



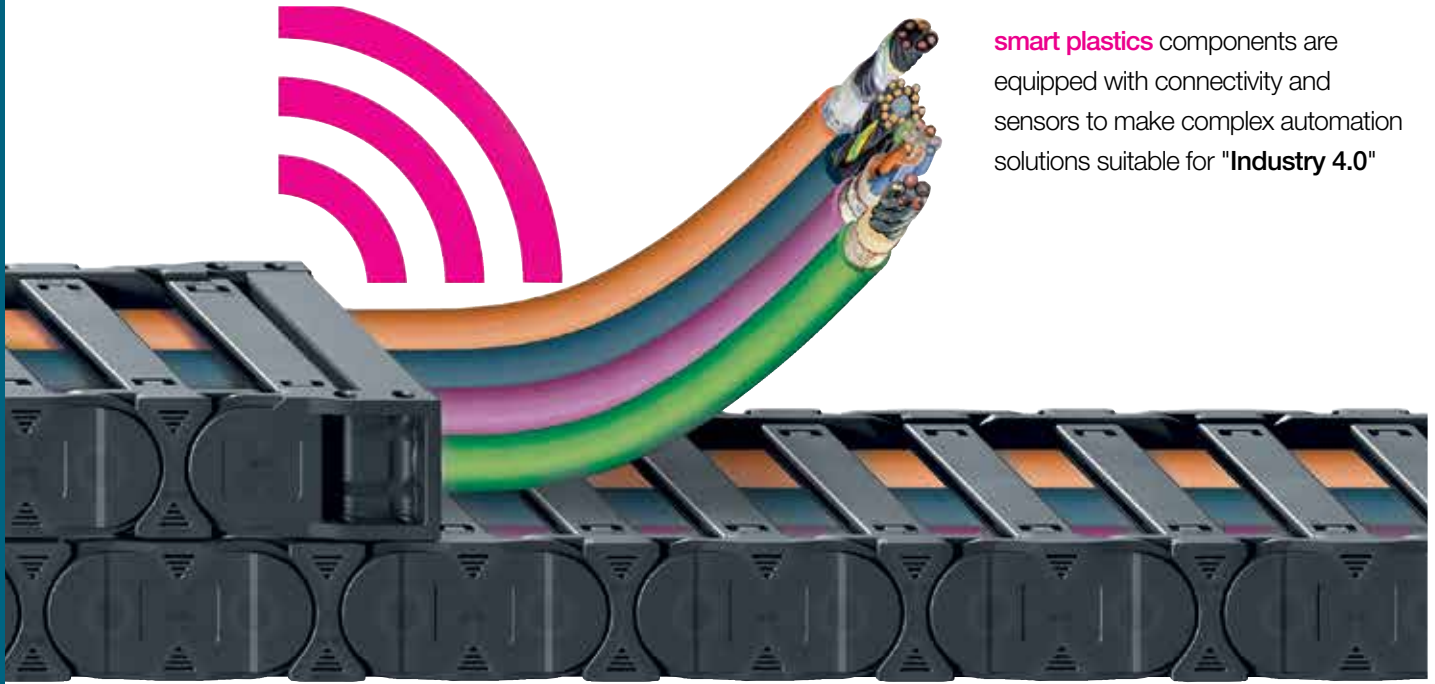
Solutions for predictive maintenance and condition monitoring

smart plastics

enable Industry 4.0
energy supply

- **smart plastics** components are equipped with connectivity and sensors to make complex automation solutions capable of "Industry 4.0"
- **smart plastics** offer two options:
 - i.Sense - condition monitoring and
 - i.Cee - predictive maintenance
- Make maintenance and repair of your machines more efficient and cost-effective with **smart plastics**
- **smart plastics** reduce failures





smart plastics components are equipped with connectivity and sensors to make complex automation solutions suitable for "Industry 4.0"

smart plastics enable Industry 4.0 energy supply

In the future, automation solutions across different industries will all have digitalization. If you want to entirely network the machines in your manufacturing plant with the internet of things (IoT) in order to be **Industry 4.0**-compatible and optimize such items as maintenance, you will need time and money. A digitalization strategy that begins by connecting and networking individual assemblies and components is faster and costs much less. Plant operators benefit immediately from the connectivity of smart components: status monitoring for automated plant can be implemented in real time without additional personnel, and maintenance can be organized predictively. **smart plastics** offer two options: the simple and rather analogue condition monitoring **i.Sense** (sense = perception), for integration with maximum safety. For the complete networking of the machines with the internet (IoT), the predictive maintenance **i.Cee** (Cee, derived from "see") is just right.

