are sensors and monitoring modules for condition monitoring and predictive maintenance.

"My energy supply system and plain bearing technology should finally be ready for Industry 4.0".

"My plant must never stop."

i.Sense condition monitoring

With condition monitoring systems, the e-chain automatically records defined measured values in real time and issues an alarm message at a defined limit value to avoid a total failure.

www.igus.com/info/smart-plastics-overview

"If only there were a switch-off function for my energy supply system to prevent the next crash ..."

Comprehensive laboratory data to determine the correct limit values:

Did you know? In order to be able to determine the guide values and limit values from which a malfunction occurs in the chain, the i.Sense modules rely on data collected millions of times by our in-house laboratory in Cologne - the largest in the industry. Over 10 billion e-chain® cycles per year are recorded and evaluated in the laboratory for e-chains® and chainflex® cables, 3 billion test cycles for e-chains alone.

From the sensor to the switch cabinet - how is the information flow structured?

igus® products for condition monitoring

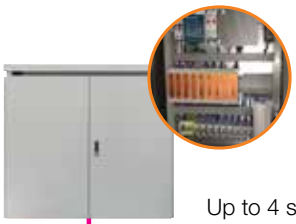
- **records the machine status regularly or permanently**
- **avoids crashes with fast switch-off**
- **data recording modules**

www.igus.com/info/smart-plastics-overview

If smart plastics are used for condition monitoring, they immediately report any unexpected operating state, switch off the system, or sound an alarm. Industrial manufacturers use this function to minimize system failures and downtime.

Control cabinet

- Simple module installation on top-hat (DIN) rail
- Integration into the existing plant control system via NC contacts
- 24V DC voltage supply

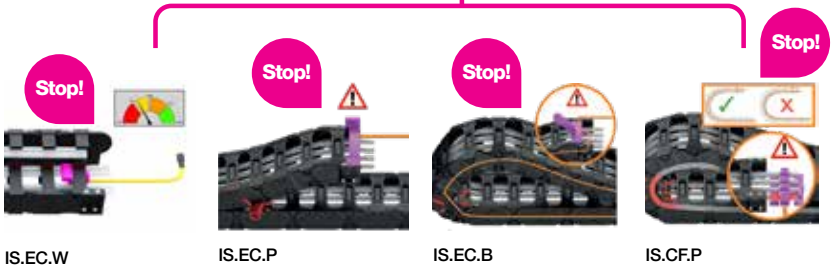


Up to 4 systems can run on 1 i.sense ii module

Modules

- Evaluate all sensor data based on igus® algorithms
- Inform the plant controls in real time of any mechanical faults that occur

iSense module II



IS.EC.W **IS.EC.P** **IS.EC.B** **IS.CF.P**

Sensor units

- **IS.EC.W** real-time wear detection for energy chains
- **IS.EC.P** push/pull force detection for energy chains
- **IS.EC.B** break detection for energy chains
- **IS.CF.P** tensile force monitoring for cables

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i.Cee predictive maintenance for e-chains

"When is it time for maintenance?"

"To see the remaining service life ... that would be science fiction."

Do you have your own question? Enter here:

i.Cee Predictive maintenance

Predictive maintenance involves the replacement of moving components such as e-chain systems at regular intervals, which is shorter than the expected service life. If they are replaced shortly before they reach the end of their actual life, the service life can sometimes be significantly extended, often even doubled. This then halves the costs and reduces the maintenance effort - without compromising reliability.

Irregularities before the end of the specific service life are detected by the system and a warning message is issued. The user is then able to eliminate the unusual operating condition before major damage occurs.
The i.Cee system reminds the customer of upcoming inspections or maintenance work. This information is provided according to use, so that longer maintenance intervals are possible with less use, thus saving costs.

Visit the web page for more information

i.Cee hardware

As an intelligent "preventive maintenance" system, i.Cee collects sensor data in the hardware in the switch cabinet and stores it locally or in the Cloud.

i.Cee:box

The weatherproof box (IP.68) is installed in the machine's switch cabinet, where it receives the e-chain sensor data.

i.Cee:plus II

The i.Cee:plus II module is installed in the switch cabinet or directly in the machine to collect data there and pass it on to the i.Cee software.

i.Cee:custom

The sensors in the e-chain communicate directly with your corporate software, which transfers the data to the i.Cee software for evaluation.

i.Cee data storage

i.Cee:local

Your data does not leave your company network at any time, as the i.Cee software only communicates within the networks of your choice.

i.Cee:cloud

This internet-based solution has two options. In the first, your data is transferred directly to the cloud, where it is made available in a protected area that can be accessed with a browser dashboard.

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chainge
The Recycling Program for energy chains

We collect old energy chains. If it is at the end of its service life, you can therefore simply send your e-chain back to us, even if it comes from another manufacturer. Our **chainge recycling program** makes this possible. The material is sorted by type, cleaned and processed to virgin material quality. The resource-saving material igumid® CG, on which our new chain range E2.1.CG is based, is created from the old energy chains. Five energy chain series with 28 chain types are available from stock.

www.igus.com/chainge

How the chain returns to us - five easy steps:

1.
Remove coarse dirt from the chain

2.
Weigh e-chain

3.
Fill out the form

4.
Pack and send the e-chain

The cradle-chain The first recycled material without a price difference

World first: The first e-chain® made from recycled material. Based on the igus® chainge program, the new E2.1 (micro) e-chain catalog range was created using 100% recycled material – saving 28% C02 according to the EPD (Environmental Product Declaration). The new igumid CG material is without any change in price vs. e-chains made of standard material and has the same technical specifications and load limits.

www.igus.com/cradle-chain

*In order to achieve the quality standards, small quantities of new material may be added during the preparation process.

voucher

5.
Get a voucher for the new igus® products

www.igus.com/info/echain-recycling-program

Sustainability at igus®

Plastic is a much-discussed material. We know that high-performance polymers can make a contribution to the protection of resources and to the environment, and have made this the focus of our corporate activities.

www.igus.com/sustainability

igus.com/machinetools

The igus® machine tool specialists

R2.1 e-tubes – cost-effective chip 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.com/R2.1

