The Magazine for Customers of the Turck Group Issue 1 | 2019

more@TURCK

IO-Link under Pressure

Simple, intuitive and reliable – the new pressure sensors of the PS+ series offer complete access to all sensor parameters via IO-Link 1.1

Refined Redundancy

Turck is supporting Profinet integration in process automation with the world's first IP67 I/O module with Profinet S2 system redundancy

Robust Route Planning

Krups Fördersysteme optimizes an assembly and testing linkage with decentralized multiprotocol IP67 PLCs

Right Order

Turck's RFID tags and Labview control production and quality control for the production of child seats at Britax Römer

Integrated Industry

Integrated Industry – Industrial Intelligence. That's the motto of this year's Hannover Messe. Even if conventional artificial intelligence is not yet the daily bread and butter of most automation specialists to any significant degree, you will be able to experience at the fair what will be possible in future. Intelligent solutions that effectively collect, transfer and evaluate data – as used with condition monitoring for predictive maintenance – are not quite as autonomous but nevertheless relevant today in professional practice.

At our new fair stand H55 in Hall 9, which will be premiered this April, we will show you what something like this can look like in reality. Supported by two video screens, we will be presenting our ideas on topics like Industry 4.0, batch size 1 or predictive maintenance through data in the cloud. You will thus be able, for example, to make your choice package of chocolate bars on a highly dynamic machine with two delta robots. Several key technologies for Industry 4.0 are used in the exhibit, from wireless RFID identification to camera and sensor solutions, right through to Ethernet data transmission as well as the evaluation of data in the cloud. The evaluated sensor data enables information about the current state of the machine to be obtained in order to implement predictive maintenance.

Integrated industry also means end-to-end networking and uniform standards. Something that Turck has supported for a long time – such as with IO-Link and Ethernet. We will therefore show you once more some interesting updates to our IO-Link portfolio, such as the new PS+ pressure sensor. The PS+ is the first device of our new fluid sensor series, which will be expanded over the course of the year with devices for measuring temperature and flow. Another new product in the portfolio is the world's first IO-Link master with protection to IP67, which also supports Profinet S2 system redundancy for the process industry.

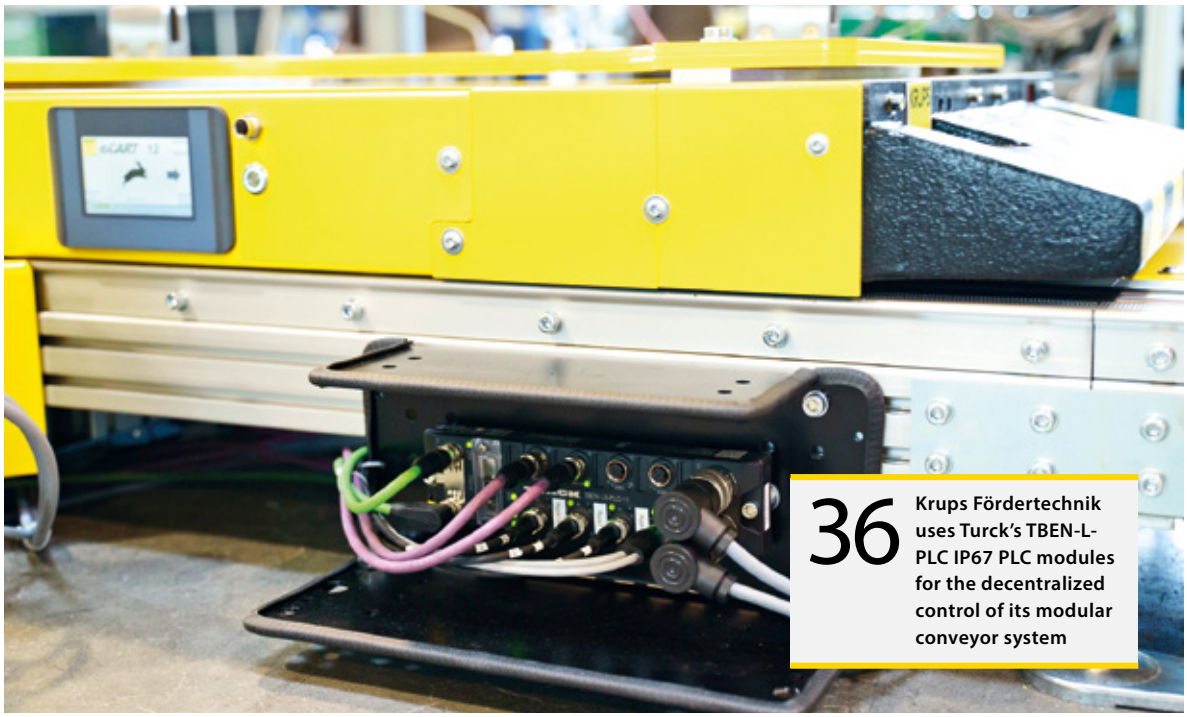
This issue of your more@TURCK customer magazine is presenting these new products in somewhat greater detail. But we once more also get our customers to talk about the interesting applications they have implemented with Turck.

If we have caught your interest, visit us at the Hannover Messe at Stand H55 in Hall 9. Looking forward to meeting you!

Yours sincerely,

Christian Wolf, Managing Director

Content



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APPLICATIONS

SERVICE

Stand premier at the Hannover Messe

Turck welcomes visitors to its new stand at the Hannover Messe 2019. As always, importance was placed on the high level of functionality in the stand concept as well as an impressive design. Two large LED walls and the associated highlight exhibits enable impressive presentations to be staged, which also give fair representation to the increasing share of software in modern Industry 4.0 solutions. While visitors can quickly gain an overview of all exhibits in the front area of the stand, they will find sufficient space at the back to converse undisturbed with the Turck specialists and discuss specific solutions for their automation tasks.

Olaf Ophoff Takes Over Automation Systems

Olaf Ophoff (53) will become the new Vice President of the Automation Systems business unit at Turck. The former VP, Oliver Merget, is leaving Turck at the end of March after almost eight years. He is leaving at his own request in order to take up new responsibilities. Turck is ensuring a seamless transition with the new replacement for the position. Olaf Ophoff joined Turck just over one and a half years ago.

PS+ Pressure Sensors with Capacitive Touchpads

read more on page 6

On time for the Hannover Messe Turck is launching the sale of the new pressure sensors of the PS+ Series. The robust sensors are the first products of a modular fluid sensor series that enables customers to provide reliable measuring instruments with intuitive operation. The sensor has already been awarded at the product start with the iF Design Award. The PS+ pressure sensors can be commissioned particularly easily. Overhead mounting are just as possible as the rotation of the sensor head in a range of 340°. After the sensor is connected, it automatically registers whether the controller or the bus module requires a PNP or NPN, current or voltage signal.

SIDI Integrates IO-Link Devices in Profinet

Turck's Simple IO-Link Device Integration, or SIDI for short, simplifies the handling of IO-Link devices in Profinet engineering systems. As the devices are already integrated in the GSDML file of the master, users can select them from the device library (for example in the TIA Portal) and integrate them into their projects via drop-down fields as if the devices are submodules on a modular I/O system. The user benefits from access to all device properties and parameters in plain text. Measuring ranges, switch points and pulse rates can be set directly from the engineering system – without any programming or additional software required. From now on, SIDI is integrated on all Turck IO-Link masters of the TBEN-L, TBEN-S and FEN20 series.

read more on page 22

I/O Solutions with S2 System Redundancy

Turck is presenting the TBEN-L5-8IOL as the first fieldbus module with Profinet S2 system redundancy. The IO-Link master with IP67 protection is the only device of its kind at present to support the Profinet redundancy concept relevant for process automation. Through the upgrade, the block I/O module is able to establish via a single connection communication relations to two controllers – the primary controller and its backup. In this way, the master module integrates the host of existing IO-Link devices, such as position indicators, valve blocks, I/O hubs and sensors in the world of high availability systems. Profinet S2 system redundancy will soon become standard in Turck's fieldbus portfolio. Read more on page 18

Factor 1 Sensor for the Food and Beverage Industry

Turck is presenting the new Q130WD uprox sensor with washdown features. Compliant with the requirements of the food and beverage industry, the rectangular proximity switch offers the highest degrees of protection (IP68/IP69K) and can be used at many locations for monitoring the production flow of beverage and food cans. The Q130WD is based on Turck's patented uprox technology, which has the same high switching distance for all metals. This technology is therefore ideal for detecting aluminium and tin cans.

Pressure Transmitters for Mobile Equipment

In order to provide solutions for use in mobile equipment, Turck is expanding its portfolio of pressure sensors with the introduction of PT1100/2100 pressure transmitters. This includes mining, forestry, agricultural and building machinery. Compared to conventional machine building, the field of mobile equipment has more demanding requirements, particularly with regard to resistance to overpressure, vibration and shock, as well as increased EMC performance. The pressure sensors of the PT1100/2100 Series were specially optimized for this and are therefore a robust solution for one of the sensor types most frequently used in mobile equipment. The PT1100/2100 pressure transmitters are available with protection to IP67 or IP69K. The compact design meets the requirements for shock and vibration resistance in accordance with ISO 16750 road vehicle standard.

Magnetic Field Sensors for C-Groove Cylinders

Turck's portfolio of magnetic field sensors is being expanded: The BIM-UNC product series was specially optimized for perfect mounting in the C-groove pneumatic cylinder of SMC. BIM-UNC sensors can be inserted from the side into the groove with one hand and without the need for any additional mounting accessories. A quarter turn of the screw causes the thread to press the sensor against the pneumatic cylinder and secure it against vibration. A tightening torque of only 0.1 Nm is required to fasten it and the cylinder is not damaged in the process. The BIM-UNC Series is ideal for applications in materials handling and automated assembly or in punching machines and industrial robots.

IO-Link under Pressure

Simple, intuitive and reliable – these are characteristics of the new pressure sensors of the PS+ series, which offer complete access to all sensor parameters via IO-Link 1.1

In the industrial environment, functionality justifiably counts more than appearance. All the better then, when products can stand out both in terms of user benefits as well as looks, and bring customers to the conclusion that: they not only look good but can also do a lot. This is precisely the boast of the new PS+ series pressure sensors, and has been underlined by the winning of the prestigious iF Design Award. From now on, users can also be impressed by its technical benefits. The Plus sign in the name of the sensor series stands for two central customer benefits: simplified commissioning and the guarantee of high plant availability.

Problem-free installation of the pressure sensors and the fast familiarization of users with the menu structure were key requirements in the development of the sensors over several years. The specifications also included the suitability for standard process connections and electrical outputs, as well as the coverage of pressure ranges up to 600 bar. A large degree of flexibility for the installation is provided, as the sensor head can be rotated freely around 340° and the display can be inverted for overhead installation. The sensors automatically detect whether the controller or bus module expects PNP or NPN signals. This same also goes for current and voltage when analog output signals have to be evaluated. This puts plug and play technology into daily practice.

Another feature is a unique compatibility mode within IO-Link systems. The PS+ series not only supports the Turck data profile for the integration but can also emulate other commonly available profiles. This means that the sensor replacement goes unnoticed by the controller.

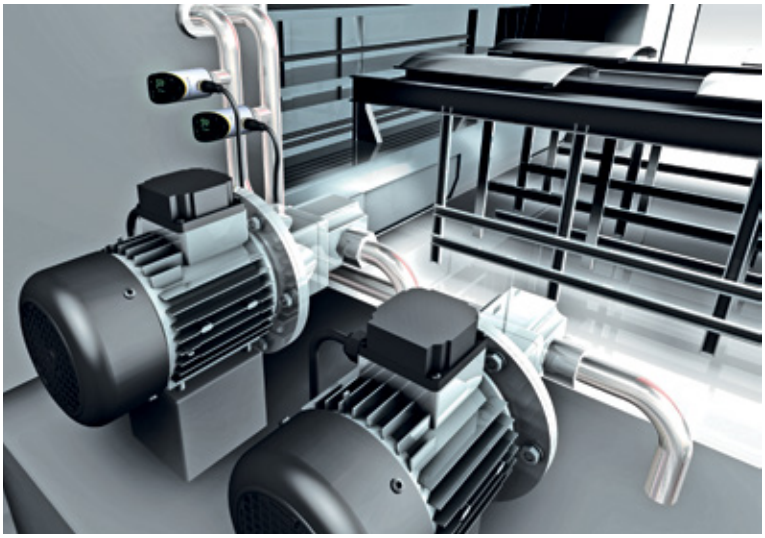
QUICK READ

At the Hannover Messe Turck is presenting the PS+ series pressure sensors as the first of a new fluid sensor series. They combine functionality together with award-winning design. The keypad features capacitive touch pads that enable unimaginably simple operation. The absence of mechanical operating elements increases robustness and helps to meet the requirements of ISO protection types IP6K6K, IP6K7 and IP6K9K. Flexible installation (overhead and rotatable around 340°) and measuring ranges up to 600 bar open up a large number of new application fields. Temperature and flow sensors with the same look and feel will be added to Turck's fluid sensor platform in the coming months.

