# APPLICATION REPORTS 2019


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# ifm in action

*The focus of "Application Reports 2019" is on showing how applications can be solved quickly and easily using ifm products. For example, the O3M camera is used as a driver assistance system that automatically prevents collisions and ensures safety in public streets. Or learn how ifm increases the transparency and operational reliability of the waterway infrastructure in the Netherlands.*

*Find inspiration for your own projects!*

***Your application in the focus***

*For our next edition, we invite you to participate: Have you set up an interesting application using ifm products? Or have you implemented a clever solution in your plant using our sensors?*

*We will be happy to present your solution in the next issue of "Application Reports".*

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# Smart lock

**The lock in Eefde, Netherlands, was built in 1933 and assumes an important function in the region. It is the entrance from the Ijssel to the Twente Canal.**

## Predictable maintenance

Numerous world-wide acting companies aim for World Class Maintenance. The high standards in all corporate sectors lead to an improvement of all processes. These guidelines are also followed for the waterway infrastructure in the Netherlands.

There is a big demand for innovations for maintenance and infrastructure management. In the Fieldlab project "CAMINO", different parties are working together to develop applications to make maintenance of the water infrastructure 100 % predictable using sensors and data analysis. In the context of this project, the Dutch ministry "Rijkwaterstaat" and the project partner Mobilis TBI have initiated a pilot project in the lock complex in Eefde, to test and apply new or innovative technologies to get more insight into the condition of the lock itself, including its close environment. The purpose is to make maintenance of infrastructure works 100 % predictable.

*The lock in Eefde (Netherlands) was built in 1933 and is now extended by another lock chamber.*

Conventional solutions such as corrective and preventive maintenance activities are no longer sufficient. The challenge is just-in-time maintenance: just in time to prevent that something goes wrong, but not too early so that costs are reduced. This requires a smart approach: intelligent maintenance, for which new developments such as the use of sensor systems, data prediction models, big data and the Internet of Things (IoT) are used. ifm as provider of real-time maintenance solutions is one of the project partners.

All participants contribute with their know-how and experience in the fields of maintenance, monitoring and administration of water systems and structures, measurement and analysis techniques as well as data architecture and storage.

## Example: Lock in Eefde

The purpose of the project in Eefde is to develop a "smart lock" which automatically indicates the actual condition, analyses it by means of algorithms and automatically suggests improvements of the construction or the required maintenance.

**Ruben Ogink**, Fieldlab CAMINO Project Manager, World Class Maintenance comments: "*Sluis Eefde is a special project, during which, in my opinion, certainly many partners can learn. Special about this project in the context of Fieldlab CAMINO is not that there are many new technologies which are not used anywhere else, but rather the fact that existing technologies are integrated at one location. The partners can learn a lot from the application, but certainly also from the cooperation.The positive development of this project at the moment is already the fact that different partners from different disciplines such as government, commercial enterprises as well as scientific institutions such as a university work together. So there is investment for everyone to develop their own solutions. ifm is playing an important role in this project because they contribute a lot of knowledge of sensors, applications of these sensors in other industries and a lot of experience which can also be used in this context. And I am very happy with it.*"

> *ifm's involvement in this project is very important for us, as they contribute a lot of know-how and experience*

## Avoid failure

The lock in Eefde assumes an important function in the region. It is the entrance from the Ijssel to the Twente Canal. Many companies rely on the canal for transport. An unplanned interruption of the lock would cause considerable problems.

The lock was built in 1933. Rijkswaterstaat (the government authority responsible for the infrastructure) wants to have a better control of the maintenance of vital plants.

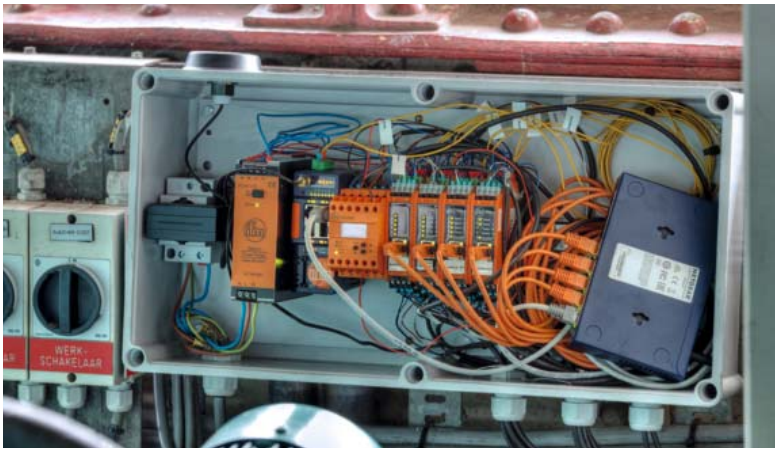
**Angelien van Boxtel**, Project Manager Rijkswaterstaat Netherlands, explains: *„We try to plan the maintenance of the lock as precisely as possible, so that shipping can prepare for it. In the event of sudden failures or unpredicted maintenance this would not be possible."*

## Permanent condition monitoring

To ensure smooth operation to open and close the lock and to avoid unplanned downtime, a condition-based maintenance solution was installed. In this respect, project partner ifm has installed a vibration diagnostic unit at the motors and gears of the lock gates. Imminent damage to the bearings leads to changed vibration characteristics. The sensors detect it and signal when threshold values have been reached. So the replacement of the components can be planned and made before a defect causes a sudden standstill.

**Ruud Schoenmakers**, Asset Manager Mobilis TBI, Netherlands explains: *"100 % predictability, that's what we want. This means that preventive or corrective maintenance is a matter of the past. We measure all data, to optimally plan and implement the required maintenance works. We call predictive maintenance when we*

*Two vibration sensors each, installed slightly shifted, permanently monitor the condition of the rotating bearings.*




*The VSE-type electronics for vibration evaluation, an ifm synchronisation monitor and the radio gateway to transfer the data to the control station, are installed in a space-saving control cabinet.*


*The power train to lift and lower the heavy lock gates. The condition of motors, shafts and gears is permanently monitored by means of vibration diagnostics.*

*measure data, collect data and get information from it to carry out maintenance at the right point of time. The right point of time is determined by a series of predictive and fixed, measurable factors such as the performance of objects, components and systems, failure characteristics, degradation behaviour, but also factors such as weather conditions, water levels and availability of staff as well as operating hours of the locks. On the basis of these measurable and objective factors, we can choose the optimum point of time for the maintenance to avoid unpleasant surprises."*

Before, there used to be regular maintenance. But this was expensive and could not completely minimise the risk of unplanned downtime. In addition, components the wear margin of which had not been completely used up yet, were replaced in case of doubt. That again caused unnecessarily high costs. With predictive maintenance, costs are minimised and operational reliability is maximised.

## No intervention in the existing plant

It was important to the operator to leave the historic lock complex unaffected. Therefore ifm has installed the solution without interfering with the plant or affecting operation in any way. Vibration diagnostics is, so to speak, "slipped over" the plant as an autonomous system.