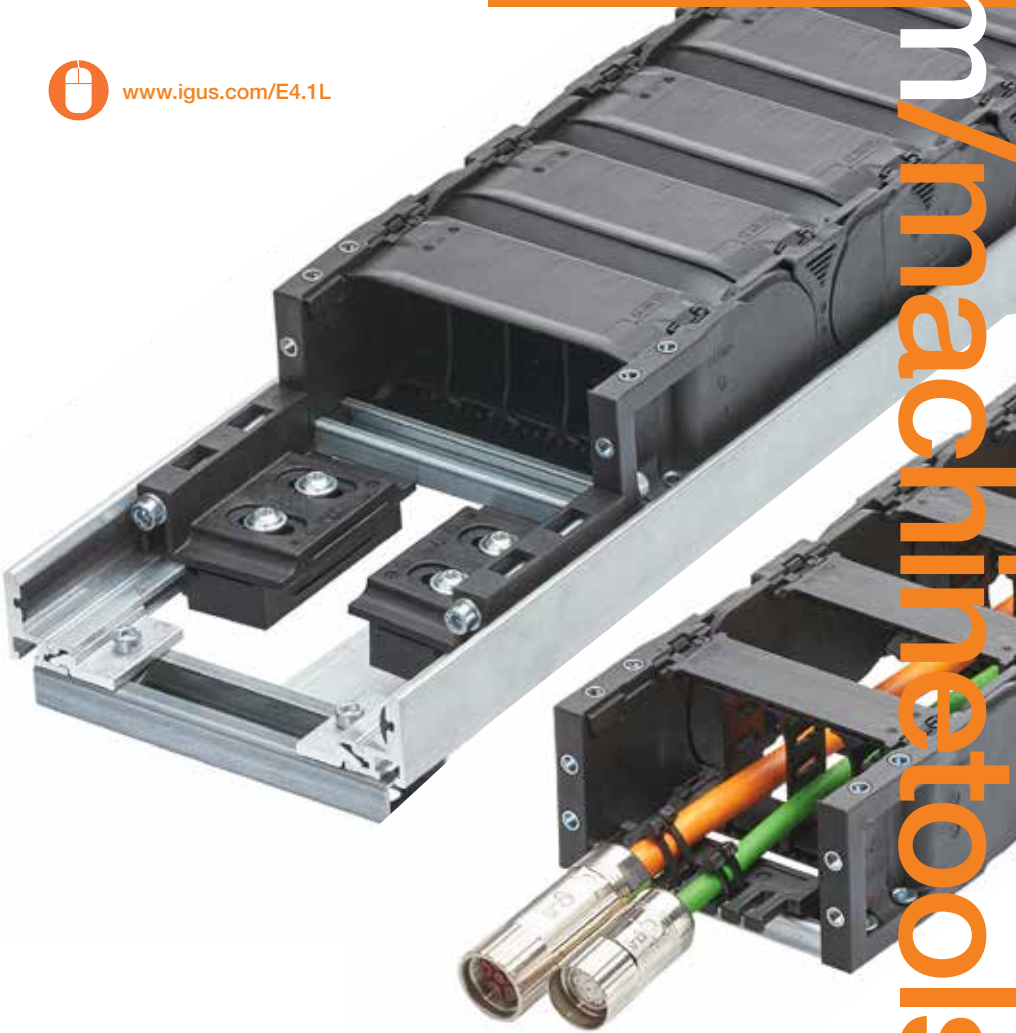
R2.1 e-tubes

Cost-effective, strong e-tubes with 26, 40, 48 and 75mm inner height. Removable lid hinged on both sides. Designed to provide a tight seal, with 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 optimized crossbar geometry
- 30% lighter and lower-priced than E4.1
- e-chains® 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.com/E4.1L



igus.com/machinetools

No breaking during bending - reliable igus® e-tubes in bending machines 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 e-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 subsidiaries. The company makes different types of bending machine in different sizes and models. Always with outstanding quality.

igus.com/machinetools


TruBend 5130

The chip-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 colored cables or colored 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 e-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.

igus.com/machinetools

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

Fail-safe cables for e-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.com/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 e-chains.

igus.com/machinetools

chainflex® cables supply KESSLER tools with energy and signals

igus.com/machinetools

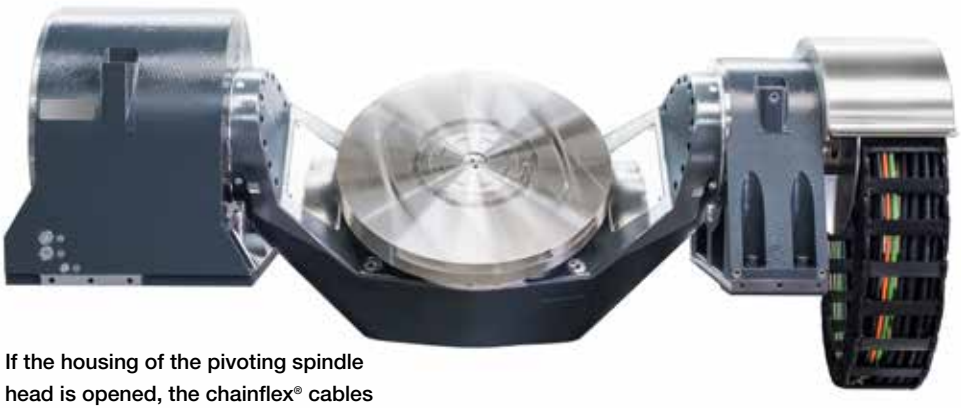
What a Brembo brake is to a sports car drive or a Cohiba is to a cigar smoker is the same as what a KESSLER spindle is to the builder of machine tools.

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, e.g. 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 Spindles & Pivoting Systems: "The heads and axes are very compact, so that there is not much space left 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.



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

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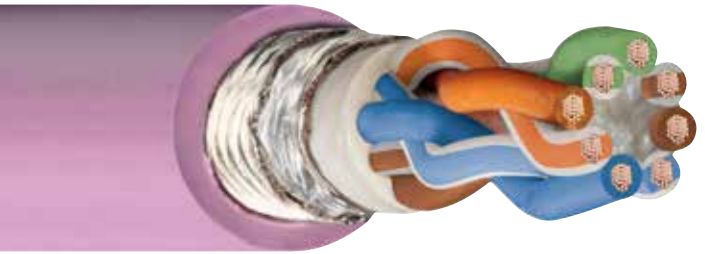
No problems for more than ten years. KESSLER has been using chainflex® cables from igus® since 2003. No problems or failures have ever been reported to the responsible design engineers. This is why KESSLER always uses chainflex® cables - even in non-moving applications. Florian Gehrmann: "For us, what 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."