Operation with smartphone haptic technology
The sensor is operated in the same way as a smartphone. The touch-sensitive keypads can also be operated wearing various types of gloves without any force or even cumbersome gadgets, and guide the user intuitively through the plain text menu. The menu structure can be set up according to either the Turck or the VDMA standard. The absence of any mechanical operating elements is another benefit: Abrasion, wear and reduced impermeability belong to the past.

The design of sensors has to take the reality of different application environments into account. This includes the ability to be commissioned quickly and the prevention of operating errors. The locking mechanism of the PS+ series therefore prevents unwanted actuation: The device can be enabled with a swipe and also a password if required. Status LEDs provide continuous indication of operating states and faults, and a programmable color change from green to red (and vice versa) on the display makes it possible to indicate whether defined switch points have been overshot.

Heavy duty metal pressure cells
The operating concept illustrates how design and functionality are mutually interdependent. A high level of availability, however, has even greater importance than user friendliness since pressure sensors are expected to perform measuring and monitoring functions over several years. The sealing concept of the PS+ series makes it tremendously robust so that the PS+ fully meets the requirements of ISO degrees of protection IP6K6K, IP6K7 and IP6K9K. The materials used are also resistant to UV radiation and salt spray, so that nothing can stop these devices from being used for outdoors applications.



Pressure monitoring on a hydraulic press: The variable mounting options enable PS+ sensors to be optimally positioned in any mounting location

Acclaimed: The pressure sensors of the PS+ series are the first devices based on Turck's new fluid sensor platform; its innovative operating concept particularly impressed the jury of the iF Design Award

Turck offers the pressure sensors both with tried and tested ceramic measuring cells (PS310) and also the fully welded metal measuring cells (PS510). These fully welded measuring cells have an overpressure resistance of up to seven times the rated pressure. If required, the sensors can also be fitted with peak pressure apertures. The ability to read measured and minimum and maximum pressures provides a function like a digital "drag indicator with long term storage". This function is very relevant in condition monitoring applications, i.e. continuous machine monitoring for predictive maintenance. Compared to the previous models, the developers were able to reduce the weight of the pressure sensors by eliminating the need for a potted design.

Modular series extension

The pressure sensors presented at the Hannover Messe represent the start of a generational change. With its new fluid sensor portfolio Turck is implementing a platform strategy and will also be launching in the coming months additional temperature and flow sensors on the market that will be based on this. Devices for level measurement will be offered at a later time. The modular design will give all fluid series sensors a uniform appearance and also the same familiar handling. In this way, customers will be able to expand and maintain their plants simply since employees only have to be trained for a single operating concept. The platform concept, which is well-established in the automotive industry, also offers the user other benefits: It helps in the creation of a wide range of product variants and shortens delivery times, so that the specially requested sensors can already be made available within a few days.

The PS+ offers user-friendly operation via capacitive touchpads; this makes the sensor fully resistant to abrasion and wear

COMMUNICATION CONCEPT FOR INDUSTRY 4.0

With their communication concept, the PS+ sensors are another addition to Turck's set of building blocks for Industry 4.0. As specialists in the acquisition, transfer and conditioning of data, the consistency and transparency of sensor data are central requirements for Turck. This is why the company supports open standards like IO-Link 1.1, via which the PS+ devices can implement bidirectional communication with the controller. This enables the sensor to not only send digital process values but also receive parameters such as switch points. The devices of the PS+ series are the only pressure sensors to offer different IO-Link process data profiles, which allow the flexible integration of a sensor in existing system landscapes with a 1:1 replacement of existing devices – even from third party manufacturers. This eliminates the need for complex adaptions to the controller environment.

Conclusion

Turck has already been supplying the fluid sensor market for over 20 years, and the pressure sensors of the PS+ series represent a significant expansion of the existing product range. The devices are designed for fast and straightforward commissioning. Flexible mounting options, an intelligent system integration facility and the innovative keypad with the haptic technology of smartphones. The sensors are far more resistant to external influences and challenging application effects such as pressure peaks. The PS+ series is thus the herald of an extensive further development, which brings improvements without additional costs as well as offering an impressive design.

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Under Pressure?
Pressure Sensors for Industry 4.0

DESIGN AWARD 2019

User-friendly: access to all sensor parameters via IO-Link 1.1, variable data mapping and NPN/PNP auto detection

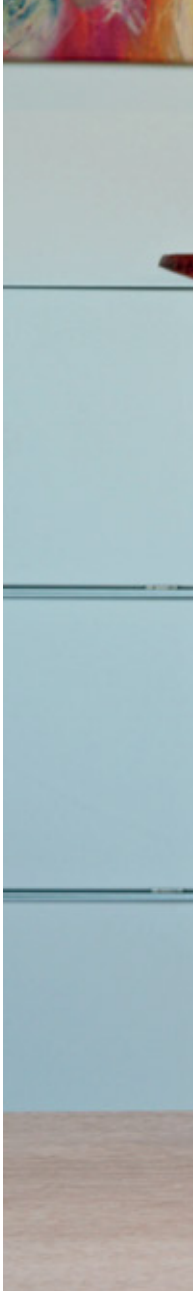
Reliable: fully welded metal measuring cell*, integrated pressure peak aperture*, highest vibration and EMC resistance, protection classes IP6K6K/6K7/6K9K *optional

Simple: intuitive operating concept via touch display, 180° invertable multi-color display with all-round visible LEDs

www.turck.com/ps+

»Even though we continue to focus our control technology in the area of IP67, we are intensively developing our PLC expertise«

Christian Wolf | Managing director



Turck is enjoying increasing success with its controller solutions. Christian Wolf, managing director of the Mülheim-based automation supplier, underlined this point in an interview with Mathis Bayerdörfer, chief editor of SPS-Magazin. They both discussed the subject of decentralized automation solutions, the role of software and digitalization, important future markets, as well as the value of equal partnerships.

When it comes to high-tech solutions for production, the range of functions provided by automation and industrial software is constantly increasing. What does the increasing trend towards digitalization mean for your company Mr Wolf?
This is a very important cultural and communication issue for Turck. The worlds of IT and automation are increasingly merging – something that also has to be supported in one's own organization. We are learning a great deal here from the IT specialists we have recently employed. However, they also have to understand how the sector operates and how automation technology has developed so far. Only in this way is it possible to combine the best of both worlds – and this is our strategy.

So Turck is not changing into an IT company, is it?
No, Turck will never focus on software alone. After all, hardware cannot simply be replaced by software. However, software can certainly cover the variance of automation components better and more easily, and this also goes for the future requirements of individual and custom solutions. This requires a properly functioning modular strategy, – which will always be based on the hardware. It is no longer possible to supply the complete solution as a hardware manufacturer alone. However, neither is this possible as an IT vendor.

"Growth in our fieldbus technology for decentralized applications last year was more than 30 %"

Some market players are nevertheless pushing the software as the answer to everything to do with Industry 4.0.
We are intentionally not doing this. What kind of a signal would that give to customers and employees who have driven the company's success over the past decades? We aim instead to motivate and encourage our hardware specialists to work jointly with the IT specialists on automation solutions for the next generation.

Success is only possible by working together?
Precisely. We are promoting this philosophy across the entire company – from development to sales: After all, the relevant co-workers obviously also have to recognize the value addition provided by the software. Only then, for example, will sales engineers be willing to go to the customer

together with the software specialist in order to offer complete solutions.

In 2018, the business related to industrial communication technology grew faster at Turck than the sensor business. Is that due to the technological change?
The main reason for this development is the fact that we are well-established and already well represented with the conventional position and proximity sensors in our target markets. Our leverage is somewhat less here than with the more complex sensors and our communication and control technology. Overall, our strategy is in any case moving away from thinking in individual product groups.

What does that mean exactly?
Instead of selling individual sensors or communication modules, we are taking a holistic approach and aim to talk with machine builders about their aims and new machine generations at a much earlier stage. This will enable us to create much more efficient and comprehensive solutions from our portfolio.

And is this being well received by the customers?
Yes. In the last financial year the solution business at Turck experienced above average growth. Customers are being supplied with holistic automation concepts including valuable advisory support. If the customer is satisfied with it, there is no reason to procure components from different suppliers. This is particularly the case because every new supplier costs time and money.

What is the ratio today between the solution business at Turck and the conventional component business?
Across the entire group of companies, the ratio is currently approx. 70 percent components and 30 percent solutions. However, there are some countries, particularly in emerging markets where the ratio is already 50:50. I think this ratio is a very good target range for the future.

Turck was able to achieve considerable growth in PLC technology. What is the reason for this?
Even though we continue to focus our control technology in the area of IP67, we are intensively developing our PLC expertise. Thanks to this approach, Turck has already managed to occupy certain segments in the machine building sector. We are now enjoying some very good success here.

Is the trend towards greater intelligence at the field level playing into the hands of this strategy?
We are noticing very much that the trend away from IP20 towards IP67 is gaining speed in many areas. Growth in our fieldbus technology for decentralized applications was consequently more than 30 per-

"Many companies with which we collaborate get the sense that we are looking for a partnership of equals"

cent last year. In many applications, control cabinets are getting smaller or are even being completely removed. With the advance in the miniaturization of IT technology, very powerful control technology can also be implemented in very small spaces – such as with our TBEN-S modules.

When it comes to intelligence at the field level, the IO-Link standard is close at hand. How do you currently rate its success?
IO-Link is increasingly gaining ground so that the sale of relevant products in our portfolio is also growing. The number of IO-Link masters sold is a good indication of the actual growth, and this has increased considerably at Turck in recent years. The approach of the standard is basically correct even if IO-Link certainly does not provide genuine added value to all sensor types and shapes. While for example the potential for simple proximity sensors is very clear, the potential for pressure, temperature or flow sensors is completely different – and this also goes for new areas such as radar sensors. Data evaluation via IO-Link can generate valuable information here.

Turck is not bound to a single communication protocol but can comply with different standards, for example by using the multiprotocol modules.
This offering has developed historically. When you do 40 percent of your business in the USA, you are well advised not only to offer Profibus and Profinet, but also DeviceNet and Ethernet/IP. As a result we are the first suppliers to offer multiprotocol solutions on the market with genuine plug and play capability. This expertise has not only become well-established with regard to America, but is also bringing international customers in Asia or in Europe tremendous benefits.

Will this approach also be targeted in the future? At the SPS 2018 fair virtually all of today's protocol competitors declared their commitment to a combination of OPC UA and Ethernet TSN.
That is an interesting question. I don't think that one of Turck's strengths will be lost in the medium term. Ultimately you have to be able to flexibly integrate even new standards in automation environments. Even in times of OPC UA and TSN, the customer will still be confronted with a choice of different protocols. There will not be one single standard running through all communication levels. We will therefore be keeping a diversified range of communication protocols and aim to be the earliest adopters here once more.

How long will OPC UA and TSN take to get established on the market?
Industrial Ethernet had already been talked about for many years before suppliers started selling a significant number of devices. This will be exactly the same for OPC UA and TSN. Due to the existing system architectures available, users will be considerably slower in adoption than is conveyed in the press or at trade fairs. For this reason, I don't expect any multi-million sales with OPC UA products initially, even though this will certainly develop into a very exciting market for us. You just need to have patience.

Let us in closing come back to your collaboration with Banner Engineering. The role of partnerships is frequently emphasized in discussions about Industry 4.0. Does Turck want to transfer its experience from the cooperation with Banner to other regions or technology areas such as IoT?
I am convinced that we maintain extraordinarily close partnerships. When you grow with this kind of cooperation, like the one Banner and Turck have had over decades, it means that you have got to know each other through all the highs and lows of the cooperation. We can therefore provide the proof of our ability to cooperate and can also benefit from this: Many companies with which we collaborate get the sense that we are looking for a partnership of equals regardless of which company is bigger, and that we don't set the terms one-sidedly, even when we are striving for solutions. We naturally have clear expectations but these can also be achieved through compromise. Companies that have made their way on their own so far will definitely not find it easy in future: Genuine partnership is ultimately a learning process – and is not always an easy one.