**Ruben Boom**, Project Manager Smart Industry, ifm Netherlands, states: *"We have placed the sensors with solenoid on the housings of motors and gears instead of screwing them there via a thread to be bored. Because it was important to the customer not to make any changes to the existing machine. One of ifm's strengths is that we can comply with such special requests of our customers due to our experience and know-how of many years."*

Besides the vibration, the temperature of the plant and the humidity are determined by means of sensors and included in the condition assessment. The measured values and the alarms are transferred to the control station via the radio gateway where the data is evaluated and analysed. Moreover, the ifm DS2505 synchronous monitor monitors the left and right chain hoist at the lock gate.

## Conclusion

Vibration monitoring is only one small module in World Class Maintenance. However, on the basis of the acquired data it helps to better understand the processes, to optimise them and to use these findings for other projects in the future so that the water infrastructure becomes 100 % predictable and failures are avoided.

**Ruud Schoenmakers**: *"At this moment, TBI is building a new lock, in addition to the maintenance of the existing lock. We can use the things that we learn here, for the design and implementation of the new lock. Therefore, the findings we make here on the technical level have a great impact on new objects but also on the renovation task which comes from Rijkswaterstaat."*

This project of a "smart lock" shows how all partners benefit from each other and bring forward their own know-how.

# Increased safety, lower cost

**Intelligent driver assistance system for rear and loading areas.**

Modern side loader vehicles are used for waste disposal in an increasing number of cities. Especially during reversing and without a banksman, the driver needs technical support to safeguard the rear and loading area. With the smart 3D sensor, ifm offers a system that not only avoids collisions in the rear area, but also ensures monitoring of the lateral loading area.

Usually, a small team is on the road for emptying waste bins: Besides the driver, other people are busy placing the bins near the kerb and later on manually hook them to the gripper at the rear of the vehicle. To lower costs, the waste disposal company in Paderborn relies on side loader vehicles. The difference to conventional refuse vehicles: The gripper is located at the side instead of at the rear. The vehicle operator manoeuvres the refuse collector parallel to the pavement towards the bin which was placed there before by the residents. The gripper grabs the bin automatically, lifts it until emptying and replaces it automatically on the pavement. Advantage: Instead of several people, only one person, namely the driver, is required which saves personnel and keeps the waste disposal cost for the municipality and the residents at a low level.

**Abfallentsorgungs- und Stadtreinigungsbetrieb Paderborn (ASP) (waste management and city cleaning) is operated by the City Council of Paderborn and has approx. 150 employees.**


## Collision avoidance

This one-man operation is challenging when reversing, however, for example in dead-end streets: If so far one of the colleagues could act as a banksman, the driver is now on his own. Also the process of lateral loading of containers carries risks, caused by pedestrians, cyclists or simply curious children who could access the hazardous area.

Therefore a technical system was installed at the vehicles which is an alternative to the banksman and which is accepted as an alternative by the German Trade Association.

**Dietmar Regener, Dr.-Ing.,** Deputy Operations Manager, ASP Paderborn: *"The system can support our drivers during reversing, i.e. the driver is warned in time when somebody is approaching the vehicle. The big advantage of this system is that it does not only give warnings but that it even stops the vehicle if the driver does not react in time. Besides, the system offers another advantage: We do not only monitor the rear area but also the*

> *The O3M system from ifm predicts collisions and, if needed, may actively intervene with driving*

*Safe collision avoidance:*
*The arm of the side loader stops automatically if a person enters the hazardous area.*

*process of loading containers. And the situation is the same as for reversing, namely that the vehicle monitors the area, warns the driver and, if the driver does not react in time, stops the emptying process of the container so that a dangerous situation does not occur."*

## Smart 3D sensor for mobile applications from ifm

The O3M system from ifm predicts collisions and, if needed, may actively intervene with driving. The complete intelligence is integrated into the sensor housing and can be configured in a few steps via an easy-to-use operating software. So ifm offers a cost-optimised solution for more safety that can be used for different types of vehicles.

The core element of this system is an integrated 3D camera chip from the automation specialist ifm. It creates a 3D image by means of the PMD technology which provides an exact distance value for each image pixel.

This image information is evaluated by predefined algorithms in the smart 3D sensor.

On the basis of different parameters, the sensor can be set to different installation and operating situations. As soon as a collision is detected, the sensor provides the respective signals - optically as visualisation for the driver but also stop signals, for example to the vehicle controller.

## Conclusion

The smart 3D sensor is a stand-alone assistance system which supports the driver by reliably preventing collisions.

**Dietmar Regener, Dr.-Ing.**: "*We are now testing a system which has been in use for 3 months already. The first results are very good. Both we, the corporate management, and the drivers are convinced of the systems. The drivers say that it does not impair them in their work but, on the contrary, it supports them. Therefore we have now decided to buy another system for the second side loader and to use the system also for the other vehicles.".*

ifm provides a cost-optimised solution which assures automated reliability and also decreases personnel costs.

# Thoughts outside the box

**HeiVi AG, located in Switzerland, is specialised in the planning and project management of heating and air conditioning systems.**

**Cold storage management by means of "zero volumetric flow" control.**

To lower costs and energy consumption, the efficient operation of building maintenance systems is becoming more and more important. This means more than just optimum setting of operating times and temperatures. The building maintenance systems are always to be considered in their entirety. Coordination between the different systems is compulsory.

In the course of the reconstruction of the branch of the Schweizerische Nationalbank in Basel, the entire building maintenance systems were redesigned. The Swiss HeiVi AG was responsible for the planning and project management of the heating and air conditioning systems. The purpose was to reduce the energy consumption, the investment costs and the interfaces and to sustainably optimise the building maintenance.


*The magnetic-inductive flow meter SM6500 features high accuracy, repeatability and measurement dynamics.*

**Peter Heimann**, co-founder of HeiVi AG, states: *"As planners of demanding heating, ventilation, air-conditioning and cooling systems as well as sanitation facilities, we support architects, building owners and project developers with the implementation of new installations and optimisation processes. Since our target is to obtain maximum energy efficiency and economic efficiency with comfort and ease for our customers, we represent innovative planning in the field of building automation. To achieve this, we often have to think outside the box."*

## Home-made wastefulness

**Figure 1** shows the conventional operating principle of the chiller with a performance-controlled compressor. The chiller compressor (M01) controls the temperature of the cold water outlet (B01). The storage charging pump (M02) supplies a constant quantity of water via the cold storage. Two probes in the storage control switch-on and switch-off of the chiller. A storage discharge pump (M03) then supplies the cold water to the consumers.

Since the storage discharge pump (M03) is controlled via the differential pressure of the consumers, the pump only transports the water quantity which the system actually requires. The result: In turndown operation, the charge mass flow is always much higher than the discharge mass flow. Due to the constant mass flow supplying the chiller, the compressor reduces its capacity only in the discharge operation. Fact is that the advantages of the performance-controlled compressor cannot be used.