i.Sense - condition monitoring

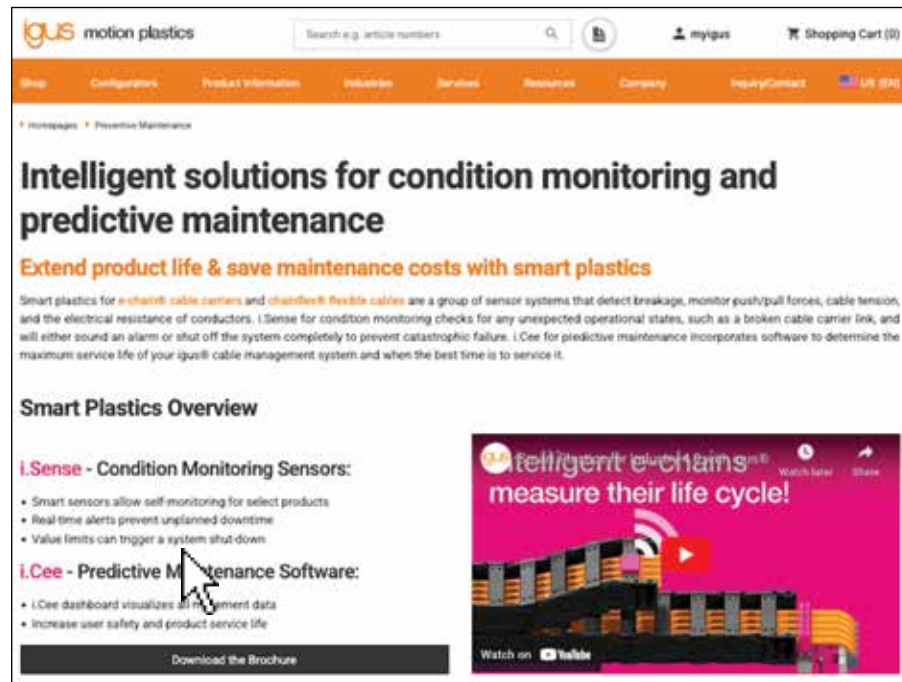
- Simplest, fastest way for a self-monitoring **smart plastics** product, by attachment of sensors
- Alarm or message when a previously defined limit value is exceeded
- Values outside defined limits can directly trigger a system shut-down

i.Cee - predictive maintenance

- Sensors and software create a system for dynamic service life calculation and optimal maintenance times
- Wide variety of designs, offering a high degree of individuality
- Maximum system and user safety and product service life

Typical industries and applications

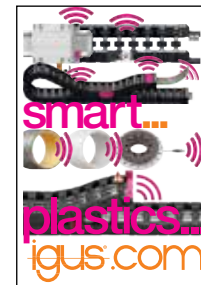
- Harbor installations
- Cranes
- Automotive production
- Bulk Handling
- Logistics
- Semi conductor industry



smart plastics Website

Always stay up to date. New products, new techniques, new applications

► www.igus.com/smartplastics

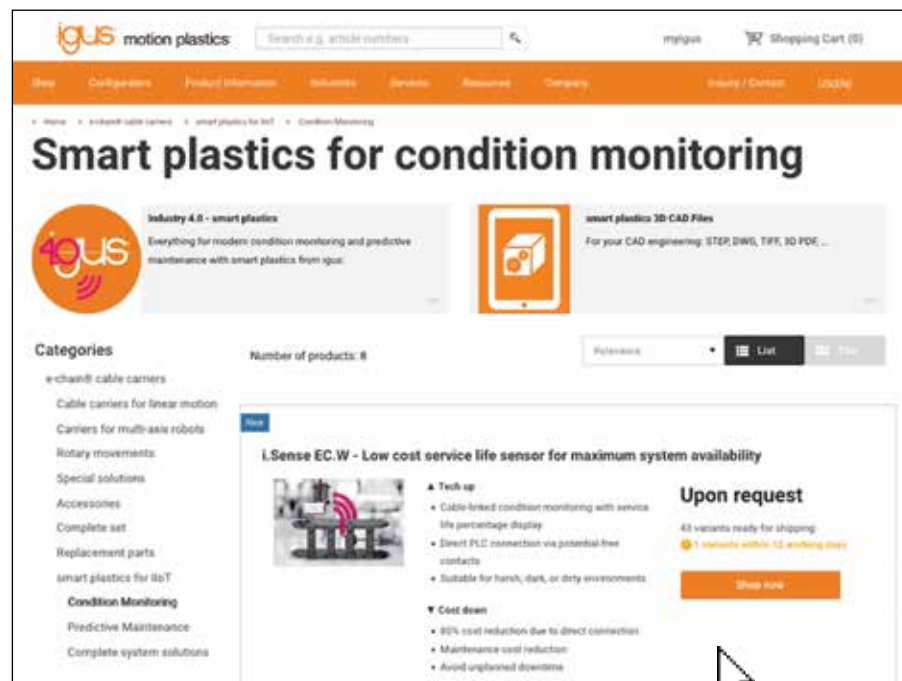


smart plastics brochure

Overview with the following topics:

- Condition monitoring (i.Sense)
- Condition monitoring products
- Condition monitoring application examples
- Predictive maintenance (i.Cee)
- Application examples for predictive maintenance
- Predictive maintenance data flows

► www.igus.com/smartplastics



smart plastics online shop

Order systems with push/pull force monitoring and breakage detection online as a complete package

► www.igus.com/smart-plastics/smart-condition-monitoring-solutions



The igus® white paper on predictive maintenance Clarifies the distinction between condition monitoring and predictive maintenance

- What igus® condition monitoring (i.Sense) means
- What igus® predictive maintenance (i.Cee) means
- What technology is behind both systems
- What the two systems offer industrial energy supply

► www.igus.com/smartplastics

Condition monitoring - i.Sense

- igus® products for condition monitoring
- Detects machine status regularly or continuously
- Uses fast switch-off to avoid crashes

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.

► www.igus.com/smart-plastics/smart-condition-monitoring-solutions

Control cabinet

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

i.Sense:module

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

Sensor units

- **IS.EC.P** push/pull force detection for energy chains
- **IS.EC.B** energy chain breakage detection
- **IS.CF.P** tensile force monitoring for cables

i.Sense

Condition monitoring



Condition Monitoring

The concept of condition monitoring is based on a regular or constant recording of the machine condition by measuring and analyzing physical parameters, e.g. vibration, temperature, position/proximity. Condition monitoring pursues two goals: safety and machine efficiency.

(Source: Wikipedia)



EC.P



EC.B



CF.P

i.Sense masters a sewage treatment plant ...



Challenge

As the plant runs around the clock, and some of the time without any human presence, faults sometimes remain undetected for hours. Although the plant runs at a very slow speed, in the event of a failure it can lead to a total breakdown. This total breakdown of the energy supply system leads to significantly higher costs than a standstill for several hours, where the system can be put back into operation after a short maintenance period.

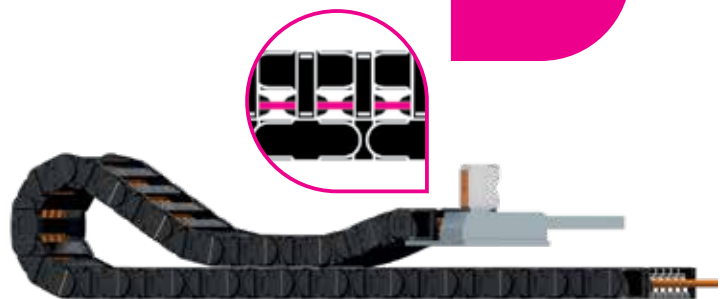


The solution with smart plastics

In this case the solution is the push/pull force monitoring system EC.P. This sensor continuously measures the force which the plant requires to move the energy supply system. If these forces change due to external influences such as ice, an animal or a tool forgotten during maintenance, the sensor detects this change and switches the system off immediately. This prevents expensive total damage to the sewage treatment plant.



Stop!



EC.P - push/pull force detection for e-chains®

- Measures the push/pull forces acting on the e-chain®
- Recommends shutdown of the equipment if a force limit is exceeded
- Prevents failure

... and other exciting challenges



"A high price can be avoided."

To avoid unplanned breakdowns and plant shutdown, **smart plastics** from igus® are used on indoor gantry cranes for the automated handling of engine blocks at an Austrian automotive supplier. EC.B modules monitor the status of the e-chain®. In the event of a chain breakage, the machine is stopped automatically to prevent subsequent damage. Additional EC.W modules signal advanced wear of the e-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.

Read more about this application at

► www.igus.com/smartplastics



"How do you put sliced bread intelligently into a bag?"

The GBK 440 packaging machine operates with high stroke rates in a compact installation space. This is why the developers used e-chains® and highly flexible chainflex® cables for reliable cable guidance. The GBK 440 ensures the safe packaging and sealing of product bags for sliced bread. The processing speed is individually adjustable. Even incredibly fast 80 cycles per minute are possible, which means considerably more than one packaged unit per second. GHD Georg Hartmann Maschinenbau was looking for a reliable energy supply system for its automatic packaging machines, including preventive monitoring to avoid machine failures.