What are the possibilities of partnership with the big IT companies which increasingly aim to penetrate the automation market?
Automation and IT still have to grow further together. However, we SMEs don't exactly have an easy time with the big IT companies. These companies don't after all place prime importance on the ability to cooperate. There is more a mindset here of dominating. The trial of strength couldn't be more different here. Certainly a lot still needs to happen until a feeling of equal partners can develop. However, I am convinced that these obstacles can be overcome. That is why I have always pleaded at the exhibitors committee of the SPS fair to bring the big IT companies to the fair. Exclusion is never a good strategy and we also don't want to bring users over to our side through manipulation. So in the end they will be the ones to bring automation and IT together at one table.

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Sensors not only have to support the steering of agricultural machinery but also the alignment of the field sprayers – attached booms can sometimes be over 30 meters in width

Lawn Chess

Sensor systems provide the basis for many precision farming applications and support farmers on their way towards efficient and environmentally-friendly field cultivation

The agricultural sector is exposed to changing external factors like no other commercial environment. Last summer in Europe demonstrated this in a most extreme way with a combination of long periods of drought and the sudden occurrence of heavy rainfall. Many farmers recorded substantial losses in harvest as a result.

Agricultural businesses are already under severe pressure to optimize production if they are required to reach the goal of global food security by 2050. In a nutshell, the agricultural sector has to succeed in achieving continually increasing yield, in spite of the continued loss of cultivatable land in many places, in order to compensate for the forecast growth in world population to nine billion people and catch up on nature conservation at the same time.

The use of modern digital technologies can make a significant contribution here. Today's measuring instruments are now able to acquire data on the condition of soils and enable farmers to make assessments with little effort. This in turn provides possibilities for making the operation of machinery more efficient and increasingly more autonomous. Representatives of the sector have been discussing this kind of potential in terms of precision farming, smart farming or also precision agriculture. In many studies, the digitalization of this economic sector has been described as probably the most important lever currently for maximizing the harvest in an environmentally-friendly way. The endeavor to produce with greater precision and fewer losses is nevertheless

QUICK READ

The next development stage of the agricultural sector is data driven and requires robust sensor technology in the field. Turck products are enabling the operation of driver assistance systems, the herald of fully automated work processes. In a steer-by-wire system QR20 encoders measure the steering angle of axles or assist in the opening of the spray arms of a field sprayer. Ultrasonic sensors and inclinometers are suitable for aligning the position of the sprayer boom, while the compact TM18 light barriers of Banner Engineering can monitor the material flow in the grain lift of a combine harvester.

as old as agriculture itself. With Industry 4.0 scenarios, however, agriculture is in the middle of a development offering many new possibilities to users.

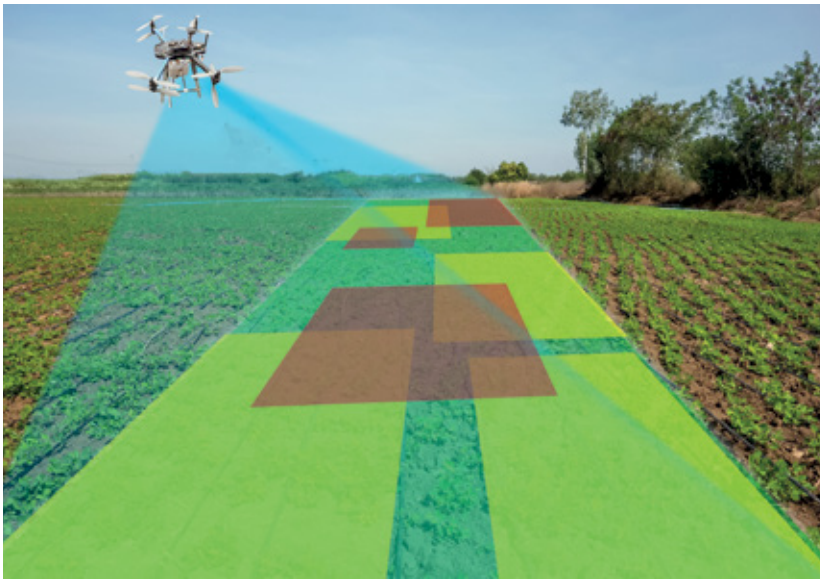
Surface analysis for coordinated field cultivation
In a high-tech agricultural process, the farmer increasingly takes on the role of a planning supervisor without continuously taking over all the control steps of the machinery. The beginning of a typical example of this process is taken up with a soil analysis, which is based on the idea of forming homogeneous areas in an actually heterogeneous field. In one area, plants could be watered more sparingly due to the greater availability of ground water reserves, while a particular sector may possibly require more fertilizer than required in other sections. This optimum method of soil and plant cultivation is carried out here through accurate prestructuring, which results in areas with as similar requirements as possible. This gradually forms a map out of the information, with which farmers can cultivate the soil according to the requirements of specific subareas.

Many small auxiliary components are used in the operation. Modern tractors and harvest machinery have now been provided with intelligent driving assistance systems and sometimes perform processes automatically. GPS positioning and location data from the cell phone network enable machinery to follow set routes precisely, which for example prevents the overlapping use of pesticides or fertilizers. Another benefit is the reduction in fuel consumption. As part of a possibly already automatically controlled drive operation, compact and robust sensors are now being used in a wide range of applications, such as low-wear steering, the alignment of field sprayers or the monitoring of material flow.

Maximum performance thanks to sensor support
The steer-by-wire technology is regarded as an established guidance process for autonomous drive systems in the future, in which a joystick can be used for the control in exactly the same way. The direction command used here is no longer given mechanically but transferred electrically to the actuator. Turck's contactless encoders measure the steering angle of the axle in this system and are resistant both to humidity (degree of protection to IP68/69k) as well as to shock. If required they can even be completely installed in the axle.

The inductive encoders have fully contactless operation and are therefore completely wear-free – a very important benefit in view of the naturally short time frame available to agriculture and the risk of machine failure. The QR20 encoders have also offered proven use in the measurement of angles on field sprayers. The sensor here measures the projection angle so that the spray arms are always located in the correct position. This demonstrates once more the ongoing trend towards continuous position measurement using measuring sensors instead of end position switches.

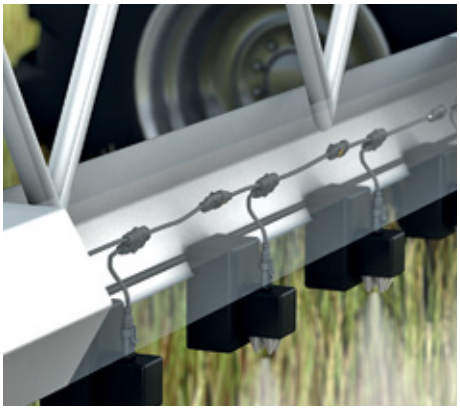
The distance to the crop determines the height at which the sprayer boom is to be positioned. Ultrasonic sensors can be used to supply information about this distance. Turck's compact and PTFE-coated sonic transducers can be used here. These come with detection ranges from 30 centimeters up to three meters. The integrated temperature compensation keeps measuring data constant over the entire range from -40 to +70 degrees centigrade, thus ensuring users accurate alignment of the spray arms. The parameters can be set to individual requirements according to the application via teach buttons or a teach cable.



The data of a soil analysis is used as the basis for precision farming. This divides up a field into areas with similar requirements

Turck's PTFE-coated ultrasonic sensors measure the distance between sprayer boom and field or crop and are resistant to commonly used plant pesticides

Contactless, wear-free encoders such as the QR20 encoder are suitable, for example, for use as angle sensors for the spray arms of field sprayers or as components of steer-by-wire solutions



Turck's pre-assembled Y splitters can be combined in modules to connect spray valves, Superseal plug connectors guarantee a reliable connection, even with vibrations

Reliable inclination measurement

The inclination of a vehicle is an important information point in most agricultural machinery, regardless of whether farmers are spreading pesticides or liquid fertilizer via a field sprayer or operating a combine harvester. If, for example, the threshing unit is always required to work horizontally on uneven ground, Turck's robust inclination sensors can detect and signal lateral deviations and deviations in the direction of travel. Severe vibrations and unforeseen shocks during operation do not corrupt the measured values since these are masked out by individually adjustable filters.

Once the thresher unit has separated the wheat from the chaff, a lift conveys the harvested grain into the grain tank. This material flow can be monitored here by photoelectric sensors. TM18 photoelectric sensors in IP67 and IP69k designs from Banner Engineering can also be used here for mounting in restricted spaces and can be aligned quickly to the receiver. Unlike other sensors, these are screwed into the grain lift with their threaded lenses, thus saving the designer the use of complex and fault prone fittings involving deflection mirrors. Data related to the quantity of grain is thus detected and is used to determine the operation of the grain lift. The seeds of a sowing machine can likewise be detected, using contactless capacitive sensors to provide level information.

Precision brings financial as well as environmental benefits at the same time

The applications illustrated show how intelligent sensors are important trailblazers in the field of precision farming. They enable farmers to use fertilizers and pesticides more efficiently and thus help to save resources and conserve the soil at the same time. This combination is a central driver of investment in the digitalization and automation of agriculture. Through more precise field cultivation, experts hope to achieve tangible ecological benefits, such as the prevention of direct contamination of river water, the reduced use of chemicals in soils, or savings in fuel consumption.

For farms on the other hand, these solutions offer improved profitability. In future, self-driven machinery in particular should open up new solution fields, including accurately timed operations during particularly favorable weather conditions. Farmers previously only took their hands off the controls for forward movement and carried out turning maneuvers themselves. However, these kinds of movements can also now be carried out precisely with the help of angle sensors.

Turck products can increasingly provide greater support to autonomously operating control systems for measuring and transferring parameters; thanks to the robust designs which are suitable even in demanding application environments, in which aggressive liquids, extreme temperatures or rugged surfaces affect technical components.

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CUSTOMIZED PLUG CONNECTORS FOR DISTRIBUTION CABLES

CAN valves are frequently used to regulate the spray volume on field sprayers, in order to constantly deliver the correct quantity of plant pesticides. Turck's pre-assembled Y cables likewise enable these valves to be wired both individually and error-free. The fully overmolded CAN distribution cables are resistant to aggressive spray media. Cable jacket, grip body and overmold are made entirely of durable thermoplastic polyurethane (TPU). Superseal connectors guarantee reliable fitting, even when subject to severe vibration. And should a cable nevertheless be damaged, only the defective splitter has to be replaced. This saves time and service costs.

Your Global Automation Partner

TURCK

Your Automation Partner for Mobile Equipment

Wear-free inductive sensors for the contactless measurement of path and angle

Rugged IP67/IP69K permanent solutions thanks to vibration and shock-resistant sensors with potted electronics

Increased EMC strength, especially for use in vehicle board nets, and vehicle-specific connectivity such as Deutsch or AMP.

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Two at the Top

Turck is supporting the way towards Profinet integration in process automation with the world's first IP67 I/O module with Profinet S2 system redundancy – other product series will follow

Profinet has become the communication standard commonly used for factory automation. Many automobile manufacturers and suppliers are already experienced users in this area, and as early adopters have been demonstrating for many years the practicality of this communication system based on Industrial Ethernet. The number of users is increasing rapidly at present, as machine builders appreciate its powerful real-time transmission capabilities. The technology gives companies the benefits of the Profibus protocol as well as far greater flexibility in the design of their network structures. The upward trend is uninterrupted; the PNO user organization expects there to be more than 22 million nodes in the coming months.

This development is also expected to experience further tangible growth as Profinet is now being used in process automation. This area, however, has some special requirements which controllers and field devices have to fulfill. Turck's trend setting contribution to Profinet integration in the world of high

Plants in the chemical and pharmaceutical industry can be more reliably protected from downtimes with I/O systems in Profinet S2 system redundancy

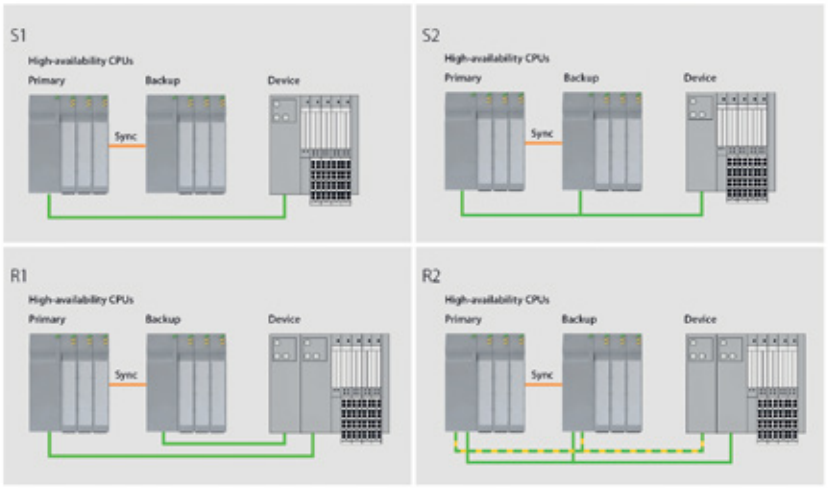
Premier at the Hannover Messe: Turck's TBEN-L5-8IOL IP67 block module is the first IO-Link master module to support S2 system redundancy

availability systems extensively increases the functionality of fieldbus products to support S2 system redundancy.