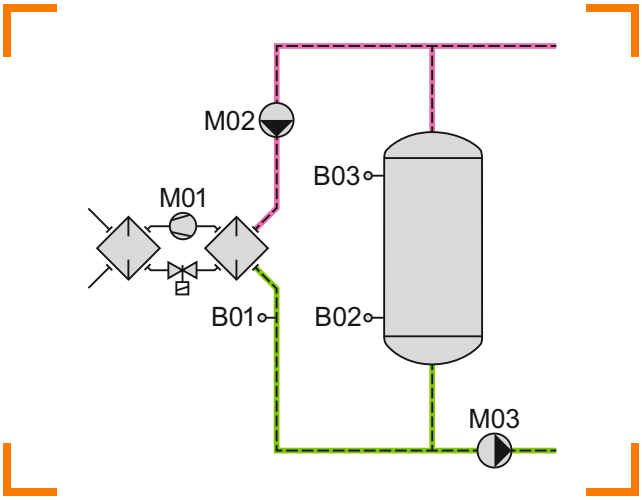



*Figure 1:*
*Conventional model, storage tank charging without ifm sensors*

*Always on board: the sensors from ifm.*

## "Thinking outside the box"

*"We have asked ourselves",* says **Heimann**, *"if the storage charging pump and thus also the compressor can be controlled according to the demand to optimise the process." This is a case of "thinking outside the box". "During this process we came across the modules from ifm",* continues Heimann.

By means of the ifm volumetric flow sensors of type SM6500, the cold storage is controlled to "zero volumetric flow". The storage charging pump is newly integrated into the system. The storage charging pump (M02) controls the difference between storage charge mass flow (G01) and storage discharge mass flow (G02). The storage charge mass flow should, however, be five to ten percent higher than the storage discharge mass flow. In addition, it has to be ensured that the mass flow of the chiller does not drop below the minimum level.

With the "zero volumetric flow" control by means of ifm flow meters, there are numerous advantages. The compressor works in the turndown operation and the performance control of the compressor is fully used. That means lower energy consumption. The energy consumption is minimised by high inlet temperatures in the chiller. Consequently, the chiller can be of smaller dimensions which reduces investment costs. There is additional savings potential because the storage charging pump (M02) in the model **(see Figure 2)** consumes less energy.

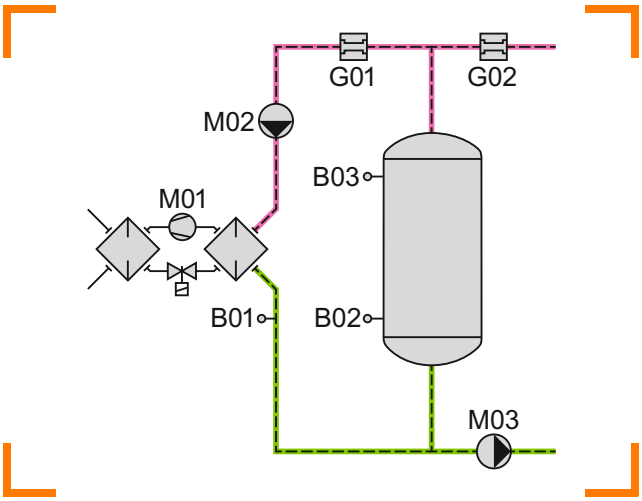



*Figure 2: Model storage charging with ifm sensors.*

## No thermometer needed

Besides the SM6500 flow meters, the branch in Gundelfingen also uses the TD2237 temperature sensors from ifm. As compared to conventional temperature sensors, they feature a digital temperature display. Therefore an additional thermometer is no longer needed. Apart from the fact that the ifm sensors measure quickly and precisely, their digital display facilitates set-up and operation optimisation. Faults in the circuit can be detected at once and be immediately eliminated.

*The TD2237 temperature transmitter is distinguished by its short response time and its display.*

## Conclusion

Success confirms Heimann: By now, HeiVi AG have equipped several branches of the Basel Kantonalbank, Cler Bank in St. Gallen and the laboratory of the Baugewerbliche Berufsschule at Zurich with the new process. Always on board: the sensors from ifm.


# For optimum temperatures in your processes

WARRANTY 5 years on ifm products

## Modular or all-in-one

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# Precise **guidance**

**ifm ecomatic in Kressbronn, a subsidiary of the ifm group of companies, is specialised in the development, production and distribution of control and evaluation systems.**

**Sensors monitor the application of 2-component media.**

The heat-conductive paste is exactly dosed to the millimetre and applied onto a PCB. The bonding agent is injected into the housing joint with the same precision, before it is glued while well-dosed pressure is applied. Different sensors ensure continuously high production quality.


A production plant at ifm in Kressbronn. This is where the new ecomat controllers of the third generation are produced. These controllers for mobile use have to withstand strong stress under adverse environmental conditions, such as in mobile machines where they are exposed to vibrations and moisture. This means special requirements on the production process.

*"We had to install a new production system so that we can manufacture the product", says* Lothar Gschwind, Industrial Engineer at ifm ecomatic in Kressbronn.

The system comprises four production processes: During the gluing process, a 2-component glue is injected in the

*The 2-component media in the mixer are monitored for temperature and level.*

*Application of the 2-component heat-conductive paste onto the PCB.*

*Cylinder sensors precisely monitor the end positions of the piston through the cylinder wall.*

groove along the housing rim and permanently bonds the two housing parts when they are pressed against each other. This ensures ingress resistance according to the protection rating IP 67. Then follows the joining process, which is also carried out automatically to avoid errors caused by manual production. In a third step, the heat-conductive paste is applied onto the PCB. A 2-component heat-conductive paste is precisely applied onto the heat-producing components of the PCB. It bonds with the aluminium die-cast housing which, in turn, dissipates the heat. Finally, the housing is screwed.

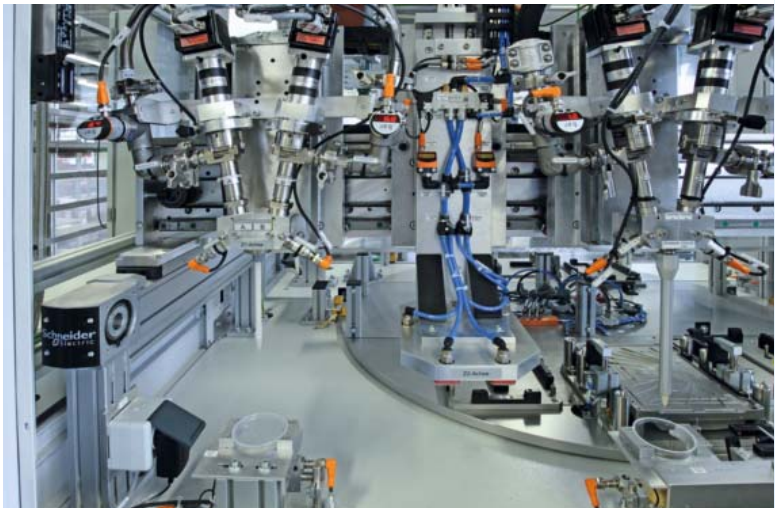
## Three companies in cooperation

The specially developed system is the result of cooperation of three companies: The company Fichter Maschinenbau from Eichstetten am Kaiserstuhl has built the system. The company Viscotec from Töging am Inn has specialised on the supply of the 2-component media – here the glue and the heat-conductive paste. And ifm is not only the originator and operator of the system but also the manufacturer of the installed sensors.