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 derivates 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 **colors of the jacket** and **core insulation**. What is important when a cable is being chosen is that you also consider the mechanical specifications 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.

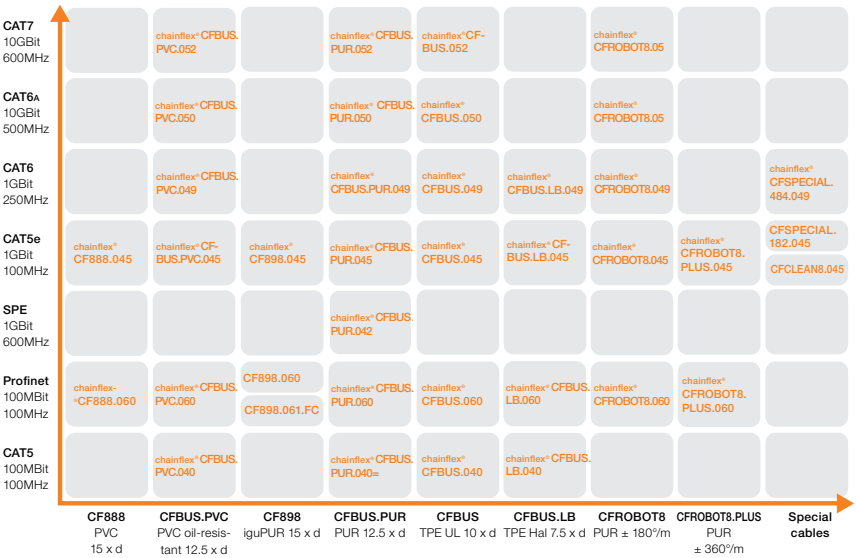


Test 3089
CAT5e Ethernet cable tested successfully in an endurance test with 76 million strokes.

igus.com/info/chainflex-tests-overview

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

Electrical performance



Mechanical performance

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 different qualities of cable mean that there are opportunities for very large **savings** or for the cabling of your equipment in a way that meet your needs in the future.

We can deliver your required length on drums or in coils to your **required length, without any cutting charges**. Upon request, we also assemble your cable with suitable plug-in connectors. No minimum order quantity, with your custom dimensions and designs.

www.igus.com/Ethernet

igus.com/machinetools

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

Spindle drives for machine tools are become 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 e-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 spindle drive cable, the CF270.UL.D **single-core chainflex® cable is considerably thinner** and, for this reason, is ideal for use in an e-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 e-chains, its outer jacket is made of a low-adhesion mixture on a PUR basis. As a result, it is **oil-resistant**, **notch-resistant** and **halogen-free** and can also be used for low-temperature applications. Due to its orange jacket color and its approval according to UL and NFPA79.2012, it meets all the requirements of the machine tool industry.

www.igus.com/product/1084

Conceived as a spindle 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 tightness and good mobility. **In chainflex® cables** for linear movements, the braided overall shield fits tightly around the stranded cores with an **optimized braid angle shielding**. In torsion cables, however, the shield wires must be able to slip and slide, whereby the shield is loosely placed around here. Movements in all directions are thus enabled and, at the same time, **reliable permanent electromagnetic compatibility 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.

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

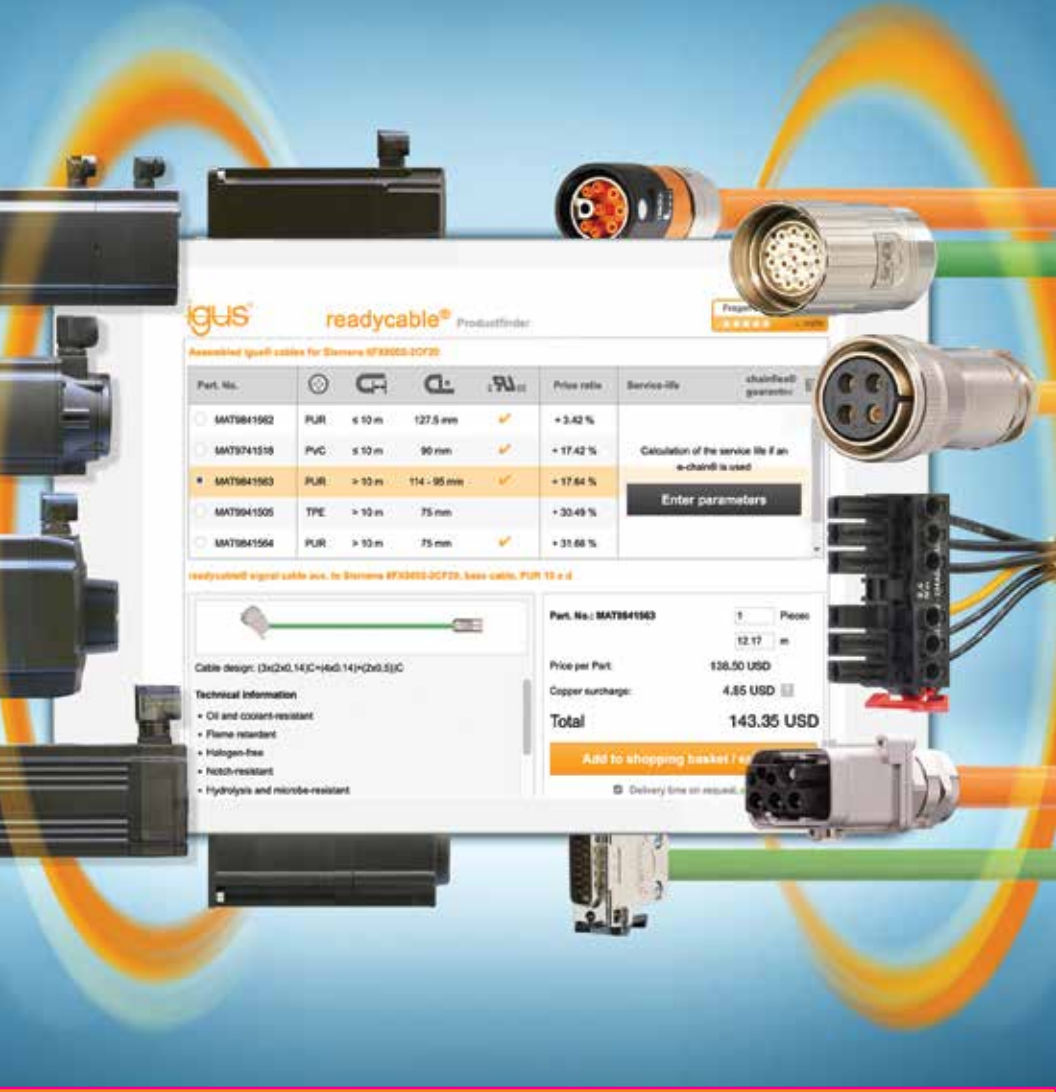
Measuring system cables for large machining centers