Protecting plants in the chemical and pharmaceutical industry from downtimes involves considerable effort. Compared to factory automation, where the focus is on higher unit quantities and short cycle times, the interruption of a continuous production process can lead to enormous financial losses. Furthermore, the handling of hazardous liquid or gaseous substances involves the observance of strict safety precautions – particularly in areas provided with explosion protection. As a preventative measure, companies therefore firstly invest in the safeguarding of potential ignition sources and secondly in a high availability system architecture. Controllers and I/O modules in the field

QUICK READ

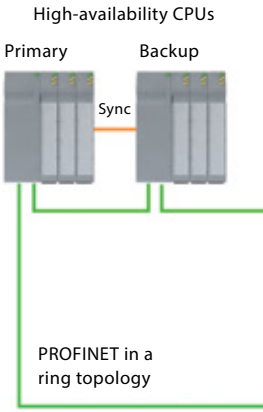
Profinet is increasingly becoming more attractive to the process automation industry, also because the new profile for system redundancy establishes a concept for high availability plant operation in Ex and non-Ex areas. Turck is presenting at the Hannover Messe the TBEN-L5-8IOL as its first IO-Link master module in IP67 that supports S2 system redundancy. The master establishes a logical communication relation to more than one controller and combines high availability with a wide range of potential uses through IO-Link in the field. In the coming months, other I/O devices from Turck will be provided with the new profile extension, including products from the TBEN-L, TBEN-S, FEN20, BL20, BL67 as well as excom series.



Redundancy principles: S1 is a simple connection, i.e. no redundancy; if a Profinet device communicates with the primary controller and its backup via this connection, this is classified as S2 – very high and maximum availability is offered only with R1 and R2 system redundancy, which also require dual systems on the field side

Turck complete package for high availability systems: S2 system redundancy and IO-Link

Use of the profile for system redundancy enables Profinet field devices to communicate with high-availability controller systems



are normally provided with redundancy in order to ensure safe plant operation. If one device or connection fails, the otherwise inactive backup solution is activated. Planners implement these complex or limited redundant systems in accordance with the relevant requirements – both on the physical device level as well as in the underlying programming logic.

S2 system redundancy preferred

In the Profinet context, a new standard was created for this with system redundancy. The terminology used here is based on a gradation that reflects the degree of fail safety that an automation system is to provide. No redundancy is implemented (S1) if a controller and field device only communicate via a single connection. However, if a Profinet device supports communication relations to the primary controller as well as its backup via this single connection, this is classified as S2. In the event that the main controller fails, a bumpless switching to its physical twin is performed. For this the I/O system and I/O module in the field must maintain this logical dual connection to two entirely spatially separated controllers. These S2 solutions meet the requirements of many applications and are preferred in practical applications. The alternative term "simple system redundancy" should not obscure this fact.

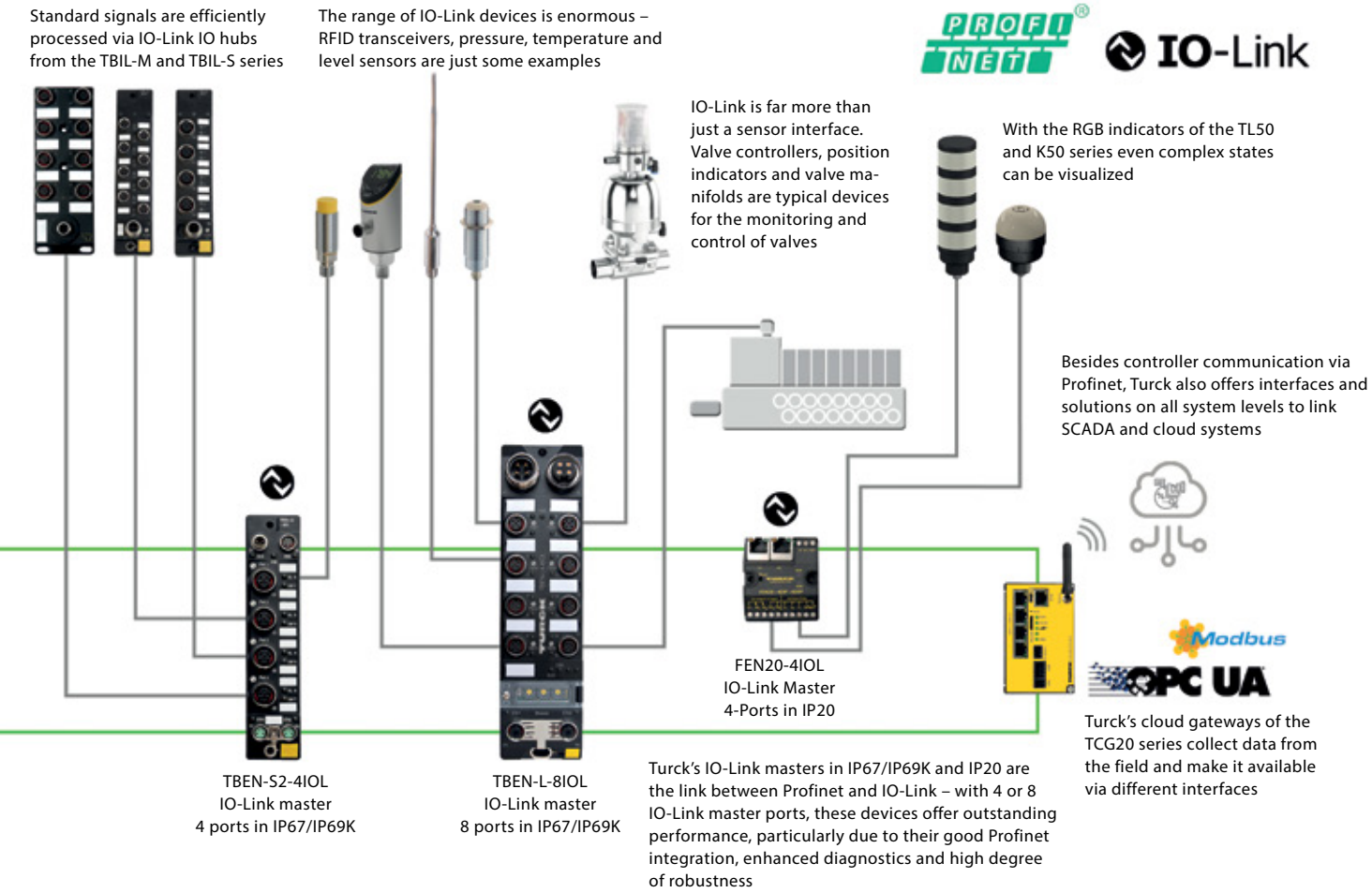
Very high and maximum availability can only be achieved with R1 or R2 system redundancy. This involves the additional implementation on a field device of a redundant communication interface, and is often used in conjunction with remote I/O. R2 with its four-way connection represents the highest level of complexity. Each of the two communication interfaces of a device here can establish communication relations – to the main controller and to its redundant copy. This crosswise protection from failures is used extremely rarely.

Turck brings high availability to the field

Siemens initiated the Profinet implementation of the redundancy profile and designed its controller systems to support redundant infrastructures. Profinet devices had previously not provided support for S2 system redundancy. Turck is now responding to this demand with an extensive expansion of functions.

The TBEN-L5-8IOL, presented to customers at the Hannover Messe, will be the first IO-Link master module that supports S2 system redundancy and offers protection to IP67 and IP69K, thanks to its fully potted electronic unit. This combination of Industrial Ethernet and IO-Link offers digitalization right through to the last meter. Furthermore, Turck's I/O modules come with an additional TCP/IP interface for read access to device data, so that all digital treasures can be gathered. Condition monitoring, asset management and predictive maintenance can thus be implemented without any limits.

Turck is also offering SIDI (Simple IO-Link Device Integration), probably the most user-friendly way of integrating IO-Link in Profinet projects. IO-Link masters



with SIDI give IO-Link devices the identity of a genuine Profinet module with their own GSDML entry. The function considerably simplifies the engineering of IO-Link devices in projects with Profinet controllers, since it allows access to all parameters and device properties from the engineering system without the need for additional software.

The first TBEN-L5-8IOL modules will soon be deployed in the USA in the plant of a biopharmaceutical manufacturer, which in future will manage its production with Profinet system redundancy and IO-Link. High availability is essential in the sector for the handling of mostly sensitive and cost-intensive products. An integrator in the pigging technology sector found the additional profile support for IP67 devices equally important. The company serves customers in the chemical, pharmaceutical and mineral oil sector. The high protection class of the TBEN field devices now simplifies the planning of systems in these sectors. Decentralized and modular network architectures can be designed so that the space required in the control cabinet is substantially reduced.

Rollout across multiple series

The IO-Link master is the first at the beginning of the major product upgrade to S2 system redundancy. Over the year, Turck will be providing other multiprotocol devices with the additional function, and block modules of the TBEN series will follow, as well as the IO systems for the control cabinet of the FEN20, BL20 and excom series. The changeover to Profinet with a wide range of signal types, both for the Ex and the non-Ex area can thus be completed without any obstacles.

MRP VS. SYSTEM REDUNDANCY

The subject of redundancy has been discussed in the context of Profinet for several years. However, two types must be distinguished here. The media redundancy that has been available for a long time – referred to as MRP due to the English name for the protocol – describes a connection between controller and Profinet device via a ring topology. All systems are simply provided once, however, plant operation in the event of a failure on one route is ensured by the spare route of the ring. System redundancy, on the other hand, refers to multiple communication relations between controller and Profinet module, which does not require an expansion of physical connections. With S2 system redundancy, the controller level is designed with redundancy by the addition of a backup controller. Thanks to the latest profile extension, Turck is supporting this logical dual connection with the TBEN-8IO-Link master. MRP and system redundancy therefore describe different concepts that can be optimally combined.

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Naturalized

IO-Link masters with SIDI (Simple IO-Link Device Integration) give IO-Link devices the identity of a genuine Profinet module with its own GSDML entry; the function simplifies the engineering of IO-Link devices in projects with Profinet controllers, since it allows access to all parameters and device properties from the engineering system without the need for additional software

The praises of IO-Link have been already been sung often enough. The benefits of the bidirectional digital communication compared to the conventional analog and digital interfaces have now been recognized worldwide. Inexpensive wiring, diagnostic features, parameterization options, intelligent data retention, simplified e-planning and not least the vendor-neutral support of the standard are impressive features for designers, e-planners and PLC programmers. This is the reason for the success and the increasingly global popularity of IO-Link and the resulting ten million devices now in use.

Wanted: integration helper for IO-Link

What has so far not been mentioned in the eulogies: IO-Link also has its limits. There has particularly been a shortfall with regard to the integration of IO-Link devices in Profinet systems. A GSDML file (generic station description markup language) is supplied with every Profinet device. This enables the control programmer to already plan and parameterize the device in the project offline (mostly in the TIA Portal), before the project is really integrated with the network and the connected devices. These two processes can initially be carried out independently, particularly in large projects.

Manufacturers of IO-Link devices do not equip them with their own GSDML file, and the device description comes in the form of an IODD (IO-Link device description). The Profinet engineering software cannot therefore detect the devices directly. The user has so far been forced to enter properties such as device class or manufacturer ID manually. Parameters such as measuring ranges and output signals had to be programmed or set via additional software.

IODD interpreters only with limited suitability

These kinds of additional software act as an interpreter of IODDs into other systems, in the same way as they are already used in various software tools. These programs enable the necessary settings to be carried out on the IO-Link device. The device is then integrated into the Profinet project. This has not been a satisfactory solution, particularly in large projects. PLC programmers therefore often had to deal with a large number of tools in order to integrate the devices of all manufacturers. Many programmers therefore took the hard route and programmed IO-Link devices again manually in their controller environment. Besides the time

QUICK READ

The station description files of Profinet devices enable them to be integrated in the engineering systems of the controllers. In this way, all devices and parameters of controller networks can be created, maintained from a single system and saved. The system does not allow this in-depth integration for IO-Link devices. Either manufacturer specific software is required for this configuration or a solution must be programmed via the controller – often involving considerable programming effort. SIDI from Turck now provides help here: The new function in Turck's IO-Link masters enables IO-Link devices to be integrated directly in a Profinet engineering software such as the TIA Portal – allowing also the display of all device properties and plain text access to the device parameters.