Read more about this application at

► www.igus.com/smartplastics



The EC.P system has been the standard in container cranes for many years.

Predictive maintenance - i.Cee

- Precisely predicts maintenance
- Prevents downtime or loss of quality
- Two options for data transmission: i.Cee:local / i.Cee:cloud

Both the above-mentioned sensors for service life calculation and the **i.Sense** sensor units for condition information provide data from which indicators for premature wear of the product or the risk of product failure can be determined at a very early stage. Based on the experience gained in the 3,800m² test laboratory for plain bearings and energy transmission solutions, in combination with self-developed algorithms, the system alerts and informs the user at an early stage about possible failure risks and/or the next maintenance date.

Offline: i.Cee:local / Online: i.Cee:cloud

i.Cee hardware

Standard: i.Cee:plus II module

- Installation on top-hat (DIN) rail in control cabinet
- Storage and processing of sensor data
- Constant calculation of the product's service life
- Additional connection of i.Sense modules via USB possible
- Upgrade to Cloud possible

Optional: i.Cee:box

- Installation outside the control cabinet for wireless communication with the sensor modules via LoRa technology
- Additional connection of i.Sense modules via USB possible

i.Cee:custom

- igus® supplies the i.Cee software and uses the customer hardware
- Individual solution development with the customer

i.Cee:net

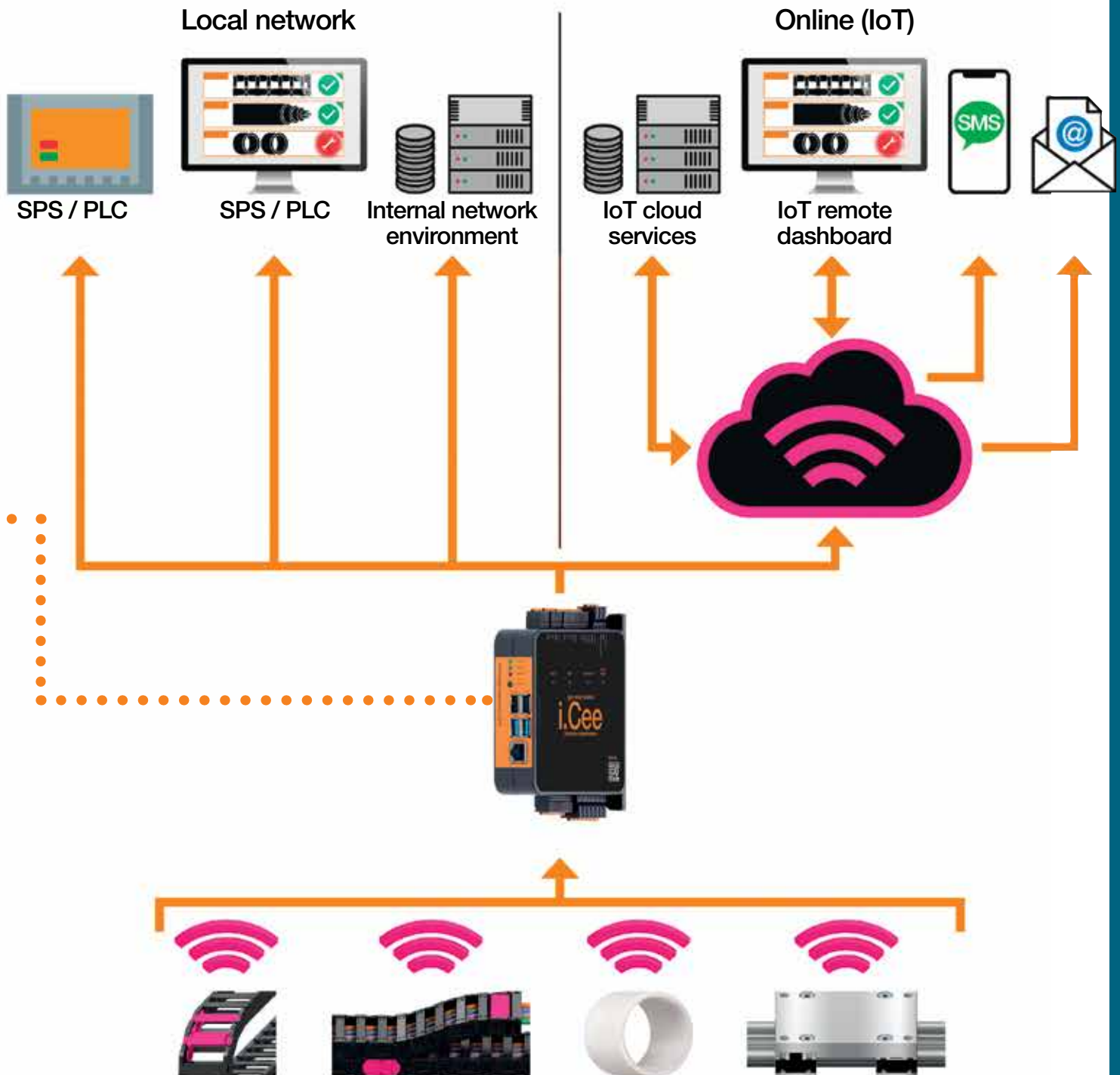
- Connection to the igus® cloud is possible