**Martin Baumann** from Fichter Maschinen: "*Here we have designed a machine for the company ifm which*

> *We have designed a machine for the company ifm which carries out various joining processes and two dosing processes for two 2-component materials.*

*In this system, heat-conductive paste and sealing compound are applied and the product passes through the final joining process.*



*Different sensors monitor pressures, temperatures and positions on the system.*

*carries out various joining processes and two dosing processes for two 2-component materials. The heat-conductive paste we use here is of very high viscosity and we had to try hard, in cooperation with the company Viscotec, to provide the dosing pumps with enough material."*

**Rolf Aberle** from Viscotec explains the special requirements this project has on his company: *"We deal with the removal of the materials from the delivery container, the supply, and, if applicable, the treatment up to the dosing head. There is a container pumping system which fills the material from the container into the supply tank via a vacuum and then supplies the material, under controlled pressure, to the dosing head. During this process, level sensors are used for monitoring tasks. Imagine the 2-component glues as below: The two media are homogeneously mixed in a static mixer. The 2-component heat-conductive paste is supplied to the 2-component mixing head via two separate supply lines. The media are homogeneously mixed by means of a static mixing head and then applied onto the PCB."*

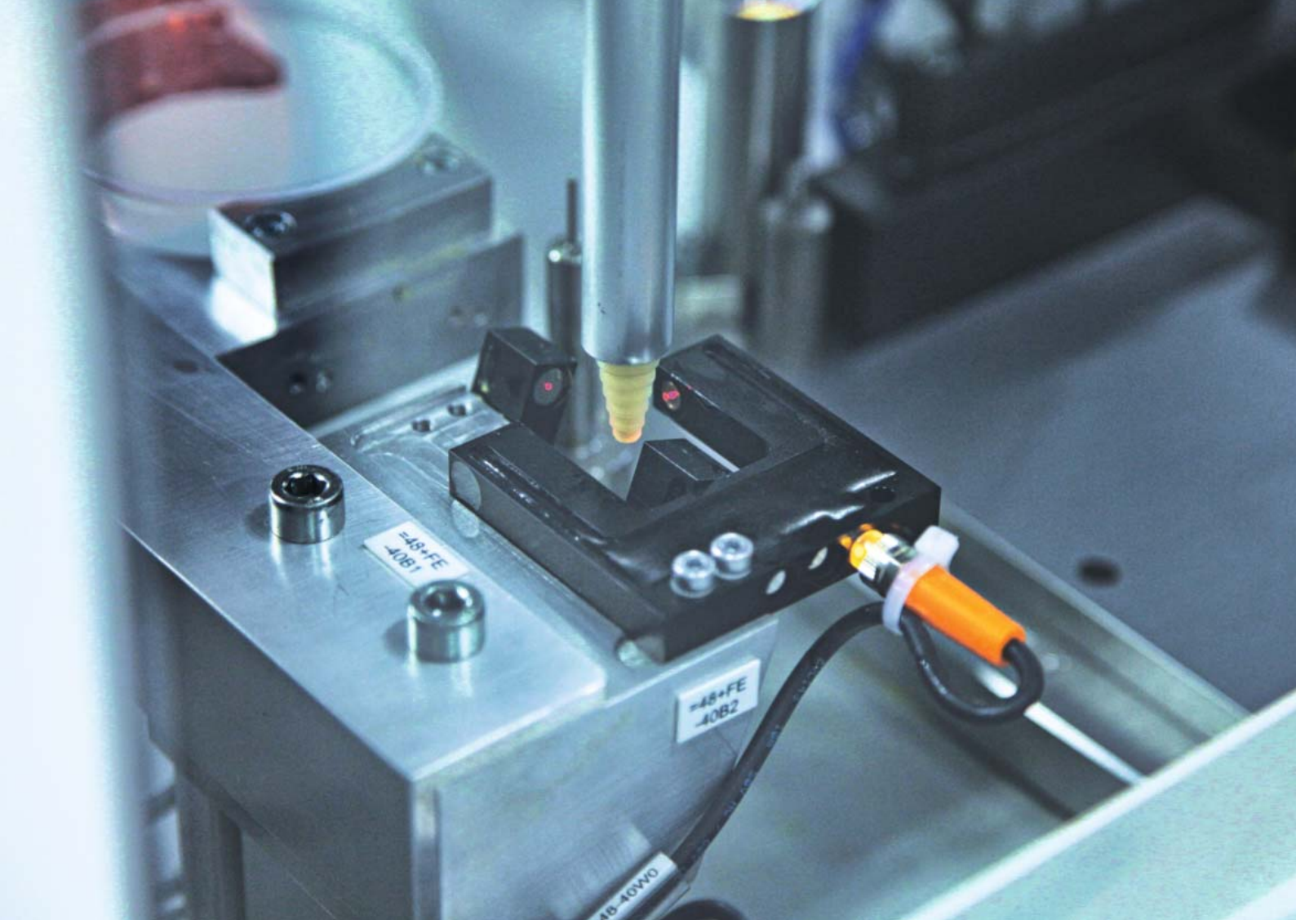
**Lothar Geschwind** from ifm adds: "*This procedure had to be developed so that process safety is ensured, that nothing goes wrong because the automatic system join certain parts and that in the end no reject parts are produced which would cause unnecessarily high production costs."*

## Efficient sensors

To monitor the complex production process, different sensors from ifm are used.

Numerous ifm PN-type pressure sensors in various pipes precisely monitor the supply of the 2-component media by means of pressure measurement. This ensures a continuously perfect mixing ratio. The ceramic measuring cell of the sensors is long-term stable and overload protected. This ensures continuous product quality, even when pressure peaks occur.

The PQ-type pressure sensors are integrated in the supply lines of the different pneumatically-controlled arms




*Two photoelectric fork sensors with fine light beam during the reference movement of the fine nozzle.*

and grippers. They detect deviations from the intended operating pressure so that the system can be stopped at once. Expensive scrap is avoided. The two-colour LED display does not only clearly indicate the measured value on site, but the colour change (green/red) accurately visualises the operating status.

The end positions of the pneumatic cylinders are precisely detected by means of ifm cylinder sensors and transmitted to the controller via a switching signal.

Two photoelectric fork sensors with a fine light beam help reference the fine nozzle applying the glue. The needle of the nozzle is moved until it hits the point of intersection of the two light beams where the X and Y axes meet. The starting position is set. The area of application of photoelectric fork and angle sensors is the detection of very small parts. An advantage of photoelectric fork or angle sensors is that transmitting and receiving elements are always perfectly aligned towards each other which is owed to the design. Maladjustment of the fine light beam is almost impossible.

LMT-type level sensors are installed on the tank to monitor the contents. They are suited both for liquid and viscous media. Special feature: They reliably suppress deposits or foam. This ensures precise level detection, even with difficult media.

Moreover, numerous inductive and photoelectric sensors are used for position detection of arms, flaps or other moving elements.

In short: ifm offers a complete range of high-performance sensors for ideal process monitoring.

## Conclusion

The perfect teamwork of the companies Fichter, Viscotec and ifm shows how demanding application requirements are reliably and efficiently implemented on a compact production machine.

# On a perfect level

**Pressure sensors for aseptic level measurement.**

The hydrostatic level detection in tanks is not new. Use in a hygienically demanding environment or even for aseptic processing of viscous media is particularly challenging. The pressure sensors from ifm provide exact measured values even under these adverse conditions. They are a clever alternative to commonly used rod probes or float ball technology.