SIDI enables IO-Link devices to be integrated directly in a Profinet engineering software such as the TIA Portal. The software can now be used on Turck's TBEN-S and TBEN-L IP67 IO-Link masters as well as the IP20 variant FEN20

involved and the great deal of know-how required for this, this solution is also error-prone. Not to mention the problems encountered by service technicians with projects which were configured with different tools

SIDI integrates IO-Link devices in GSDML files

Turck identified this weakness in IO-Link early on and has already been working on its SIDI function for several years. IO-Link devices are entered here as Profinet submodules in the GSDML of the IO-Link masters. As an IO-Link member from the very beginning, the company is now equipping its IO-Link master in a block module design (in IP20 and IP67) with the SIDI function. Anyone integrating one of these IO-Link masters in a Profibus project can immediately use the connected IO-Link devices as Profinet modules.

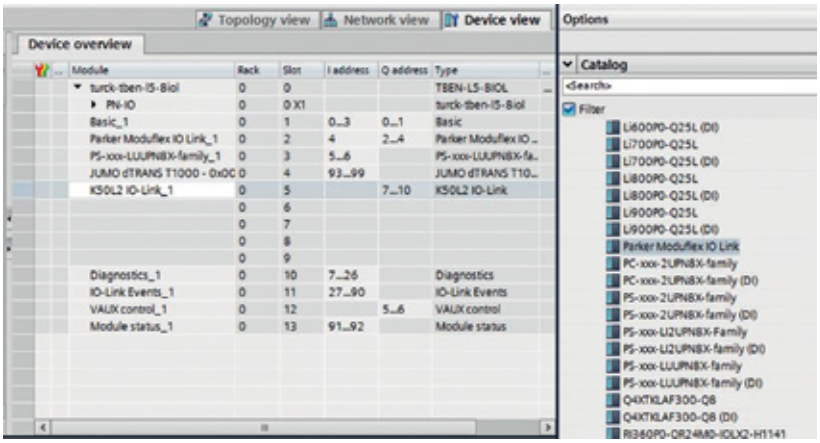
Turck integrates all its proprietary IO-Link devices in the SIDI library, as well as the devices of its strategic partner for optical sensors, Banner Engineering. The first IO-Link devices of third party manufacturers are also already included. More devices of other manufacturers are expected to be included in the SIDI library in future. For this, each device to be included must first be tested rigorously in order to ensure the smooth operation and the user-friendliness of the tool. Turck is also willing to integrate the devices of third party manufacturers on request – particularly those that are not included in the portfolio of the automation specialist. Turck has benefitted in the development of SIDI from its experience as manufacturers of IO-Link masters and devices. This double expertise is rare to find in the automation sector.

IO-Link devices by drop-down in Profinet projects

If the connected device is in the SIDI GSDML, PLC programmers can select it from the device catalog in their programming environment. The programmer can now view all the relevant IO-Link properties for these devices and alter parameters, such as measuring ranges, output signals or pulse rates in the plain text field.

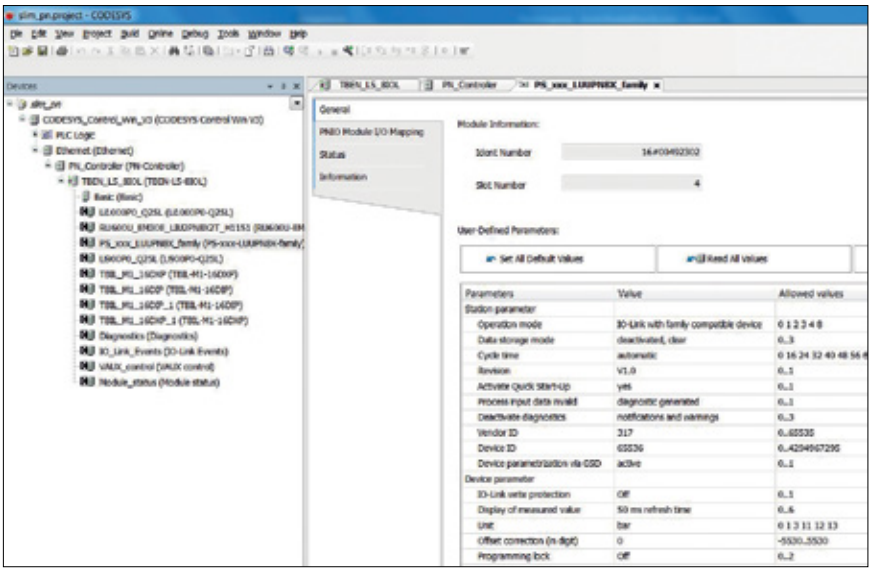
Offline engineering with SIDI saves considerable time

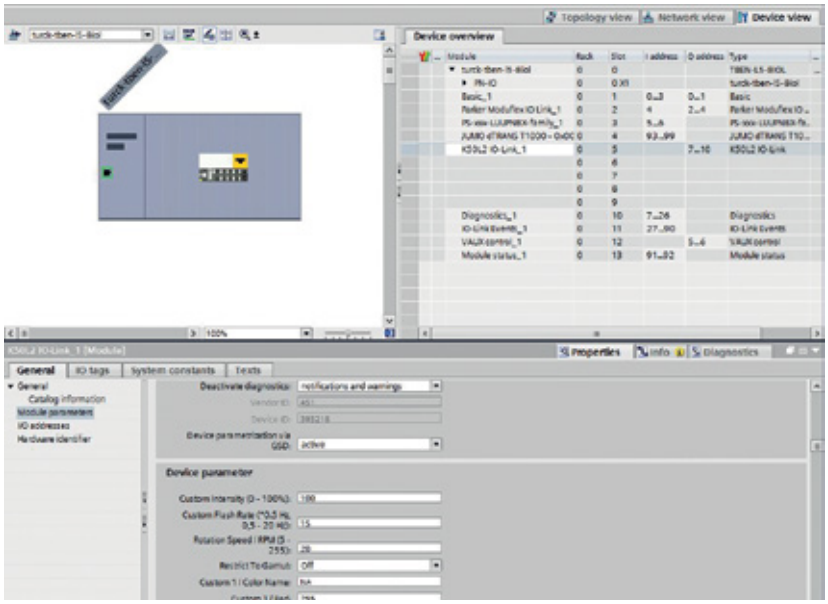
The benefits of SIDI particularly become apparent in large projects where using previous alternatives involved a lot of problems. Large plants and machines can normally be entered as a project offline first of all.



SIDI allows IO-Link devices to be selected from the hardware catalog exactly like Profinet modules

SIDI operates with different engineering systems since it is based on standard Profinet mechanisms





The parameters of the IO-Link devices can be set directly from the engineering system

The Profinet nodes are added in the device tree and selected normally from the library of the TIA Portal. Offline engineering is now also entirely possible with IO-Link devices. The devices therefore no longer have to be available on the PLC programmer's desk. Programmers also no longer have to visit each device in advance with the laptop in order to enter the necessary settings via a USB adapter. Consistent offline access from the office desk to all device data therefore saves a lot of time in large projects compared to integrating IO-Link without SIDI. The wiring of pure IO-Link projects is basically childs' play for fitters and electronic technicians.

Simple maintenance: Plug and play device replacement

Besides engineering, SIDI also supports maintenance. As all device properties and parameters of masters and devices are directly available in the central project location of the controller, automatic device replacement can be carried out easily without any problem – both for IO-Link masters as well as devices. Only the Profinet name has to be set. By using Profinet with topology information this even takes place automatically. Any laborious setting of the measuring ranges and other parameters is no longer necessary for the used devices.

The best of both worlds

By opening the engineering benefits of the Profinet world also for IO-Link installations, Turck as an automation manufacturer is trying to make the IO-Link standard attractive for die-hard Profinet fans. The cost saving benefits are in favor of IO-Link installations anyway. SIDI could in this respect rekindle some discussion between e-planning, design and purchasing.

SIDI – AT A GLANCE

- Full configuration of IO-Link devices directly from the Profinet engineering systems
- No additional software required for configuring IO-Link
- Intuitive operation and entry in plain text
- All devices in one project location
- Fast commissioning of large projects thanks to offline engineering
- Configuration-free device replacement of master and devices, since all parameters are kept in the controller itself

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Cart Track 4.0

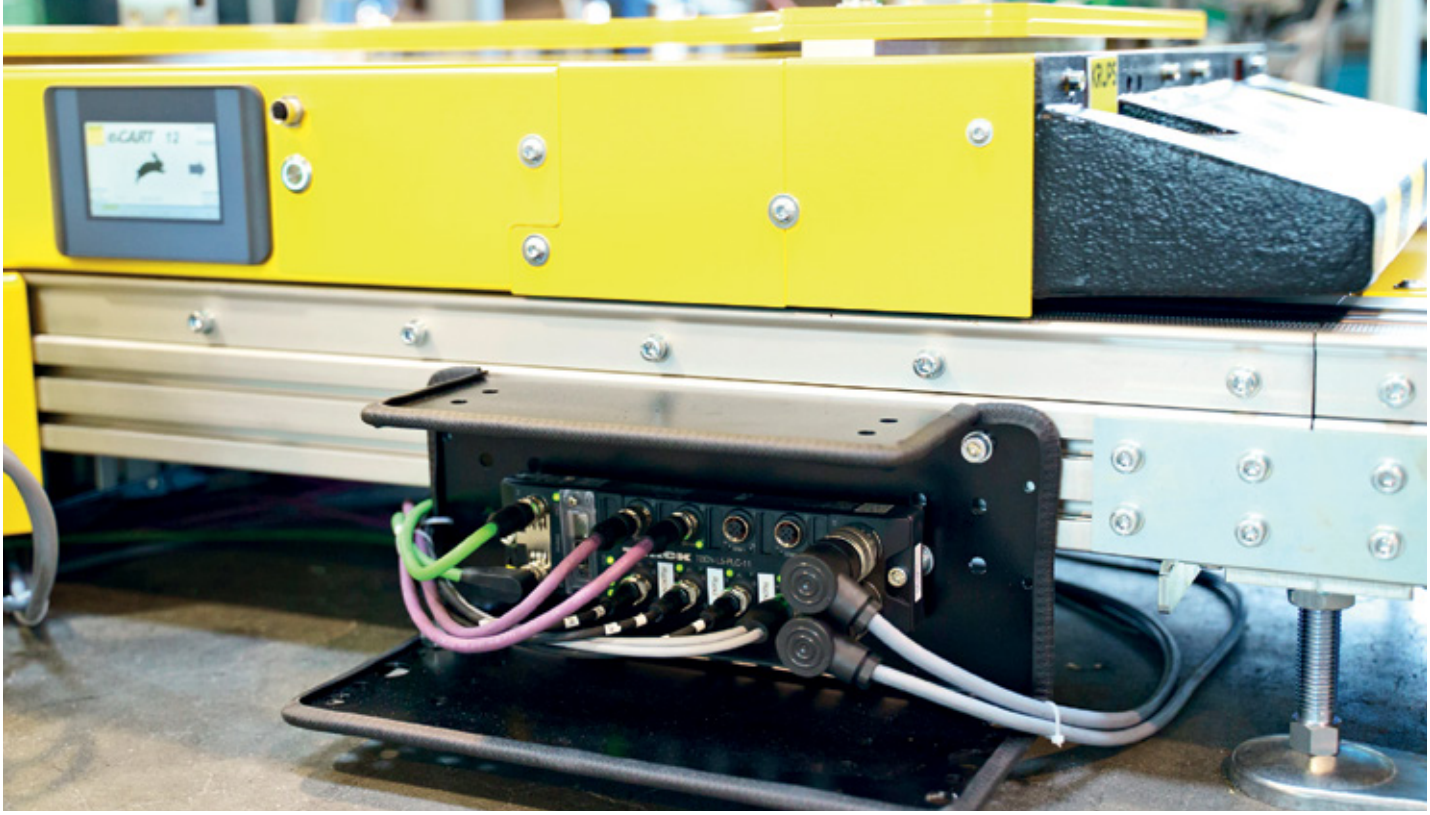
Self-driven, electric e-Carts from Krups Fördersysteme optimize the assembly and testing track in the battery pack production of a German car manufacturer; Turck's robust IP67 PLCs provide the decentralized operation control of the individual conveyor modules

In many places, the production halls of automobile manufacturers or tier-1 suppliers very much resemble a clockwork mechanism. The operating steps of robots and co-workers at the individual stations are closely synchronized so that the treated object can then be returned to the process flow. However, if one cog sticks, particularly if this cog is the production conveyor system, the entire plant gets out of step.