The machining of large components such as diesel engines, turbines, generators or ships' propellers means that machining centers 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 company Waldrich Coburg GmbH is one of the world's largest machine tool engineering companies. "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."

The specialist in large machining centers 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 based 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.

igus.com/machinetools



Reduce throughput times ...

... with readycable®, ready-to-connect assembled cables for use in e-chains. As a manufacturer and assembler, igus® provides everything from one source, reducing processing time and the number of suppliers.

Guarantee igus chainflex 36

up to 36 months guaranteed

www.igus.com/readycableproductfinder

Assembled cables with a guarantee - readycable®

The portfolio includes an extensive range of catalog products

- 4,200 assembled drive cables similar to 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 customized 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.com/readycable

The most cost-effective drive cable

... that is guaranteed to work!

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

www.igus.com/ibow

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readycable® cables similar to standards of drive manufacturers for machine tools

The readycable® at a glance:

- No minimum order quantity or cutting charge
- Required length
- 100% quality-checked
- Industrially assembled

readycable® cables for these and other drive manufacturers can be found in the readycable shop:

The readycable® factory in detail:

- Cable assembly and inspection at 14 locations worldwide
- Tested and checked by our adjoining readycable® test laboratory
- Project planning and documentation directly from the manufacturer

Siemens

Over 1,000 different drive cables similar to Siemens standard

https://www.igus.com/readycable/similar-to-siemens

Heidenhain

More than 115 different cable configurations similar to Heidenhain standard

https://www.igus.com/readycable/similar-to-heidenhain

Fanuc

123 options for ready-to-connect cables similar to Fanuc standard

https://www.igus.com/readycable/similar-to-fanuc

Mitsubishi

Over 40 different drive cables similar to Mitsubishi standard

https://www.igus.com/readycable/similar-to-mitsubishi

igus.com/machinetools

Rotation in a machine tool

Lathes, spindles and machine tools nearly always involve some form of rotation.
The guidance of electric cables and hydraulic and pneumatic hoses is usually a difficult challenge. We have various solutions for rotary movements.

More blog articles on machine tools

toolbox.igus.com/motion-plastics-blog

Winding an e-chain®
This is the simplest method. A standard e-chain is coiled around the rotary axis. If there is enough space, a rotation of nearly 360° is possible. This is used in pivoting tables, among other things.

Winding an e-chain® with reverse bend radius The functioning principle on the rotary axis is identical. However, the reverse bend radius makes it possible to guide the chain into a free area of the machine. This variation is very popular, especially if movement in space is to take place along with the rotation. Often encountered for the supply of energy to grinding spindles.

Rotating energy supply with Reverse Bend Radius (RBR) and Multi Rotation Module (MRM)

The RBR system takes up a lot of space but works very reliably in highly dynamic applications. The e-chain® is guided reliably during the entire rotation. A rotation angle of up to 540° can be made possible in one position. This system is used in automatic multi-spindle lathes, for example. With the extended MRM system, additional layers are added, each of which allows rotation angles of up to 360°.

Twisterband HD

The twisterband system has proved itself over a long period of time. With the latest HD version, it offers sufficient space for the reliable guidance of servo cables as well. Thanks to a diameter of only 500mm, rotation angles of up to 900° are achieved.

www.igus.com/twisterbandHD

triflex® 3D-chain

This chain has proven itself as a high-end solution for robots. The triflex® solution opens up new possibilities, especially in the case of complex movements involving rotation. It can move in space with a defined radius and is inherently twistable. This variant is especially helpful if the grinding spindle is supplied with power from above.

www.igus.com/triflexr

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igus® WHITEPAPER

Influence of vibration on machine tools

Vibration behavior of e-chains

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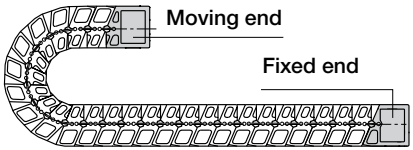
The problem: The requirements for precision of machine tools are constantly growing. Their increasing automation gives specific challenges; for example, the influence of the vibration of machine components on the finished workpiece is an important factor when cutting and milling. e-chain® cable carriers, the “umbilical cord” of the modern machine tool, are a possible source of vibration that can cause problems. As the technology usage increases, the use of cables and hoses guided by e-chain® cable carriers also grows. During the necessary operational movements, vibration occurs in the trough and at the moving end and can adversely affect the result and the entire production process if they exceed a certain tolerance band. In international competition, the German machine tool industry especially depends on premium products whose 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 offer minimal vibration and extremely smooth operation.



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

An overview of all igus® white papers:

Cutting and milling precision

Dynamic loads always generate types of vibration that can cause displacement of the tool and the workpiece during machining, which impairs metal cutting. Increasing deterioration of the cutting conditions of metal-cutting machine tools can lead to process instability. So-called chatter vibration occurs which leads to loss of quality in the machining result and increased wear of machine components. Product defects and production downtimes are the consequence. As the materials that are used are increasingly 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 important than ever. Smoothly operating e-chain® cable carriers are therefore indispensable for the limitation of self-generated machine vibration.