Sensors

- Provide abrasion and movement data

i.Cee

Predictive maintenance



i.Cee ... in use at train washing station in Luxembourg ...



The solution with smart plastics

The aim was to find a product that not only safely supplies the washing trolleys with data, voltage, compressed air, water and cleaning agents, but also fulfills CFL's requirement to operate Europe's most modern train washing plant. For this purpose, a system was required that allows the operator to monitor each individual energy chain and to avoid a breakdown of the plant. Besides an igus® energy chain designed for long travels, igus® smart plastics components were installed. Sensors monitor the status of every igus® energy chain during operation with regard to the application of force but also with regard to wear and tear, and inform in good time as soon as a repair or replacement is required. In the course of the modernization of the energy chain systems, the entire cleaning system was also renewed, so that in addition to particularly environmentally friendly cleaning agents, the used washing water was also reused again and again through reprocessing.

Challenge

The previous energy chain systems of a competitor caused disruptions in the operation of the plant, as they were often failing. This was particularly problematic because the washing plant is operated autonomously and a failure of an energy chain system could bring the entire washing process to a halt. The necessary repair measures were therefore time-consuming and partly necessary at night and on weekends. Failure would mean the confinement of a rail vehicle in the wash hall, which could result in the cancellation of several train runs.



EC.P/EC.W/EC.M

- EC.P sensor measures the tensile forces acting on the e-chain®
- EC.W Sensor measures the e-chain® wear
- EC.M sensor measures all dynamic parameters of the energy supply

... and many other exciting projects



"If the containers stop ..."

A big German crane manufacturer relies on the **i.Sense** online system to ensure optimum production. Here, using "machine learning" and AI algorithms, a calculation of the service life is performed and displayed in a Web dashboard on any Internet-enabled device as a statement of "days until the next recommended maintenance".