Maximum availability and flexibility are top of the list of customer requirements. This puts conveyor system manufacturers under pressure to innovate. They are required here to provide maintenance-free and more flexible conveyor systems that are simpler and faster to integrate, which are less expensive and available faster than alternative solutions once all direct and inidirect costs have been offset.
Krups, a company with its main plant in Dernbach Rhineland-Pfalz, is one of the market leaders in assembly and test automation. The company specializes in automation systems for the efficient linking of assembly and testing stations. The new e-Cart system provides actively powered, intelligent workpiece carriers, which are able to rotate, lift, clamp or tilt workpieces.

Krups latest device is a highly available conveyor system which is breaking (or making) new ground. Philipp Krups, second generation head of the company, explains the basic idea behind it: “In a conventional roller conveyor system the drive is located in the conveyor track. This involves a lot of mechanical parts in the track, and also the associated amount of wear. With permanently installed systems, maintenance is therefore always a problem. That's why we wanted to turn the system round and remove the maintenance from the track. We therefore developed a passive track that is completely maintenance free. The whole technology and electrical system is now located in the carts, the so-called e-Carts. These electrically driven carts have a self-diagnostic function and can be discharged from operation if required for preventative maintenance. This means that the downtimes are reduced and the track remains operational. It also

The e-Cart system takes the drive and thus also the maintenance away from the conveyor track, thus maximizing its availability



Turck's TBEN-L-PLC controls the Krups conveyor system modules – communication to the periphery is via CAN and to the main controller via Profinet or Ethernet/IP

makes any later expansions to the conveyor line very easy to implement. The e-Cart system furthermore makes it possible to implement more flexible production processes with smaller batch sizes. It could even be said that it is an Industry 4.0 conveyor."

e-Cart revolutionizes materials handling for e-mobility

Krups has launched the new conveyor system under the name "LOGO!MAT e-Cart". And where if not in the automobile industry should one of the first applications of this conveyor system be implemented? The automotive sector is after all the early adopter of industrial automation. This is a home game for Krups since the company does around 95 percent of its sales in the automobile industry. Some of the customers of the company based in the Westerwald are integrators that supply complete systems for automobile manufacturers, or also the integrators of the automobile manufacturers themselves. A major German automobile manufacturer will therefore be using an e-Cart system in future in the battery production facility for electric cars.

Krups uses a modular concept in order not to have to re-invent the wheel. The system consists of a few standard modules: Rotate modules, shuttle modules, stopper modules and indexers. These units are combined in a layout according to individual customer requirements and connected to the onsite control system of the plant. The conveyor system supplies the customer's production system with report data and enables the implementation of bidirectional communication interfaces.

Decentralized control for modular conveyor systems

"Previously there was always a main controller, to which all signals were routed. This partly involved point-to-point wiring, but increasingly more often also decentralized I/O units. The problem here was the programming. A plant programmer normally programs everything in one sequencer. However, if any condition at switchon or after an emergency startup is present that is not represented in this sequencer, the users must move units by hand in order to restore a known situation," explains Christian Mies, control developer at Krups. "A conveyor system has to be programmed

"In the long term we don't just want to be a supplier of mechanical systems but a supplier of plug and play conveyor systems – smart systems that control themselves and only need a higher-level master controller"

QUICK READ

With its e-Cart system Krups Fördersysteme is responding to the increasing requirements of modern assembly and test automation in terms of safety, low maintenance and communication. A zero maintenance track and intelligent self-driven carts, combined with decentralized system components with standard controls ensure the possibility of flexible and safe assembly automation. This increases availability and allows flexible processes for small batch sizes. The individual modules of the track are autonomously controlled by Turck's TBEN-L-PLC. With the multiprotocol-enabled IP67 PLC, Krups can offer standard and optimized control sequences for the individual components. Customers can thus reduce the time required for wiring and commissioning and expand the system easily.

At the stoppers and other function modules the e-Cart system communicates with the carts via NFC

differently in order to eliminate the need for manual interventions. Conditions and appropriate reactions have to be defined that are suitable for all situations." If the modules are controlled in the central controller, customers have to make some changes that interrupt the overall process. If faults later occur, these come back to Krups – even though the company was not responsible for them. This experience taught Krups one thing: Ideally, every module should be autonomously controlled.

Autonomous control increases process safety

Today each module operates externally as a black box, which simply communicates bidirectionally with the central controller in both directions via a bus connection. The module runs its program in order to perform its particular task: Rotating, transferring, traffic monitoring and reporting of module status. Each module is therefore controlled – exactly according to the development – and perfectly implements all possible sequences. A plant controller is installed at the level above this and controls the overall flow. However, the actual positioning sequences and the monitoring of conditions is taken over by each controller at the module.

Krups then no longer has to intervene in the control of the overall plant, neither does the plant operator have to control the conveyor system modules. Only the communication between the general controller and the modules has to be implemented at base level. In-house, Krups calls these conveyor system modules which have their own intelligence smart modules. The company therefore looked for autonomous controllers ten years ago, which can be installed directly on the modules.

Before – after: The controller built in-house by Krups (left) worked well but, compared to Turck's TBEN-L module (right), was considerably larger and more complicated to install and only worked in Profinet networks

Self-built IP67 controller

"At that time we already looked for compact controllers with IP67 protection. However, there was nothing on the market," Christian Mies reports. Krups therefore helped itself first of all: "We had our own controller built on a board, fitted all M12 plug connectors and placed everything in a housing. This housing had to be provided with drill holes plus a pneumatic system and a display. These were very big units and relatively difficult to manufacture. We had to have the boards built, the housings assembled and everything wired up. Although this was successful, it was a laborious task," senior boss Peter Krups explained the journey towards an in-house module controller.

Since Turck launched its TBEN-L-PLC block controller on the market a few years ago, Krups has been able to save the effort required for a self-build. The company is now using the IP67 controller in many machine models – not only in the e-Cart system. The control system for every conveyor system element was written in Codesys. The communication to the drives or valve blocks and other components of the module is implemented via a bus interface, while the communication to the main controller is mostly implemented via Profinet. "We now have the benefit: The modules can be deployed immediately and without the need for any other field programming device, i.e. replace, insert, data backup. In the ideal situation: the customer just has to connect the 7/8 inch plug connector for 24 volt and the Ethernet connector for the bus connection," Mies explains the benefits for the users. For an international company like Krups even the range of protocols offered by the compact controller pays for itself, according to IT manager Mies: "We can serve the US market with

Ethernet/IP in exactly the same way as the European and Asian market, where the protocols are mixed. We are currently concentrating on Ethernet/IP and Profinet, but Modbus TCP would also be possible in principle if this is required by a customer. The great thing here is also the fact that all the Codesys licenses are contained in the Turck device. The license is there and we can use it, regardless of the fieldbus the customer uses. We can even use them when we sometimes need a small main controller because the master licenses are also available," Mies describes the different scenarios in which the TBEN-L-PLC can be deployed.

e-Cart system saves power in battery production

The specifications of the e-Cart conveyor system in battery production already make it clear that the manufacturer means it with e-mobility. With 130 self-driven carts on a kilometer of conveyor track, the stage of small series production has been left behind. Krups fitted 70 turntables and around 140 stoppers on the track. 10 stoppers use a TBEN-L-PLC jointly as a gateway to the customer's main controller. This considerably reduces the number of bus nodes required for the customer.

To change direction, the carts are moved by transfer units to parallel tracks or their direction is changed by turntables. Unlike most conventional systems it is possible to communicate with the carts of the e-Cart system. NFC (near field communication) units are provided at the stoppers in order to use the TBEN-L-PLC as a gateway to implement communication between the main controller and the carts. In this way, carts can be removed depending on their state or the presence of warning messages. Another benefit: When the carts are waiting, they do not consume any power – unlike the conventional roller conveyor systems in which the drives normally continue running – even if no cartons have to be moved.

BL compact provides additional I/Os via CAN

The sensors and actuators of the modules are connected directly to the TBEN-L-PLC. The block controller provides eight universal channels on four sockets, which can be set automatically to the required configuration as input or output. If other I/Os are required, Krups can expand the number of signals required with the BL compact I/O module via the CAN bus connection. The BL compact modules are likewise designed with IP67 protection and are mounted directly at the units.

IP67 saves wiring

Krups has recognized the work that can be saved with the IP67 technology. "Just routing the 24V cables and signals to the twelve controllers on the stoppers and labeling would be very labor intensive. The price of the TBEN-L-PLC covers this easily," IT manager Christian Mies expresses his appreciation.

The e-Cart system is not only energy-saving and fail-safe, it also enables more flexible processes as outlined in Industry 4.0 model scenarios and also already implemented. Through the communication with the workpiece carriers greater product variance can be achieved, as shown in another application example: Likewise in the automobile industry, the e-Cart conveyor system transports the vehicle axles of two models. There are, however, 140 different types of axles that the carts can move through production. The actively driven workpiece carriers enable different production steps to be activated easily or left out. Wait times are minimized and different speeds can be assigned to the carts at the stations.

The e-Cart system with smart control technology in the field thus helps to ensure the smooth and highly efficient execution of flexible production processes. In view of all this, it becomes clear that the image of production as a highly synchronized clockwork mechanism comes from a different time. Even if production 4.0 requires the meshing of one cog in another, the clocks of production 4.0 have to be flexible like those in Salvador Dali paintings.

»Just routing the 24V cables and signals to the twelve controllers on the stoppers and labeling would be very labor intensive. The price of the TBEN-L-PLC covers this easily.«

Christian Mies | Krups Fördersysteme GmbH

Author | Frank Paluch is sales specialist at Turck
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The thumbnail sized tag in the base of the seat will in future control, save and document the production process

»By using the solution without a PLC we were able to save thousands of euros at the rework station.«

Craig Craill | Kirschenhofer Maschinen GmbH

Tag Team

Kirschenhofer Maschinen GmbH developed a production control and quality assurance system for Britax Römer using Turck's RFID tags and TBEN-S-Ethernet multiprotocol modules in conjunction with Labview – entirely without the need for a PLC

Anyone who has ever had to fit a child safety seat in a car appreciates what a blessing the Isofix standards are. Two clicks and the seat is reliably fixed in any car provided with the Isofix fixing points. The idea: The seat has two permanently fixed anchors via which it can be clipped into the Isofix anchor points of the vehicle. The Isofix connector simplifies the construction of the seat and thus increases safety. This godsend for parents is down to a collaboration between child seat manufacturer Britax Römer and VW, who jointly brought the standard into being. Since then it has become an international requirement for private cars and child seats.

Customers and manufacturers pay special attention to the safety of products for the safeguarding and protection of children, such as bicycle seats, helmets, prams or car seats. Production faults cannot be tolerated here and must be ruled out as far as this is possible. This is often out of the control of the manufacturers, particularly if suppliers deliver faulty components. The second priority is therefore to ensure that product recalls are carried out quickly and smoothly.

Streamlined Labview-based system saves costs

Before building its production line for the Advansafix IV child seat, Britax Römer consulted Kirschenhofer Maschinen GmbH, the automation specialists and special machine builders. Both companies are located near Ulm, only a few minutes drive away from each other. The collaboration was therefore also close in the literal sense of the word. The representatives responsible on both sides soon had a similar picture about how the safety of the largely manual production of the new series of child seats could be automatically ensured. The control of the system was to be based on Labview, one of the most widely used system development software environments for testing, instrumentation and control applications, and RFID tags used for the data pool. The benefit: Britax Römer makes savings on major production conversions and infrastructure investments.

The production process for the Advansafix IV consists of 16 individual steps. One feature has to be checked at each of these steps. This starts with the construction of the base of the seat and ends with the packaging of the seat in a cardboard box. Each successful production step has to be documented as "okay" (OK). If a station is missed or cannot be completed successfully, this feature is marked as "not okay" (NOK).

Tracking system without PLC and database

Nico Dreher, the process engineer at Britax Römer responsible for the project, wanted a system that also allowed mobile use, in order to simplify the identification of seats at dealers. Kirschenhofer developed a completely new system approach that could meet both demands: process control using an RFID system that stores all the data on the tag on the product. This

QUICK READ

How the Industry 4.0 philosophy can be implemented in specific projects was recently demonstrated by Kirschenhofer Maschinen GmbH in a project for Britax Römer Kindersicherheit GmbH. Kirschenhofer implemented a tracking system for child seats without any kind of higher-level controllers or central databases and using an RFID tag on the product as the data pool. This tag contains the sequence of the assembly stations and documents all production steps. This ensures quality and makes it possible to later identify the product quickly and easily even in its packaging – at any location and without any access to a database. The successful project is based on the connection Kirschenhofer implemented from Turck's TBEN-S multiprotocol RFID I/O modules to the Labview system development software from National Instruments.