State of the art

Most e-chain® cable carriers 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 in dynamic applications. 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 so called “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 behavior of e-chain® cable carriers 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®e-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-chain® cable carriers with a pin/bore connection system, igus® also adopts the small pitch approach as a design principle for smooth, low-noise operation. For especially challenging applications where a maximum reduction of vibrations is the goal, igus® has also designed an innovative connecting component for the links: an elastic spring element made of high-performance plastic. Instead of the conventional, relatively rigid connection consisting of pin and bore, the E3, E6 and E6.1 series of e-chain® cable carrier feature flexible connectivity, which reduces the polygon effect to a minimum

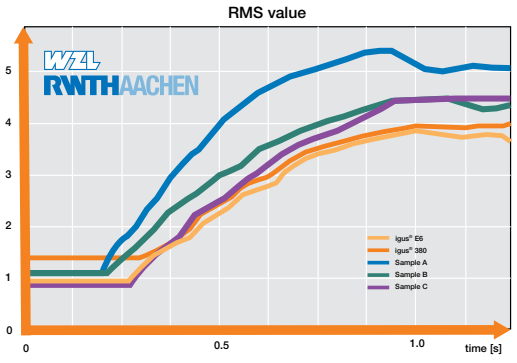
when the chain rolls. In this way, extremely low noise and almost vibration-free operation of the chain are possible. Very smooth, low noise operation and simultaneously high rates of acceleration can be achieved with the E6 e-chain® cable carriers. In 220 million test cycles in the igus® technical center, the design innovation was able to demonstrate its advantages and effectiveness. In a long-term test in 2008 with the E6.29 e-chain® cable carrier, the spring element underwent more than 400 million complete bending movements. As an independent assessment by the Fachhochschule (technical college) in Cologne showed, none of the fasteners used showed any visible or measurable damage.

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

The spring element also fits in with the modular approach to the e-chain® cable carrier structure. The links on the sides 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 and assembled. 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 organized in a variety of different ways through the use of separators and dividers on the one hand, and different width shelves on the other, allows a specifically defined layout and fast cable filling.

According to tests of the IP Fraunhofer Institute, the corrosion-resistant polymer material of the chain and springs is characterized 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; the measured sound pressure level of only 37 dB(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 any 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 behavior is reduced to a minimum, which is beneficial for the workpiece when finally produced.

Case study of "vibration behavior": a scientific comparison of e-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 behavior of five different e-chain® cable carriers. The two E6 e-chain® cable carriers from igus® and three comparable e-chain® cable carriers of other suppliers were examined. With inner widths of 100 to 105 mm and inner heights of 42 to 52 mm, 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 14,000 N) at four speeds (25 m/min, 50 m/min, 100 m/min, 200 m/min) and at two rates of acceleration (10 m/s2, 20 m/s2) over a travel of 800 mm. 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 e-chain® cable carriers 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 value is a measurement of the vibration energy at the measuring point. The RMS (Root Mean Square) value of the vibration energy at the measurement point was the lowest for the two igus® e-chain® cable carriers (source: RWTH Aachen).



(Source: WZL RWTH Aachen)

In the case of all e-chain® cable carriers, 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 10 m/s2 and 20 m/s2 had no significant influence on the vibration values of the e-chain® cable carriers. The results show that, compared to the other e-chain® cable carriers, the E6 e-chain® cable carrier has the best properties in regards to vibration behavior 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 e-chain® cable carriers. The E6 type of chain had the maximum RMS value of approx. 4 m/s2. The RMS value of the cable carrier with the most vibrations was even 40 per cent worse at 5.6 m/s2. At the moment, the E6 e-chain® cable carrier is the e-chain system® solution with the lowest levels of noise and vibration.

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

With its comprehensive range of 90,000 e-chain® products, igus® has acquired technical market leadership in this special area of energy supply. The company has almost 50 years of practical experience with e-chain® cable carriers. 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 2,750 m^2, 30 employees carry out 4,100 tests per year on 65 test machines in the e-chain® laboratory alone. Technical innovations such as the elastic spring element are subjected to a test marathon consisting of tests under realistic conditions, whereby behavior 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-centered. 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 e-chains with inner heights up to 80mm.

Summary

The growing requirements regarding the precision of machine tools call for technical innovations in the area of vibration reduction. Achieving smoother operation of e-chain systems® in dynamic applications is an important component of a successful strategy. The avoidance of vibration by using machine components that have been optimized for low 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 e-chain® cable carriers 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 centers, CNC lathes, machining centers** 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.

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

68-69

ROMI has been relying on e-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 machining center **ROMI DCM 620-5X Hybrid Vertical,** 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.

igus.com/machinetools

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

In the **ROMI GL240 gantry loader,** e-chain systems® from igus® also ensure reliable cable management. This application is an automation system for loading and unloading workpieces in ROMI machining centers. 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 characterizes 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® of the E2/000 series have crossbars openable on both sides, which makes assembly much easier.

In the **latest generation** of its vertical machining centres, **ROMI D**, the Brazilian machine tool manufacturer ROMI uses igus® e-chains. "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 e-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.

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

igus.com/machinetools

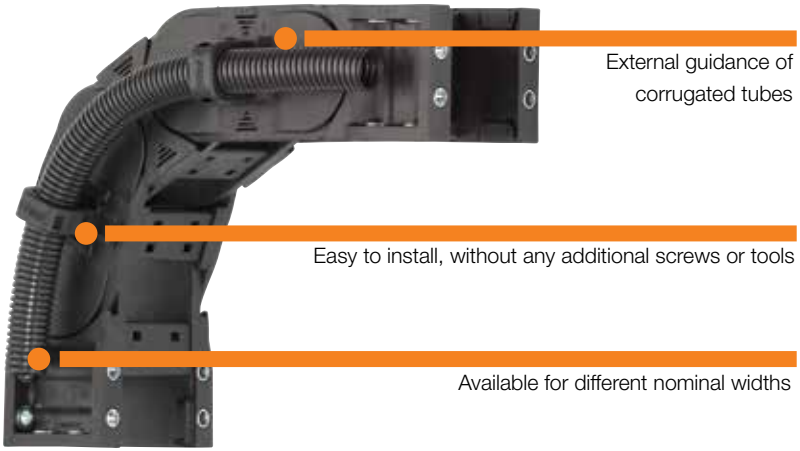
Safe guidance for corrugated tubes parallel to an e-chain®

TUB is an addition to our E4 modular system. 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 e-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 application areas:
General mechanical engineering,
machine tools, laser cutting machines, wherever something needs to be guided (retrospectively) outside the chain cross section.

www.igus.com/E4-1



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

Messer Cutting Systems increases productivity by using igus® e-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 manufacturer's specifications 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 for all housings 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

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.