Read more about this application at

► www.igus.com/smartplastics

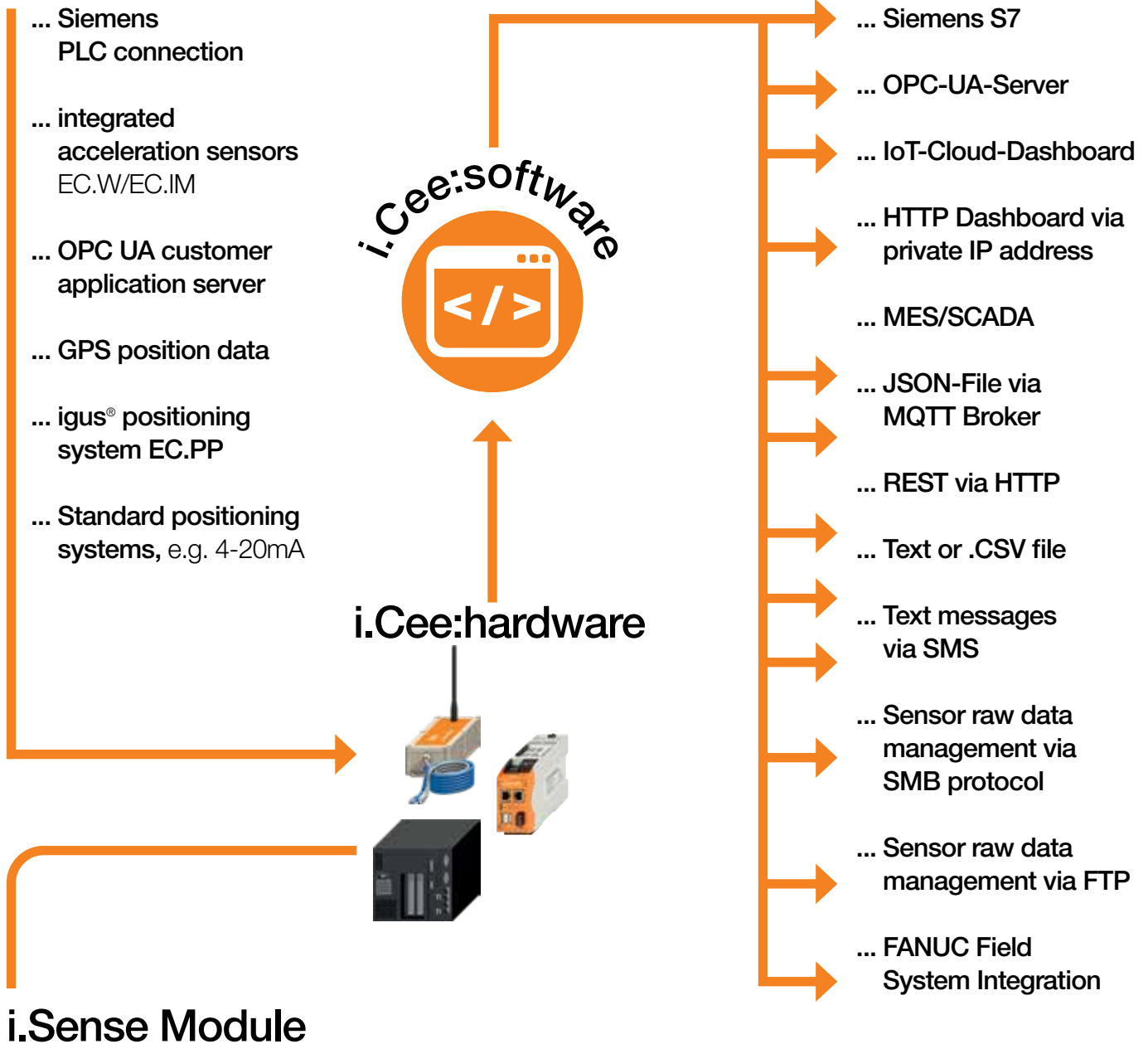


... Input options

... Output options

Motion profile

i.Cee:output



Anyone who can make reliable and useful predictions about maintenance work is one step ahead of the competition. In the age of digitalization, more than Big Data is required for such predictions. In order to be able to use the sensor data to derive the correct recommendations for maintenance to be accurately scheduled, long term empirical values from the igus® test database are used.

- 12,467ft² test area
- 4,100 energy chain system tests annually at 180 test stations: climate chamber, outdoor tests, noise chamber, travel lengths up to 426ft (130m), robot systems, etc.
- 2 billion test cycles a year for highly flexible cables
- 1 million electrical measurements recorded annually
- 15,000 tribological tests (friction and wear) in 300 test set-ups
- 140 trillion test movements in the bearings business unit
- Sensors on the test machines provide permanent measurement data, processing in the central database