Before the seat is provided with the orange sticker containing the serial number, the system checks whether all process stations are marked as OK on the seat

Turck's TBEN-S-RFID interface talks both Profinet with the Siemens PLC as well as Ethernet/IP as an interface to Labview on the rework station

does not initially sound spectacular but this form of production tracking system has never been implemented before. Tracking systems normally only use the ID of the tag and save the associated production data in a database, which can be accessed from all relevant process points. However, Kirschenhofer wanted to save its customers from this type of server infrastructure – after all, every dealer should also be able to access the database. A decentralized system without a permanent data link and without a PLC has its advantages: firstly, the mobility and independence provided, and secondly the lower costs. The limited storage capacity of the tags is one small restriction. Only the relevant information and features could be stored.

Five central process steps implemented as proof of concept

Once the general outline was ready, the five key positions of the 16-stage production line had to be implemented in a pilot system as proof of concept. The tag is pasted into the base plate of the subsequent seat at the first station. An RFID read/write head checks that it is seated correctly by reading the freshly pasted in tag and writing it with the process image. A robot testing cell was chosen as the second station. This carries out a visual examination for the 16 production features on the largely finished seat. If seat variants have to be implemented later, the test robot could select an alternative test run with other features via the tag on the seat. The third station checks the Isofix function. Before the finished seat is packed, the fourth station checks whether all previous process steps were documented as OK on the tag. The fifth station is the rework station, on which the seats marked with NOK are reworked.

The entire process is stored on the RFID tag. There is only one approved order of production steps. The system ensures that the correct sequence is observed by setting OK after the assembly process has been successfully completed at each of the four stations. Station 2 can thus only follow after station 1 (pasting in the tag). The check whether the step at the previous station 1 was successfully completed on the current seat is carried out at station 2. Only then is the process continued.

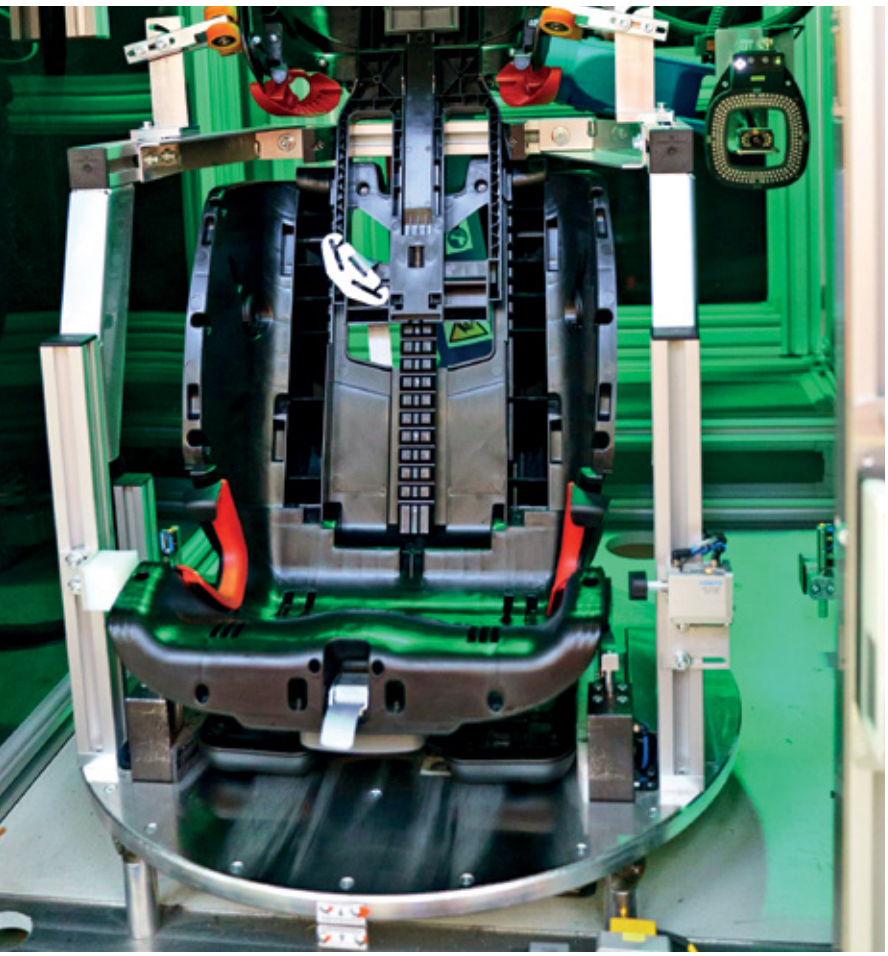
Adhesive tags with 320 bytes of memory

Kirschenhofer found the right tag for this at Turck. As the tag had to be pasted directly in the seat, it could not be too big. It also had to be relatively cheap as it would stay on the product. Turck could offer the TW-L36-18-F-B320 smart label as a tag that met all the requirements. With 320 bytes, the thumbnail sized label even offers more memory than the minimum amount required and could therefore implement enhancements of the later system if any set measuring ranges or more stations had to be added.

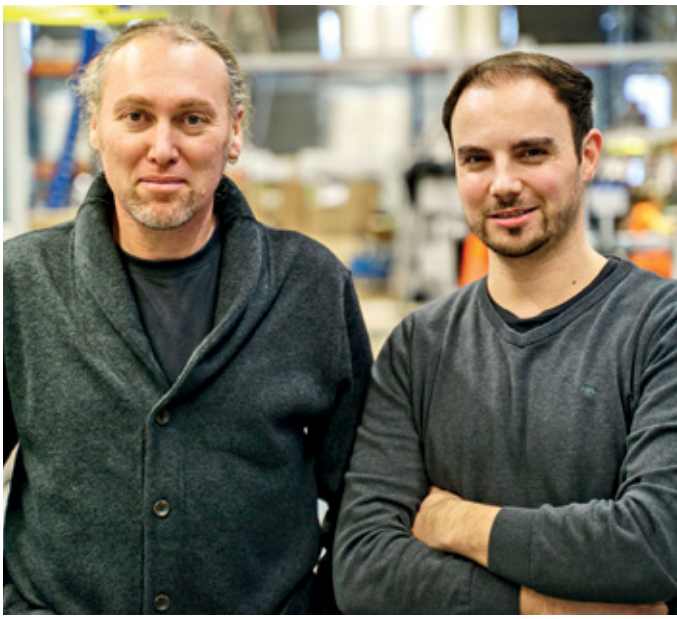
Streamlined solution without PLC

No PLCs are required for these kinds of tracking and testing systems. The processes are not time critical and could also be recorded with conventional office hardware. However, the interfaces in this case are often the problem. RFID interfaces are normally designed for connecting to industrial Ethernet networks and cannot therefore easily communicate with PC applications or mobile terminal devices.

Craig Craill, managing partner and PLC programmer at Kirschenhofer, looked for a solution that enabled the operation of the RFID system without the use of a PLC. The rework station was the crucial point. The operator here sees all the necessary information on a tablet PC. It shows which feature is faulty and shows in an image the reference state of assembly in the final system. This system is based on standard software so that Britax can incorporate images and texts without any further integration costs. Kirschenhofer uses Labview at the rework station. As the software did not, however, have any connection to the RFID system, a solution had to be found.



Pleased with the successful project: Craig Craill, Kirschenhofer Maschinen GmbH, and Nico Dreher, Britax Römer Kindersicherheit GmbH (right)



TTN-Q14 read/write head, which writes the test result to the tag in the bottom of the seat, is fitted in the metal base underneath it

Interface between Labview and Ethernet/IP programmed

Kirschenhofer chose compact TBEN-S-RFID interfaces for the Britax Römer system and different read/write heads from Turck, depending on the station. The TBEN-S module can output the RFID data of the read/write heads pre-filtered via Profinet, Ethernet/IP or Modbus TCP to higher-level systems, which are normally controllers. Craill decided to program a direct interface between Labview and Ethernet/IP in order to avoid the indirect route via a controller. He expects a positive development of the protocol: "Ethernet/IP has a great deal of potential as it has the benefits of an industrial Ethernet network, but unlike Profinet is completely open and operates without license fees." The program also places accordingly high value on the potential of the interface between Ethernet/IP and Labview, as the software is virtually the industry standard for test rigs. Craig Craill and his colleagues at Kirschenhofer dug through a total of 900 manual pages over several months, immersed themselves in the Ethernet/IP codes and worked out a device description file for Labview, which is similar to a driver. The previous experience with the pilot system confirms the trouble-free operation of the interface and provides Kirschenhofer with the freedom for subsequent projects.

Another benefit of the system is the fact that Britax Römer itself can define additional features, add them to the tag and have them checked. The system is so open that it can be expanded without any programming knowledge. The employees of the seat manufacturer can also adapt it for extended production processes, the production of a different seat variant or even a different product.

Tag-based system saves PLC and money

Craig Craill roughly compares the price of a PLC solution to that of a Windows tablet solution: "The solution without a PLC has enabled us to save several thousands of euros at the rework station. A simple Windows Surface tablet here replaces a PLC, a screen and an additional IPC for managing the database." The test robot is still controlled by a PLC in the current expansion stage. Craill can also imagine working without a PLC here. "This is not possible at present due to the safety signals. But I have already tested Turck's TBPN safety module. This could be used to also control the test robot without the need for a PLC."

Increased process safety for the rework

However, the project is not only outstanding in terms of costs. The processes involved, particularly the rework, are more efficient today and safer. "Previously it was necessary after the test to record in writing what the fault was on the product or check each feature at the rework station oneself. Today, we place the seat in the station and see on the display which feature is

At a glance: The tablet (right) at the rework station shows via Labview which station has to be reworked

The seat can be identified in the closed box using a suitable RFID reader – a tremendous advantage, also for product recalls

defective. This is a considerable benefit because it is faster and safer than before," says an impressed Dreher of the solution. Kirschenhofer selected for the rework station the elongated TNLR-Q80L400 read/write head, because no fixed anchor points are provided for the seat and the read/write head has to cover a larger range. "The long read/write head ensures that the tag is detected reliably in all positions. The station also allows mobile use and can detect the seats in closed boxes," Craig Craill explains the choice of the 80 x 400 millimeter RFID reader.

Efficient product logistics

The successfully reworked seats finally land like all others at the end-of-line station. A final check whether all features are OK is carried out here. Only then is the seat provided with an approval label with a unique serial number. It is then packed into a box in such a way that the tag can be read through the carton without having to open the box. "We can even implement a mobile rework station ourselves. For this we just need another tablet, a reader, the switch and a Labview license. We would then be operational and could then drive to the dealers in the event of a fault and check through the seats. This would be more efficient to carry out than what was done before," says Nico Dreher. In this kind of situation, we previously had to remove all seats from their boxes at the dealer in order to identify them uniquely. Each seat then had to be put back in its precise packaging. This was a laborious task, both for the dealer but also in our own warehouse if the seats concerned had to be checked before shipment.

Conclusion

The operation of the five stations of the pilot system proves the validity of the concept that Kirschenhofer had implemented with Turck's BL ident RFID solution. The project is now due to be rolled out on the other stations. This is not the first project in which Craig Craill has been impressed by the Turck components. "Kirschenhofer has already been using the TBEN-S modules for a long time. We were some of the first to test the I/O modules and the first to also use the RFID modules. We were impressed by the multiprotocol concept because it allowed us to just keep one module in stock. We can use this in Profinet like on the robot test cell or in Ethernet/IP like on the rework station – we always use the right device. The range of read/write heads and tags also impressed us. A product package like this can only be found at Turck."

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Turck's UHF read/write head transfers product information to the RFID tag of the transport carrier

Track That Table!

Flexibility thanks to RFID: UHF readers and handhelds ensure efficiency and reduced downtimes in the finishing section of a Chinese furniture manufacturer

The rising standard of living is boosting the consumer goods business. This is also apparent in the Chinese furniture industry. Besides orders from overseas, orders from the domestic market have also increased in recent years – with a demand for varied and high quality products. The furniture manufacturers are having to keep up with these requirements. Traditional work intensive processes are increasingly having to compete with modern, highly coordinated manufacturing and logistics processes, which are expected to enable companies to implement more flexible manufacturing.

In order to achieve the goal of tailored mass production, more and more companies are using RFID technology, one of the most important pacemakers of Industry 4.0. A company in China, which Turck (Tianjin) Industrial Engineering Co., Ltd. has supplied with modules from its own BL ident RFID complete system, is demonstrating the advances in efficiency that are possible with this.