We are visiting a specialist in the field of aseptic process technology in Kirchberg, Switzerland. In the 80s, they started to build filling stations for dairies, beverages and food mainly for their own needs, but also for OEMs (original equipment manufacturer).

Since April 2012, the company has been part of an international group which is one of the biggest system providers for the food-processing industry with 19,000 employees and an annual turnover of about EUR 5 billion. Together with the parent company, the entire product range in the field of valve technology is covered.

## Leading specialist in aseptic technology

Aseptic process technology is a field in which absolute precision and reliability are imperative. Highly-sensitive products such as baby food, dairy produce or clinical products are processed using aseptic valves. For this reason, the high quality of the systems and components is very important. *"Right from the start, we specialised on the aseptic process technology and have developed products suited for exactly this area with its special requirements,"* emphasises the **managing director** of the company.

PI27

*"Since we started using ifm sensors, we have not experienced any production losses any more*

*A pressure sensor on the tank bottom measures the hydrostatic pressure. Based on this, the precise level can be determined.*

*"Owing to the very special requirements, we constantly have to develop special solutions which we use for further development."*

## From the valve to the system solution

The company mainly develops and produces aseptic valves for process systems which are used above all in the food industry. The valves are used, for example, in ultra-heat treatment of milk and other dairy produce. According to the managing directors, the solutions are distinguished by functionality, long-life quality and user-friendly operation.

Moreover, the company also provides system solutions in the field of aseptic filling systems, for example for fully aseptic filling of intermediate bulk containers with a capacity of up to 1,000 litres.

## Alternative to the rod probe

Extraordinarily high demands on function, design and characteristics apply to components which are used in sterile or aseptic processes. When it comes to the subject of level measurement in containers for filling systems, specialists often criticise that the frequently used level measurement by means of rod probes or float ball technology is not reliable enough, susceptible to failure and cleaning of such systems is often only possible with complex, highly-hygienic processes. They were looking for a solution providing significantly better values with respect to measurement accuracy, hygiene and reliability. This solution was found with the PI27-type pressure sensor from ifm.

## Pressure sensor for hygienic areas

It is a full-metal pressure sensor with display. The measuring cell is installed flush without dead space. Deposits are prevented and optimum cleaning is possible.

It consists of high-purity ceramics (99.9 % $Al_2O_3$). The other materials in contact with the medium are PTFE and stainless steel 1.4435/316L. Together with the surface characteristics of RA < 0.4 / RZ4, the sensor meets all requirements for aseptic applications.

Thanks to the high protection rating IP 68/69K, the hygienic design and the high temperature resistance, the sensor is also resistant to high-pressure cleaning with

*Pressure sensors of the PI27 series have a robust stainless steel housing and are resistant to high-pressure cleaning with aggressive cleaning agents.*

> *We do not use any rod probes any more*

aggressive cleaning agents common in the food, beverage and pharmaceutical industries.

The parameters are set via the buttons on the sensor. The highly visible display, combined with a user-friendly interface, enables fast and easy set-up.

The units feature two switching outputs which can be programmed as normally open or normally closed. To provide the measured value, one switching output can also be configured as a scalable analogue output.

Moreover, the sensor has an IO-Link interface. It permits external parameter setting or digital measured value transfer. Sensor diagnostics via IO-Link is also possible. This provides additional reliability in application monitoring.

The G1 Aseptoflex Vario process connection with four sealing options and, if required, different adapters, is used for the connection to the process.

IO-Link

## Maximum reliability

*"In principle, it is a pressure measuring device",* reports the **managing director** of the company and he explains *"but we measure very exact levels with it."*

Since the level has to be exactly maintained, the consequences would be very serious if measurement were not precise. It is important that there is neither overfill nor underfill which occur quite often when rod probes are used. *"When the system has to be refilled and cleaned, you have to account for a loss of time of at least four hours. That means a production loss of half a day. Since we use ifm sensors, we have not had these problems any more",* adds the **managing director.**

In addition, the considerably lower investment sum for an ifm pressure sensor as compared to common rod probes, the five-year warranty and ready-to-work functionality of the modules is emphasised.

*"We do not use any rod probes any more",* he concludes at the end of the visit.

*The high-purity ceramic measuring cell is installed flush without dead space and meets the requirements for aseptic applications.*


# IO-Link – we connect you!

WARRANTY 5 years on ifm products

## More functions: Smart IO-Link sensors from ifm

IO-Link devices protect against tampering, transmit the measured value as a digital value, ensure easy replacement without parameterisation on site, and are available without surcharge. You see, there are many reasons for using IO-Link sensors.
ifm as the technology leader for IO-Link offers the highest number of smart sensors with IO-Link in the market. Take the right step into an innovative future and benefit from the many years of experience which have set benchmarks in functionality and service.
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# Collision avoidance in reverse gear

*Automatic collision avoidance: 3D camera at the rear automatically warns of obstacles and possible collisions.*

**Container handling on ships, trains and HGVs: Duisburg Intermodal Terminal (DIT) in Duisburg-Rheinhausen.**

## 3D sensors:
## Safe manoeuvring instead of colliding

Gigantic, weighing dozens of tons and confusing: In all container ports worldwide reach stackers are used to stack and handle containers. To avoid collision within the container terminals during narrow and rapid manoeuvring ifm electronic offers automatic collision avoidance: A 3D camera at the rear monitors the rear area, detects objects in the travel path and warns the driver of possible collision.

The driver's eyes look straight ahead when moving the 14 m wide and up to 40 ton containers attached to booms through the narrow container stacks. Even when manoeuvring in reverse the driver must keep an eye on the transverse container to avoid hitting the containers stacked on top of each other like a wall.

Again and again this brings about critical situations, for example when two reach stackers move towards each other while being manoeuvred in reverse, when trucks cross the way or objects or people are in the manoeuvring range. With an ordinary rear view camera the driver can look behind but such a camera is passive, i.e. it does not warn in critical situations.

### ■ Automatic collision avoidance

ifm's O3M camera provides active protection: The integrated 3D sensor not only displays obstacles behind the vehicle on a screen in the cockpit but also determines the obstacle's size, position and movement, if any. Based on this detection of the environment and the reach stacker's own movement the O3M system assesses the critical relevance of objects. It warns the driver of the obstacles that are in the path or on a collision course. This prevents

*ifm offers a cost-optimised solution for more safety (not only) in port logistics*

the driver from being irritated by too many warnings of objects in non-critical areas. Another advantage of the intelligent O3M system is that if another vehicle moves into the travel path from the side the, risk is detected much faster than with a distance-based warning.

## Camera image with overlaid 3D objects

The O3M system has two integrated cameras:
A conventional 2D camera and a 3D camera that determines the exact distance to each pixel.

The advantage for the user: Detected objects are highlighted in colour in the produced 2D image. Critical obstacles can be highlighted, for example, in red, less critical objects in yellow or green. Furthermore, an additional warning symbol can be provided in this case.

This overlay is completely generated in the O3M – so neither additional hardware nor complex set-up or programming is needed. Visualisation can be easily and conveniently adapted to the application conditions with the ifm "Vision Assistant" software (colour, symbols, language, etc.).