P4.1 e-chain® with EC.PP in the igus® outdoor test

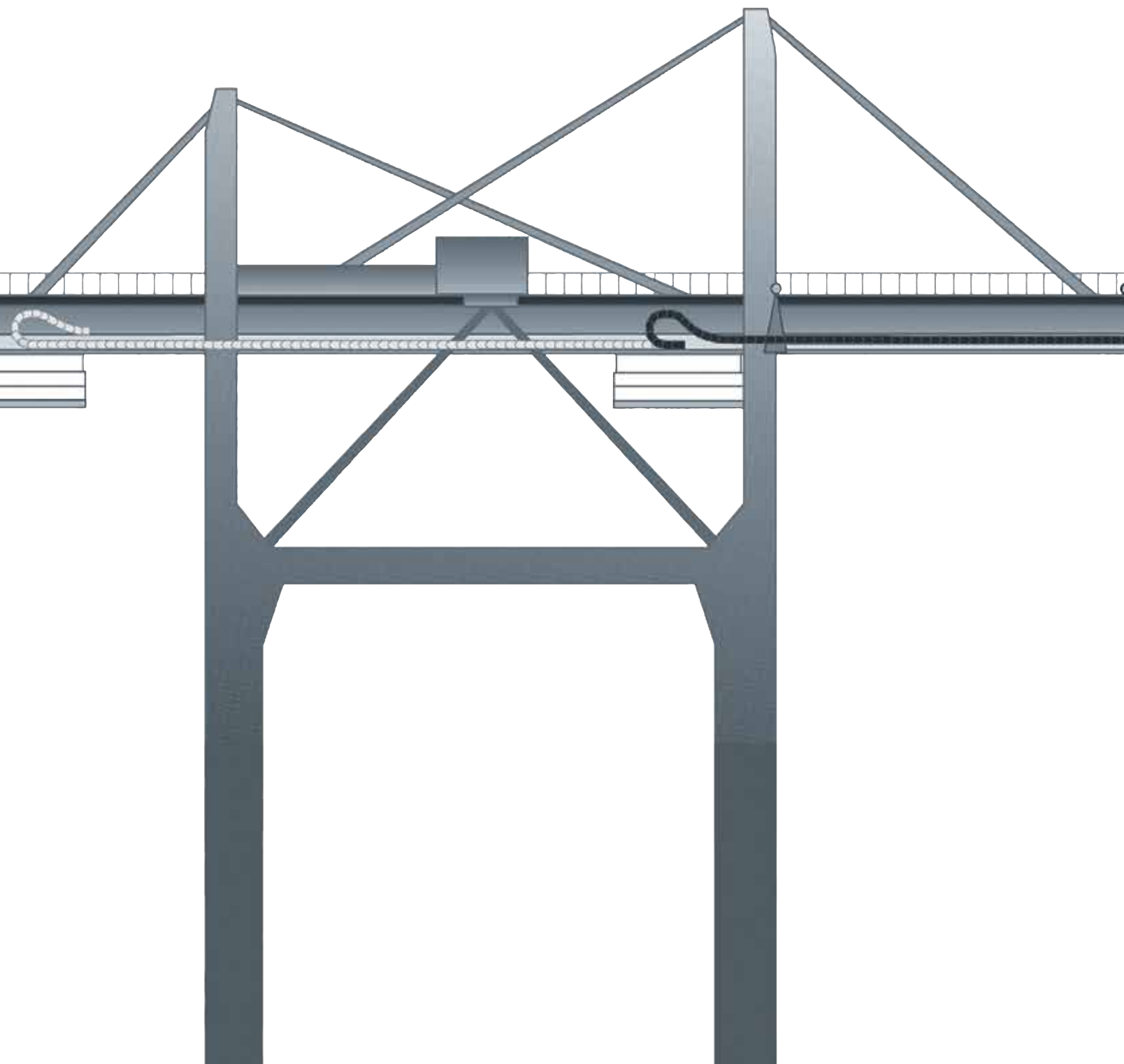


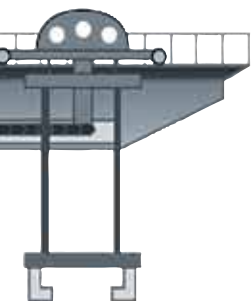
Switch cabinet with **smart plastics** modules

Calculate service life online and get up to a 4 year guarantee!



igus® lab, Cologne. A section of the motion plastics® test laboratory spread over 12,467ft²