What is particularly difficult for the industrial production of furniture? Above all, it is the variety of shapes and colors appreciated by the consumers. The differences in the requirements of the production processes are as great as the characteristics and requirements of the workpieces. Anyone involved in batch production is unavoidably faced with the challenge of varying workloads at the individual stations. Without the support of intelligent systems, it would be absolutely impossible to ensure the economical deployment of machinery, employees and equipment. The brief of a Chinese customer was for a comprehensive and extensive production logistics management system that would provide a solution. This involved specifically the smooth and efficient coordination of different work processes, taking the conveyor systems and paint robots into account. The company wanted this system to gradually replace difficult manual operations.

Read/write heads transfer product codes

RFID products now control important operations in the finishing processes at the furniture manufacturer. Directly after production, a conveyor system moves the main components of tables, chairs and cupboards

toward the coating line. The individual workpieces are each provided with an RFID tag, which stores the particular product code. This is important since the workpieces on the conveyor belts have to receive this data. Only in this way can the piece of furniture be later transported to the correct process position. A Q175-UHF reader transfers here the product ID of each workpiece to the workpiece carrier, which is then pushed onto a movable transport module. This module is also provided with a UHF reader. The further journey of the furniture parts is thus decided by the captured information, which is also accessed by the paint robot in order to move according to the settings.

In a further step, employees are also informed through RFID technology of the number of workpieces that have already reached the end of production. The data here can be manually scanned using a UHF handheld. After production, another UHF reader captures the data of the workpiece, transfers it to the production system and writes back the result of the inspection on the tag.

Tailored signal strength

The different read/write ranges to the tags on the workpiece carriers and furniture parts required the use of RFID technology in the UHF range. High frequency RFID (HF) would not have met the requirements and would have been too complex to install and very inflexible in use. Due to their longer ranges, the UHF read/write heads could be very easily fitted along the production routes, and the handheld devices offer a long range so that employees can use them to read data quickly and from a back-friendly position. However, in order to rule out the possibility of overreaches and null spots, the system integrator reduced the transmission power of the Q175 appropriately. The electronic product code on the workpiece carriers was also designed so that it could be distinguished from the information on the RFID tags of the furniture components. This prevents the possibility of read errors as the reader only filters in the process the data that is locally relevant.

The read/write heads and UHF handhelds in the production hall of the furniture manufacturer are the directly visible representatives of Turck's BL ident RFID system. In the control cabinet, the customer also uses the RFID-S expansion modules for his BL20 I/O system. The gateway is compatible with other modules so that signals of the RFID readers and from other sources can be transmitted at the same time.

Durable UHF tags bring opportunities

The RFID support has enabled the Chinese furniture manufacturer to increase the efficiency of the finishing process with reduced downtimes. Workpieces can be tracked live and extensive information on the condition of the customer's products can be obtained. In the coming years it is intended for the UHF tags on the furniture to also serve two additional purposes: firstly to provide protection from product counterfeiting and secondly to provide long-term quality tracking. A suitable mini-tag would be used to provide every sold object with permanent identification. The furniture industry can therefore considerably benefit from the RFID technology – and move closer to the intended target of "Made in China 2025".

The moving rail transporter uses the Q175 reader to find out the section in which the individual workpieces are to be assembled

The Chinese furniture market is booming and is placing high demands on the manufacturers

RFID inlays are inexpensive data carriers for complex process chains

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QUICK READ

The mixed manufacturing processes of a varied production range can only be implemented efficiently with the help of intelligent systems. A Chinese manufacturer used for this project components from Turck's comprehensive BL ident RFID solution. The Q175 read/write heads transfer product codes and ensure that each workpiece gets the correct coating. In the final inspection, employees use UHF handhelds to record the results of the checks on the tags and in the overall system.

Niemann included the installation of Turck inductive proximity switches in the machine column in order to query the height of the hydraulic ram

QUICK READ

Wilhelm Niemann Maschinenfabrik is a company that manufactures mixers and mills for the paint, varnish and chemical industry. Customers use them almost exclusively in explosion hazardous areas. The manufacturer based in Melle installs space saving isolating switching amplifiers and temperature measuring amplifiers from Turck's IMX12 interface series in the control cabinet. These send the signals of the operator buttons to the field and transfer intrinsically safe digital and analog input signals. Niemann has also relied for many years on the IM36 potentiometer amplifiers for positioning the height of toothed discs. Turck inductive initiators with a Namur output have been even longer in use, and were able to impress Niemann due to their large switching distances.

Ex To Stay

Wilhelm Niemann Maschinenfabrik guarantees the reliable operation of their machines with safe and efficient Ex protection solutions from Turck, consisting of accurate sensors and fast compact interface devices

"What's on the outside must also be on the inside" – this is a maxim on which Wilhelm Niemann Maschinenfabrik places particular importance. From the special screw to the pneumatic cylinder, the company based in Lower Saxony produces a number of components for its industrial and laboratory devices itself. Customers, mostly consisting of manufacturers of paint, varnish, adhesives or silicone, come from all over the world. "We stick to the maxim: made in Germany, made by Niemann", says Hendrik Werges, workshop and project manager for electrical engineering.

The range of the different machines from Niemann is not apparent to outsiders at first glance, especially since only three basic types are produced in Melle-Neuenkirchen. The dissolver is suitable for mixing processes but also for dispersing – through which a rotating toothed disc splits solid materials into a liquid, mills it and mixes it. The result could then be a wall paint. The basket mill offers an even finer milling of predispersed material. The suction of a pump disc pulls the product through a basket filled with ceramic pearls with an action that is used by manufacturers of car paint.

From Melle out into the big wide world: Niemann equips its machines, like this Kreis dissolver with sensors and interface technology from Turck

Tailor made machines

The requirements placed on the devices increase with the viscosity of the products. "There are high viscous products, in which the dissolver disc would only make a hole in the substance," explains process engineer Michael Diddens. In order to move the content of the container at the same time, Niemann's third machine series, the "Butterfly" Kreis dissolver, also features a centrally positioned butterfly tool to which scrapers are fitted on the outside. The slow circular movement of this machine, for example, ensures the mixing of the material for the production of sealing materials, and passes it to the dispersion area of the eccentric dissolver toothed disc.

Depending on the requirements of the product, customers choose one of these basic types, but place far more requirements in practice on the quality of the machines. The technical office of the family-run company must create its project drawings according to the local requirements of the customer on site. For example, whether a 5,000 liter container is required due to restricted room height or whether a heating system should be added to the cooling circuit on the mixing tank for the production of a special product. Niemann also supplies its dissolvers in a standard design or in a top-mounted design for mounting in steel platforms or ceilings.

Safety in restricted space

One thing is common to all machines here – their use in explosion hazardous areas. This must also be taken into account in the control cabinet outside of Zone 1. Niemann generally follows at this point two systems, which are firstly dependent on whether a complex controller is required. Touch panels at the machines require PLC support without exception. This also applies to the operation of the dissolver butterfly in around 90 percent of cases. Encapsulated Profinet or Profibus cables can be run here from the PLC in the control cabinet to an operating element.

However, some companies cannot draw on the expertise of PLC programmers, and bus technology may possibly not even be necessary elsewhere. The second variant without PLC technology requires hard wiring. This sends signals from the operator button to the field via IMX12 isolating switching amplifiers from Turck. Devices from the IMX12 interface series are also used if users wish to pass certain digital or analog values from the Ex area. The data from proximity sensors or temperature values are thus run as intrinsically safe signals to the control cabinet.

The new isolating switching amplifiers purchased had to have a slim design and a power supply rail. Turck's IMX12 devices were chosen here thanks to their narrow width of only 12.5 millimeters, but also due to their power supply via a power bridge. The individual housings are thus fed in the control cabinet via the DIN rail, thus saving the panel builders the need for any

»Turck's sensors with this design simply have the advantage of a one to two millimeter switching distance larger than its competitors«

Hendrik Werges | Wilhelm Niemann Maschinenfabrik

IMX12 and IM36 amplifiers guarantee safe signal transmission in the Ex environment

laborious bridging. A separate power supply device is also unnecessary on the IMX12, as a single plug connector is sufficient for the coupled series.

Three environments, three initiators

Niemann had been using Turck sensor technology for a long time before the interface technology devices. The interface modules now also convert some signals supplied by the initiators from the field. "Turck's sensors with this design simply have the advantage of a one to two millimeter switching distance larger than its competitors," says Hendrik Werges. These differences in range enable many things to be simplified. For example, the technicians at Niemann install M18 inductive proximity switches in the columns of its machines in order to query heights. A hydraulic ram for lifting a machine moves in the column. This is required, however, not to overshoot certain ranges so that the toothed disc only runs in the tank or stays on the cover. Sensors that monitor the central ram are installed at suitable points in order to limit the stroke and as a safety-relevant circuit. The mounting of these sensors is made more difficult by an approximately four millimeter thick reinforcement ring at the bottom end of the ram, which must not be blocked by the initiator. The sensor must detect the cylinder and ring in spite of the distance. This demonstrates the benefit of Turck's NI10-G18 proximity switches with a NAMUR output, which are suitable for Ex zones 0 and 20 and are used by Niemann in a large number of products.

Anyone wanting to look for the smallest Turck components in a Niemann machine must look really closely. With a housing length of 31 millimeters and a height of six millimeters, the BIM-UNT-AY1X magnetic field sensor is hidden in the cover hinge of a tank fill opening. This detects here whether the cover is open or closed. The miniature sensor has a highly all-round visible LED and is clamped securely in the groove with a special screw.

A specially designed inductive sensor must withstand wear in the drive. This scans a switch lug in the very demanding atmosphere. Background: Top-mounted dissolvers with volumes up to 15,000 liters require a scraper that must not be located underneath the ball valves during the filling process in order to prevent the formation of deposits. The designers have therefore defined a park position for the container scraper and fitted a detection plate on the top chain drive which is monitored by the sensor.

IM36 passes speed test

The position of the toothed disc inside the container is determined by a cable sensor. This supplies resistance values via the contact of the measuring cable, which have to be supplied as analog values. A potentiometer amplifier converts this quickly to an intrinsically safe

The power bridge system simplifies the power supply of the IMX12 devices by feeding the voltage via the DIN rail connection

During the production process a double suction disc in the container rotates at the set height

Compact BIM-UNT magnetic field sensors are concealed in the fill openings

4-20 mA value so that connected systems can regulate the height steadily.

The process sometimes still caused problems five years ago, recalls Werges from experience: "Customers specify in the recipe certain heights at which the toothed disc must move. If the conversion takes too long, the machine misses these points by a few centimeters and then continuously oscillates." A transducer with a cycle time of less than 700 milliseconds was required as a solution. Niemann therefore turned at that time to Turck interface technology. To be precise, the IM36 amplifier, which completes a conversion within 30 milliseconds and thus enables the toothed disc to be positioned within the hysteresis range.

As a specialist for high-speed analog conversion, the IM36 has now been fitted in the control cabinets of Niemann machinery for a long time and has recently gained close neighborly acquaintance with the slimline IMX12 amplifiers. The machine builder in Lower Saxony is currently testing another solution using Turck sensor technology, in which initiators are required to replace the previous solution for limiting the speed of older drives. "We are talking here about spare parts business," explains Hendrik Werges. The current machines are controlled by frequency inverters and the operator can regulate the speed of the machine via a potentiometer in the control panel. This type of haptic control continues to be popular with customers.

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08.04. – 11.04.2019	Pro Mat	Chicago, USA
09.04. – 10.04.2019	ISA/AEC	Calgary, Canada
09.04. – 11.04.2019	International Industry Fair	Celje, Slovenia
15.04. – 18.04.2019	Oil & Gas	Moscow, Russia
07.05. – 09.05.2019	Fabtech	Monterrey, Mexico
14.05. – 16.05.2019	Smart Automation	Linz, Austria
14.05. – 17.05.2019	Industry Days	Budapest, Hungaria
15.05. – 18.05.2019	Metaltech-Automex	Kuala Lumpur, Malaysia
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22.10. – 25.10.2019	Congreso Internacional Minero	Acapulco, Mexico
06.11. – 08.11.2019	FMB	Bad Salzuflen, Deutschland
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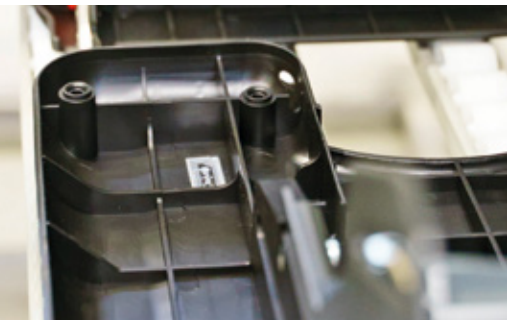

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