## Graded warnings

Parallel to the visual representation, a warning is transmitted to the CAN bus which is used to produce an additional acoustic signal or even to intervene with braking.

This reaction can be graded depending on the distance to the obstacle, i.e. at first an acoustic and visual warning is given. If the driver does not react and the situation becomes more critical, the vehicle can brake gently.

*Example for a critical situation because of a moving object.*

*Challenge when reversing: Keep an eye on the container ahead, watch traffic behind.*

*The O3M system has two integrated cameras: A conventional 2D camera and a 3D camera that determines the exact distance to each pixel*

## Example for a graded reaction

The integrated PMD 3D chip from ifm detects scenes and objects three-dimensionally with only one image capture. This avoids the motion blur that can occur with line scanners. ifm's award-winning patented PMD technology forms the basis for a sensor system that can cope with the harsh operating conditions of mobile machines.
Besides the robust and compact design the O3M sensor system is specially designed for outdoor applications with changing light conditions or bright sunlight.
The ifm 3D sensor has no moving components in contrast to other sensors such as laser scanners. Therefore it is particularly robust and not subject to wear. The operating principle of the PMD technology is based on the time-of-flight principle. The scene is illuminated by modulated, invisible infrared light and the reflected light hits the PMD sensor. This sensor is also connected to the source of modulation. Each pixel of the PMD chip determines the distances to the scene due to the phase shift between the transmitted and the received signal.
The integrated, active suppression of background illumination almost completely prevents saturation of the image sensor by extraneous light. That means that the PMD 3D sensor can be operated in bright sunlight up to 120 klx. The integrated 2 x 32-bit processor architecture ensures rapid and reliable calculation of the 3D data directly in the system with up to 50 images per second.

## Smart functions

The mobile 3D smart sensors feature some integrated evaluation functions which besides the collision avoidance described here, enable a multitude of other applications to be solved, e.g. line guidance or area monitoring. A highly developed algorithm from the automotive industry is used, ensuring reliable automatic object recognition of up to 20 objects.

In just a few steps the parameters of the system are set via the easy-to-use "ifm Vision Assistant" for Windows. To do so the user only needs to enter some parameters, e.g. regarding the vehicle's geometry. Usually this set-up only takes a couple of minutes and the system is then ready for operation.

## Communication interfaces

The preprocessed function data is output via the CAN bus using CANopen or SAE J 1939. If needed, the complete 3D information can be processed via Ethernet UDP and an external process unit. This provides developers with an open system.

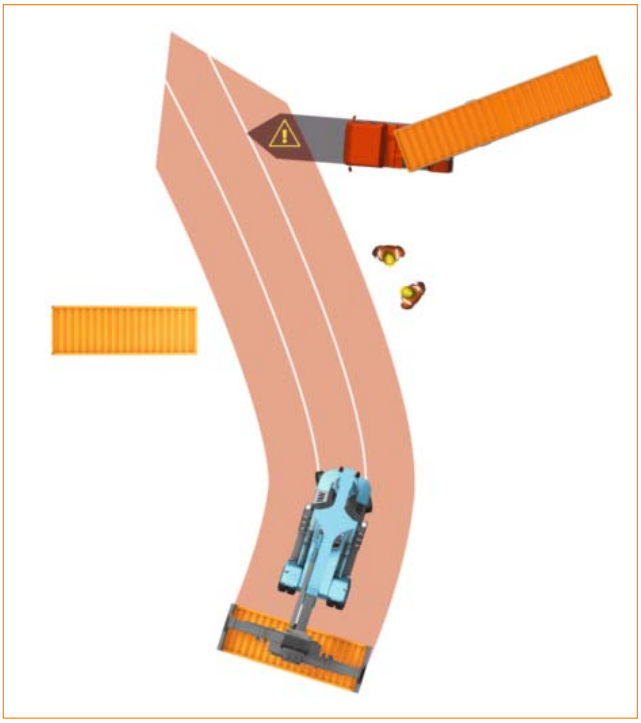
*Critical objects are marked in the camera image.*


*Camera image with a clear warning in the event of objects on a collision course.*

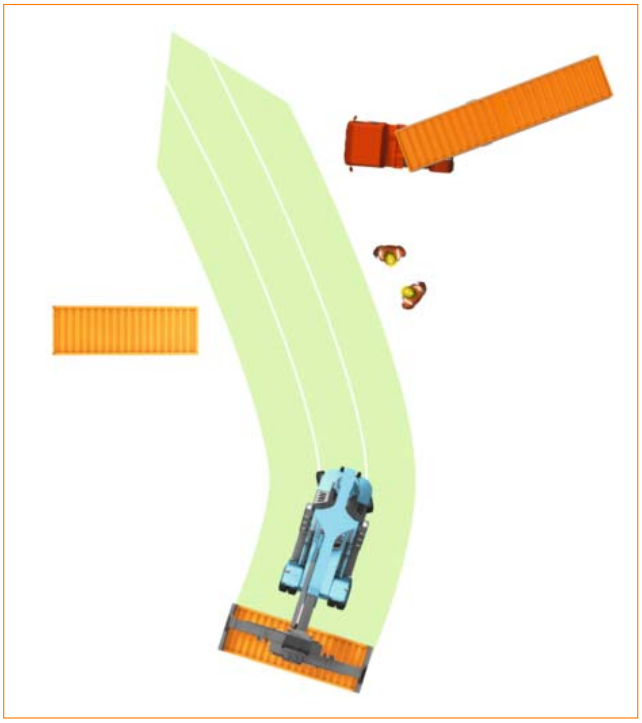
*O3M system: 3D camera (right) and infrared illumination unit (left).*

## Conclusion

The O3M system is a stand-alone assistance system for mobile use which predicts collisions and, if needed, may actively intervene with driving. The complete "intelligence" is integrated into the compact sensor housing. Parameters are set in a few steps via easy-to-use operating software. Therefore the system can be used for different types of vehicles. So ifm offers a cost-optimised solution for more safety (not only) in port logistics.



*Example for a critical situation because of a moving object.*



*Example for a non-critical situation in a curve.*

# Precise photoelectric sensors for perfect edges

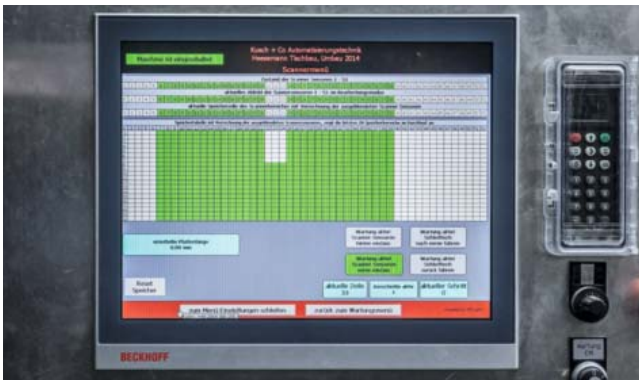
**The medium-sized enterprise Kusch+Co from Hallenberg, Sauerland, is a manufacturer of design-oriented seating and tables for furnishings. The furniture can be found in numerous international architectural objects worldwide. In the field of airport seating Kusch+Co is one of the worldwide leaders furnishing waiting areas in more than 200 international airports.**


*53 lowerable pressure shoe segments adapt to the surface of the workpiece geometry during sanding. That avoids undesired rounded sanding edges.*

## Optical contour detection

High-performance diffuse reflection sensors are used for contour detection during the processing of veneer top surfaces thus ensuring highest quality during the sanding process.