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. 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 e-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.

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.com/triflexR

igus.com/machinetools

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

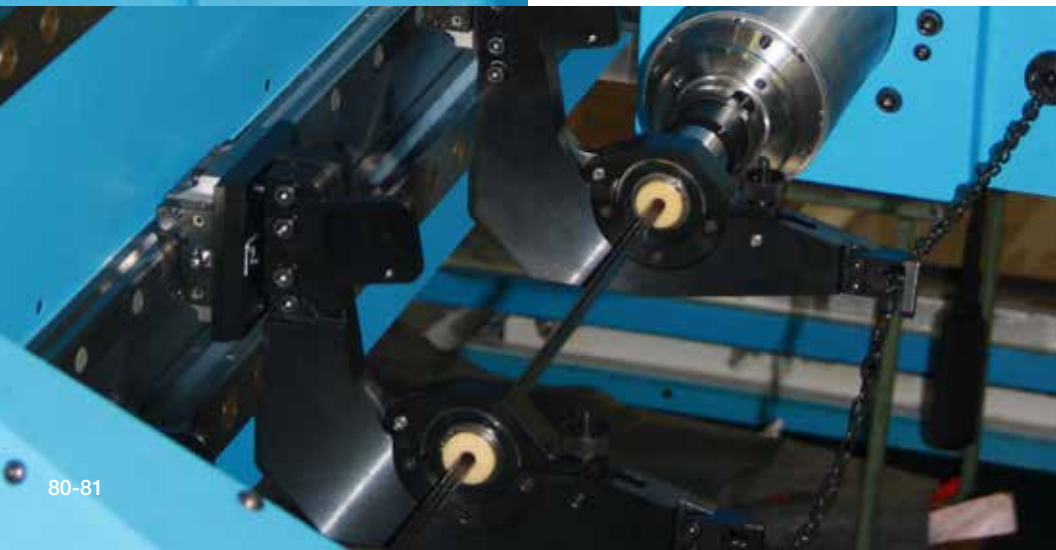
Chip-proof e-tube for combination machine used for milling and drilling.

In this machine tool, extremely high requirements are placed on the energy supply system that delivers energy to the main lead screw. 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 chip-proof plastic energy tube for supply purposes. It protects and carries all cables and hoses.

igus.com/machinetools

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, Werk AUERBACH**. "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 e-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% chip-proof and, even used continually, provides reliable cable protection.



igus.com/machinetools

Extremely chip-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 chip-proof characteristic, the new **"RX" tubes** have supplemented the **"E2"** and **"E4" energy tubes since 2009.**

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

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

The linear system for maximum design freedom
With our drylin® W linear guides, you have a cost-effective, pre-assembled system at hand that allows you maximum flexibility in design and easy installation.

- 14 rail profiles, 50 carriage versions
- 100% free of maintenance and lubrication
- Resistant to corrosion, dirt and moisture as well as wear-resistant
- Up to 40% more cost-effective than recirculating ball bearing guides

Ideal for sliding doors: hybrid roller bearing smooth-running, no tangling and self-lubricating due to combination of sliding elements and roller bearings

Operator panels pivot easily iglide® PRT slewing rings are ready-to-install for self-lubricating, dry operation. They consist of rings made of lightweight anodized aluminum or stainless steel, which move on sliding elements made of our tribologically optimized iglide® materials. They have been used successfully in operator panels of machine tools for a long time. Absolutely maintenance-free

- Easy to install and replaceable sliding pads
- High wear resistance
- Save installation time and cost
- For very high loads and high stiffness

Typical application areas:
General mechanical engineering, machine tools, laser cutting machines, wherever something needs to be guided (retrospectively) outside the chain cross section.

www.igus.com/prt

igus.com/machinetools

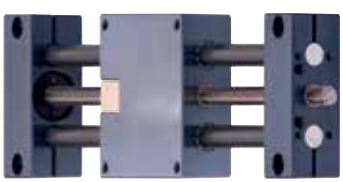
Linear axes and electric motors for automated door adjustment

If door adjustment has to be completely automated, our linear axes are used with connection to our drylin® electric motors. With a wide range of linear systems - from axes with lead screw or toothed belt drives, from lightweight plastic systems to solid solutions made of stainless steel - we can offer the right solution for every situation. The linear systems and drive are available from us from a single source. Stepper motors, DC motors or EC/BLDC motors: with the electric motors from our drylin® E product range, anything is possible!

Perfectly aligned to the complete system: to ensure that the right axis and electric motor end up in your shopping cart, you can use our drive technology configurator to put together the system of your choice

Discover drylin® linear axes in the shop …

https://www.igus.com/info/linear-actuators



... and find the matching drive for it:

https://www.igus.com/info/stepper-motors



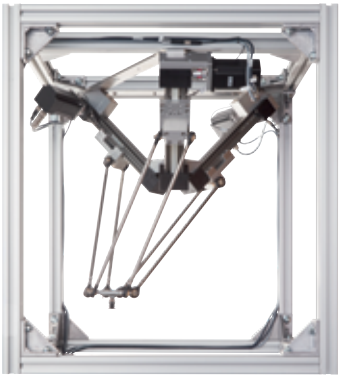
igus.com/machinetools

igus® ReBel® lightweight robot for Low Cost Automation

Programmed and tested quickly. Starting right away, you can program and test your individual service robotics application before purchase. Start right away with pre-programmed projects for various kinematic elements such as, e.g. the ReBeL.

Weighing just 8kg, the ReBeL® robot is lightweight.
It is designed to be as flexible and easy as possible to adapt to the respective machine environment. The compact and space-saving design with integrated control system in the base contributes to this. The low-cost robot with 4 or 6 degrees of freedom does not require a control cabinet.

drylin® delta robot

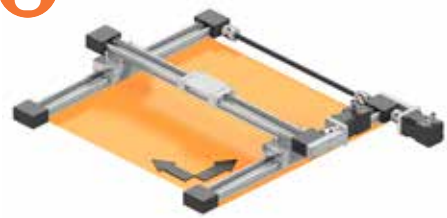


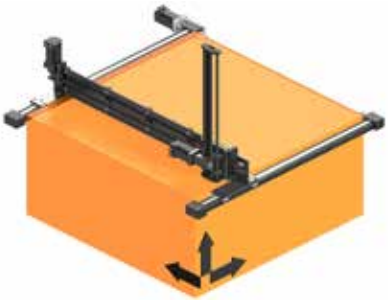
Thanks to its simple modular system, the drylin® delta robot can be easily assembled or ordered directly as a preconfigured kit. The lightweight, self-lubricating and maintenance-free bearing technology enables a long-lasting and precise solution for pick & place tasks - and that at a pick rate of 60/min.