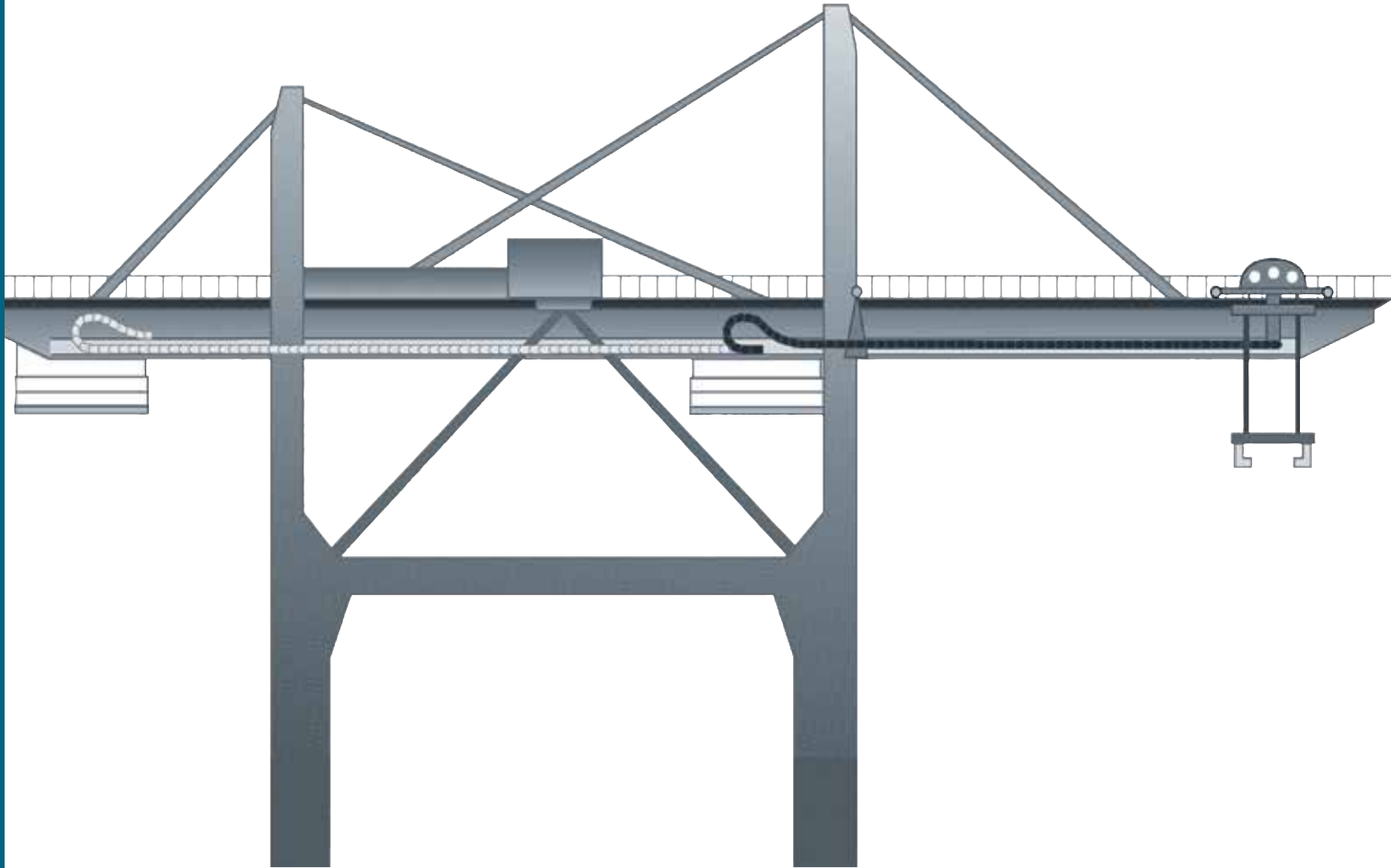




Modular projects

Special solutions

- Faster quotations, faster project planning
- Detailed service manuals and documentation
- Time and cost savings
- Absolute functional reliability
- System guarantee available upon request and depending on the application
- Electronic Push/Pull Detection System - **i.Sense** EC.P
- Fixed end modules for easy attachment of the e-chain® inside the guide trough, with no drilling required
- Extreme gliding - gliding elements for even longer service life of e-chains® where long travels are involved
- HD trough systems with different installation set designs, matching the respective application and duty levels



Special solutions - modular projects

The igus® project kit system - tested project solutions proven in numerous applications are now available as standard modular kits.

- Faster quotations, faster project planning
- Detailed service manuals and documentation
- Time and cost savings
- Absolute functional reliability
- System guarantee available upon request and depending on the application
- **i.Sense** EC.P - Push/Pull Detection System
- Fixed end modules for easy attachment of the e-chain® inside the guide trough, with no drilling required
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- HD trough systems with different installation set designs, matching the respective application and duty levels

Typical industries and applications

- Cranes ● Offshore ● and many other industries



Find a video online

► www.igus.com/System-Project



i.Sense conditioning monitoring system



Engineering - customer-specific developments with many solutions



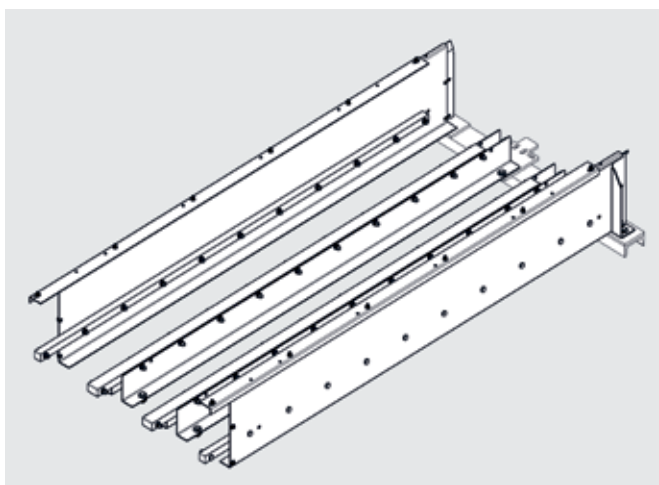
Series 4040R on a coal unloading system. Travel 623ft (190m), speed 1.645ft/s (0.5m/s), fill weight 5.41lbs/ft (8.05kg/m)



Series 4040HD on 591ft (180m) travel lengths with housing. Temperature range from -40°C/+40°C and in very dirty environments



Crane system designed by igus®



igus® project planning example, here: trough modules