*The high-performance photoelectric sensors of the O6 design ensure optimum sanding results*



*The controller receives an image of the workpiece from the sensors and controls the lowering of the individual sanding segments.*

One of the numerous processing steps during the manufacture of furniture is smoothing and levelling of veneer surfaces. A sanding machine from the company Heesemann optimised by Kusch+Co is used for large furniture panels such as table tops for conference tables.

The challenge during the sanding process: The edges of both the outer ends and the cut-outs of the high-quality veneer must not be rounded by sanding. Therefore no pressure must be applied by the sanding shoe segments where there is no veneer underneath. For this reason the contour and cut-outs of the workpiece, if any, are detected during each cycle and transferred to the controller.

## Sensor replaces mechanics

The problem of this longitudinal sanding machine used to be the scanning of table tops because this scanning was effected by mechanical switches. The table top was detected via levers with rollers and evaluated by an old PLC. The PLC inputs only require a small current of approx. 1 mA. There used to be problems with the switching contacts of the mechanical switches since they did not switch reliably when the contacts were worn away in the course of time. Another big problem was the detection by the rollers. The sanding dust took its toll on the rollers' bearings thus causing the rollers to fail more and more often.

The rollers caused stress marks on the veneer so that the table top could no longer be used. So they were looking for a solution using non-contact detection without mechanical switches. The technical service at Kusch+Co found it from their long-standing supplier, ifm electronic. The company ifm provided its diffuse reflection sensors of the O6 design free of charge and after tests such as the reaction of the diffuse reflection sensors to dust and to the different colours of the veneers, showed that the sensor met all required criteria.
In this context the PLC was also completely updated and the sensing of the diffuse reflection sensors was visualised on a 19" display to show any wrong detection at an early stage.

## Optical contour detection

Now 51 compact ifm diffuse reflection sensors of the O6 design detect the contour and cut-outs of the furniture panel from the front and another 51 from the back, both when the panel is moved forward and backwards underneath the sanding belt. Depending on the workpiece geometry and the individual cut-outs they control the up and down movements of the individual pressure shoe segments via a PLC. This avoids excessive pressure on the edges caused by the neighbouring pressure shoe segments. The result are precise, right-angled edges.

The requirements on the photoelectric sensors that are aligned like a scanner strip are high: Different veneers with light, dark, matt or glossy top surfaces have to be reliably verified without the sensors having to be readjusted. Simultaneously the background, i.e. the contact area, has to be suppressed. Depending on the thickness of the furniture panel this means a range of a few millimetres. Therefore sensors with precise background suppression are required.

## Small photoelectric sensors with high performance

The sensor specialist from Essen supplies the suitable sensors – its diffuse reflection sensors of the O6 design. The O6H201 diffuse reflection sensors feature an adjustable range from 2 to 200 mm. The maximum range is colour-independent. It applies, for example, both to white surfaces with 90 % remission and black surfaces with just 6 % remission. Readjustment for surfaces of different reflectivity is not necessary for these ifm sensors.

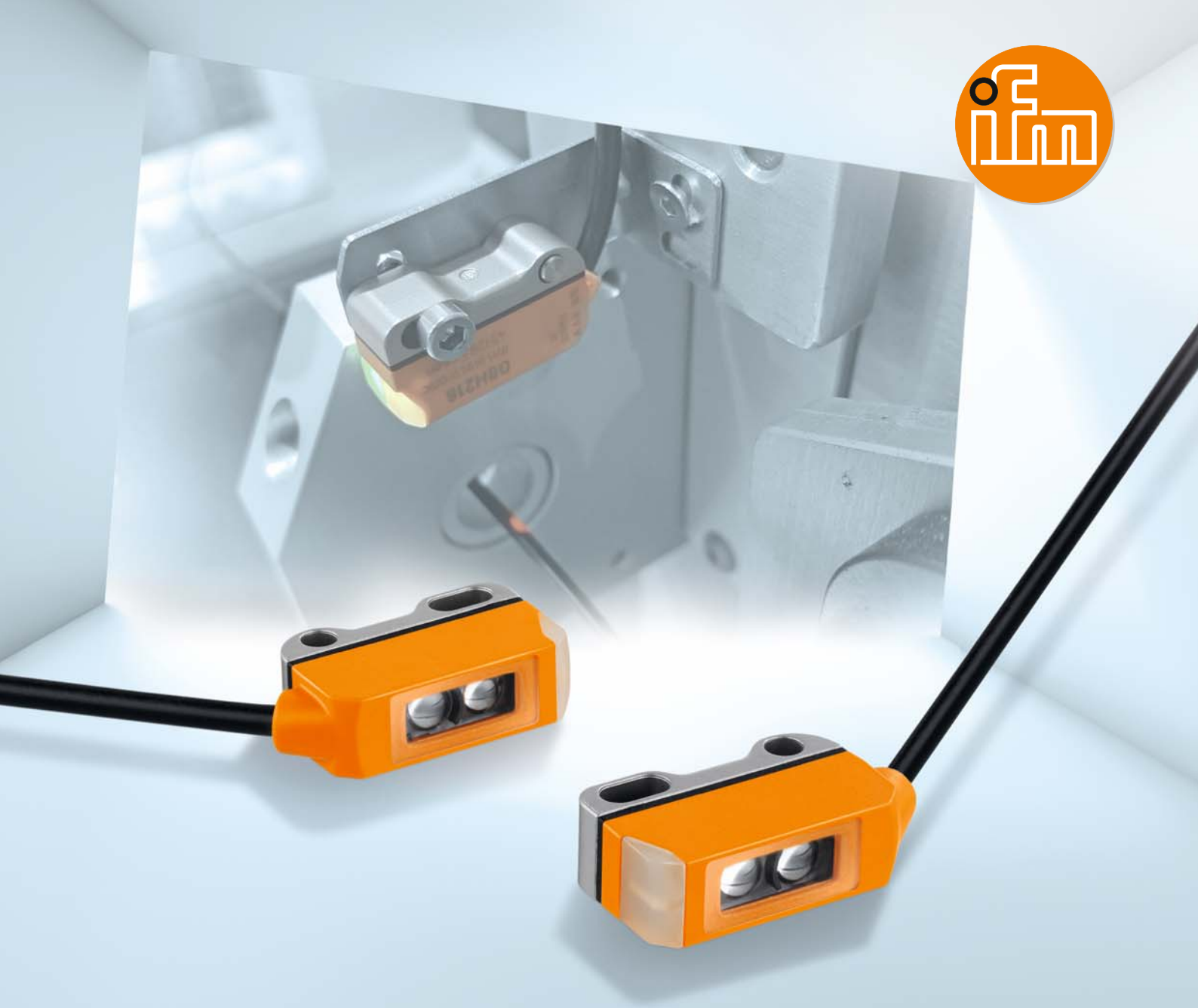
The diffuse reflection sensors suppress background interference effectively. Depending on the distance and the degree of remission of the object surface distances of only a few millimetres can be reliably differentiated. In addition the background suppression is extremely interference immune: Even highly reflective backgrounds such as stainless steel or reflections caused by moving machine parts do not influence the detection.