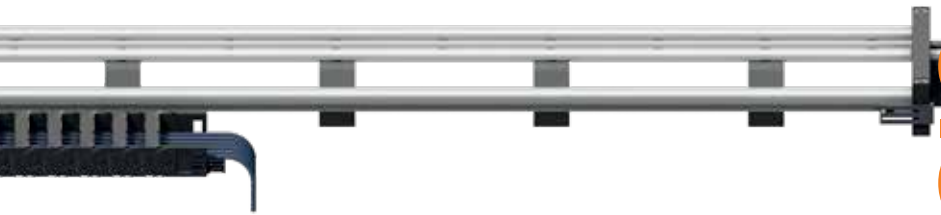
www.igus.com/delta

Consisting of linear axes, motors and motor control system, drylin® linear robots enable a wide range of movements in the xyz direction. The components are self-lubricating, corrosion-free and lightweight. Pick & place applications are typical, but the areas of responsibility are diverse. The igus® Robot Control provides you with a graphical user interface for programming and controlling your linear robot.

www.igus.com/info/gantry-robots







igus.com/machinetools

igus® robolink® modular system for low-cost robotics

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 self-lubricating 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 characterized 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.com/robolink

igus.com/machinetools

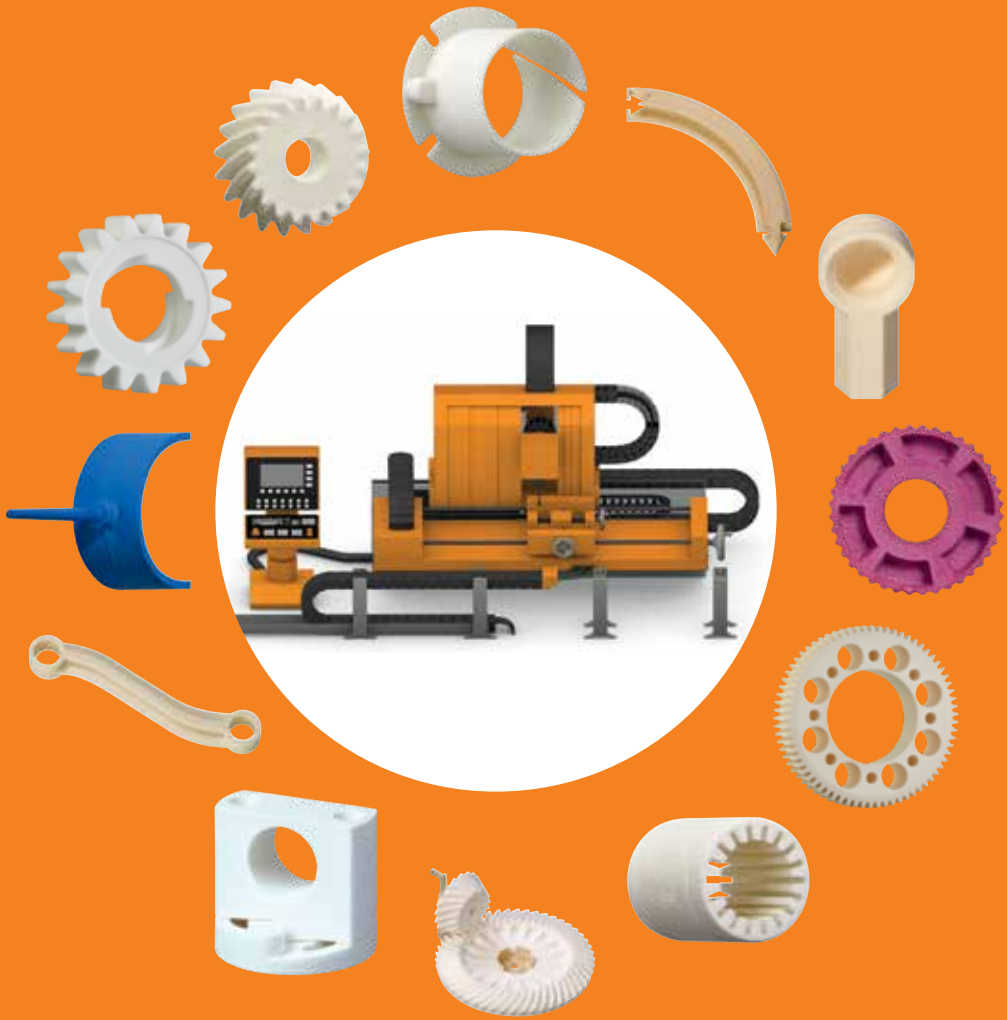
robolink® removes components from a machine tool. robolink® articulated arms are suitable for difficult-to-access, hazardous work areas and for use where the environment is wet. In an application of a Chinese machine tool manufacturer, a robolink® D is being used under exactly these conditions. In a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

RBTX - the marketplace for robotics components

The RBTX platform brings users and suppliers of low-cost robotics components together quickly and easily. Users can find gantries, robot arms, end effectors, camera modules, control systems and much more centrally in one place - and can find individual components or assemble entire robots.

www.rbtx.de

To your specification.



https://www.igus.com/info/custom-parts-services

Special parts: printed, injection molded or from bar stock

We can do things differently: customized solutions, special types, special materials, special quantities - (almost) anything is possible
Standard parts do not suit every application. That is why we also manufacture several customer-specific special parts. We have 55 years of experience dealing with complex molds, complicated contours and special materials.

From prototypes and small batches to small series to high volume production: the right production process for an affordable product 3D-printed, machined from bar stock, or injection molded: We have a wide range of manufacturing options for bespoke designs. We would be happy to advise you on the most technically and economically efficient manufacturing method and recommend the perfect plastic material.

3D printing service

Extremely wear-resistant special parts in 1-3 days.
Your individual component made of self-lubricating and abrasion-resistant iglide® high-performance plastics. Only a few steps are needed: upload CAD model, select manufacturing process and material - done. You can immediately see the price and can order or inquire about your component immediately.

www.igus.com/3d-print-service

igus.com/machinetools

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 laboratory
Every igus® product is tested thoroughly before it is made available for sale. To this end, we have been operating our own test laboratory since 1985. With a floor area of 41,000ft², it not only is the largest test laboratory for tribopolymers in the industry in terms of area, but also conducts the highest number of product tests and test procedures. There are over 15,000 tests a year, with 10 billion e-chain® cycles, 3,500 tested cables and 450 bearing test stations.

The test data flows into our online tools, which make it possible to determine the cost-effectiveness and safety of our products online easily, quickly and around the clock. This means a high degree of transparency for our customers, enabling them to find the most cost-effective, functioning solution to their problem.

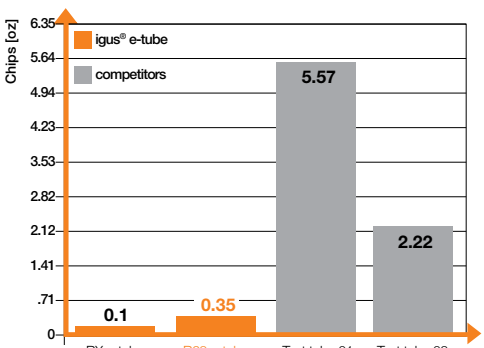
To achieve maximum realistic conditions, we also test customer applications and conduct industry tests. 400 customer-specific examinations are conducted every year. We would be happy to test your specific application.

Tested ...

Outstanding chip-tightness in realistic ambient conditions Chip penetration test - various types of tube were exposed to a defined quantity of chips. After 251,900 cycles, only 0.1 oz of chips 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.com/test-lab

igus.com/machinetools



*Interruption of test after 2,600 cycles

Tested ...

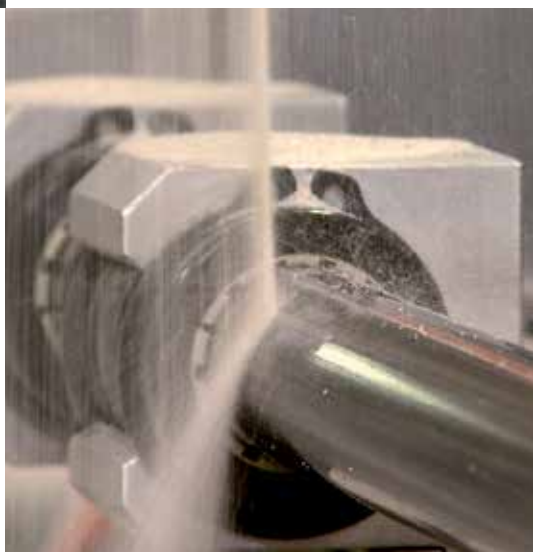
- twisterband with chainflex® cables
- Test for torsion and twisting
- Rotate up to 7,000°

Tested ...

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

Tested ...

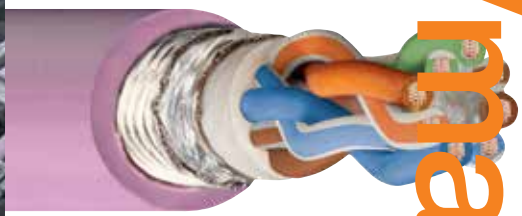
- dry-tech® bearing technology with over 11,000 tests on an area of 300m^2
- Load tests rotating, pivoting, linear, tumbling, at high and low temperatures, under water, when exposed to dirt and much more.



Tested ...

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

Tested ...



- Ethernet bus cable Cat 5e, CF-BUS.045
- Tested for more than 76 million strokes in e-chains®
- With a bend factor of 9.4xd

The world's largest test database has been created from over 15,000 tests per year. 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.com/test-lab

Extensive test database

igus.com/machinetools

Lots of room for innovation - the flexible igus® factory

From a garage in Cologne to the global market with ideas and tribopolymers.
What began in 1964 in a garage in Cologne with a single injection molding machine and confidence in the potential of polymer materials grew to be a globally active enterprise. Today, the 4,500 employees come up with new ideas daily, make high-quality products, ensure streamlined processes and delivery times and stay close to the customer. igus® dispatches around 5,500 consignments per day. To ensure speedy service and individual consulting, 14 storage and assembly centers around the world are available to customers.

Cycling into the future of urban transportation with the igus:bike
One of these innovations: the igus:bike. We tackle the vision of a completely lubrication-free and maintenance-free urban bicycle on a collaborative platform. With igus.bike, all components or bicycle manufacturers can get involved - and thus help shape new paths for sustainable transportation in the future.

https://igus.bike/en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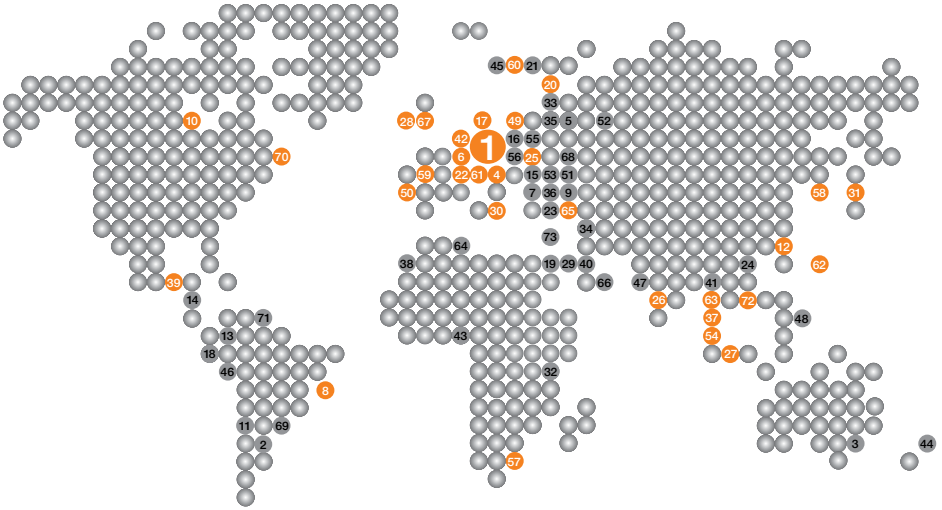

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