The clearly limited round light spot of only 8 mm diameter (at maximum range) provides a homogeneous light distribution in the light cone. Scattered light around the light spot potentially disturbing other photoelectric sensors due to reflections is avoided. This ensures additional reliability in particular in this application where the sensors are mounted closely to each other.

## Conclusion

The high-performance photoelectric sensors of the O6 design ensure optimum sanding results – a perfect example of two leaders on the worldwide market combining their competences.

*O6 miniature photoelectric sensors with high-performance. Setting of ranges via potentiometer and a rotary switch is intuitive and simple (light-on / dark-on selection).*



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# Permanent vibration diagnostics

*Sensors allow vibration diagnostics in places that you could never access during operation for safety reasons.*

**With an annual output of about 765 million litres the Hassia group is one of Germany's largest mineral springs offering mineral waters and non-alcohol beverages in the upper price classes with various subsidiaries and brands. In the parent plant in Bad Vilbel, Hesse, alone there are six filling stations parallel in three-shift operation.**

**Permanent vibration diagnostics in mineral water bottling**

To avoid unplanned machine downtimes Hassia Mineralquellen rely on permanent electronic vibration diagnostics in bottle filling. The investment already paid off in the pilot phase: Imminent damage to a drive was detected in time and eliminated. Unplanned downtime could thus be prevented.

High-performance drives transport the bottles across several hundreds of metres through the individual stations – from rinser, filler, capper, labelling to packaging and dispatch.

When the bottles pass from one conveyor belt to the next and when bottles touch the guide rail and each other, these stress points add up – via hundreds of bottles – to strong irregular vibration at the drive. Therefore the bearings on the gear and motor have to be monitored to predict the wear limit in time so that maintenance can be carried out.

## Manual detection of sounds

A common method to monitor vibration characteristics is the manual, acoustic detection of sounds using a stethoscope.

**Gerhard Simon,** Maintenance Manager at Hassia Mineralquellen, says: *"In the past we used to monitor manually. A person was sent to the machine to listen to the sound of its motor. That was, however, a rather subjective feeling. Three people listening to the drive, motor or gear feel completely different things. This manual listening has one decisive disadvantage: There are never the same operating states when listening three times. I must listen to the machine when it is rotating, but I cannot do it during the filling process, e.g. filler / rinser areas, for microbiological reasons: You cannot enter this clean room during filling. That means you can only do it at the weekend when there is no filling. During idling operation there is, however, a different vibration characteristic. And then there are areas, for example at the labelling machine, where drive shafts are running, where the motors and gears are very close to each other. You can't get in there when it's running."*

## Electronic vibration diagnostics

There was urgent need for another solution for machine diagnostics. The automation and sensor specialist ifm offers vibration diagnostic systems under the name "efector 800". Quickly a meeting was agreed.

**Gerhard Simon:** *"We have decided to make first tests with the electronic vibration diagnostics on one of our returnable PET bottle plants. Some machines such as Spiragrip, the machine cleaning machine, de-labelling machine, decapper and the filler-rinser area were equipped with the sensors."*

*Sensors detect in time that the wear limit on the motor and gearbox has been reached.*

> *In the beverage industry we are probably the first bottling plant that has started to work with the ifm vibration diagnostics*

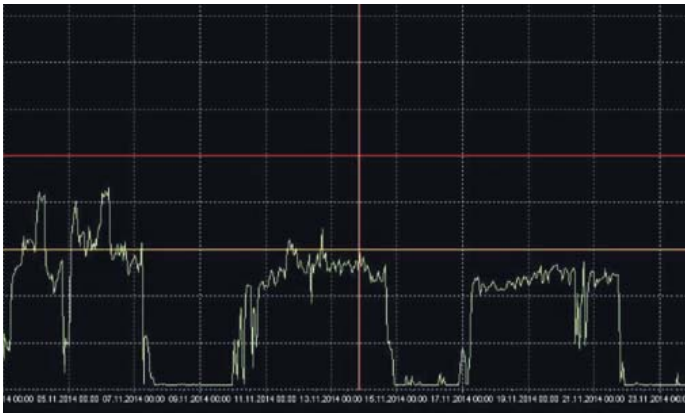
The system consists of type VSA001 vibration sensors and type VSE100 evaluation units.

The cylindrical sensors are screwed directly into the motor or gearbox via bore holes. They continuously detect vibration on non-rotating machine surfaces.

They operate according to the capacitive measuring principle and are free from saturation and tribo-electrical noise interference thanks to their special microelectro-mechanical design (MEMS). An integrated self-test provides additional protection.

The type VSE evaluation unit monitors up to 32 accelerometers (objects) on up to 4 different measurement points where a type VSA vibration pick-up is installed.

*The vibration characteristics can be visualised on the PC in the control room; furthermore the operator can set limits (yellow and red lines for pre-alarm and main alarm).*



*Vibration sensors on the drives detect even smallest vibrations.*


The pre-alarm and main alarm are provided via switching outputs and, as is the case at Hassia, via light indicators. The evaluation unit communicates for example with the machine controller or the process control level via Ethernet TCP/IP.

Gerhard Simon: *"Here I have a value-free system where I can define my own limits and say "OK that is my level, I do not want to exceed it, there I must intervene and make some mechanical improvement, for example by lubrication or replacement of components". Before this was not possible."*

## Crucial test passed

Shortly after installation the vibration diagnostics was already successful in a major challenge.

*"After just a few weeks we had first successes when an imminent plant downtime was detected by the vibration diagnostics on the basis of a mechanical disturbance value. We could make a repair in time thus preventing a plant failure. The yellow light indicators signalled a pre-alarm. Then the machine was thoroughly inspected at the weekend and it was found that a bearing had increased tolerances at a transfer starwheel where the bottles are transferred from the rinser to the filler and also a shaft that drives the rinser and the capper block was off-centre causing vibration in the entire system. We could repair these sources of interference thus preventing an unplanned stop in the middle of production which would have had fatal consequences in a 3-shift operation and meant immense cost."* said Gerhard Simon.

*The VSE100 evaluation unit evaluates the signals from up to four vibration sensors.*

## Full protection

Besides local display of the vibration status by indicator lights the evaluation unit can also be networked with the control desk via Ethernet TCP/IP.

Here Hassia plan a further extension of their plant.

Maintenance Manager **Simon**: *"At the moment only one single line is networked through to a staff working station. We will gradually extend this. The other three lines are at present monitored by operators who inform the maintenance staff about a yellow pre-alarm or a red main alarm displayed on the indicator lights. Then we can react in time. But the system is being gradually extended. The goal is that we in maintenance can permanently monitor the live state of our systems. So far we have been monitoring four machines in our pilot plant.*

*In the future we want to monitor the entire plant by means of vibration diagnostics and to document what had to be replaced in what kind of damage event so that the plant can be further optimised, if necessary. We also want to record the cost to prove that the investment into the diagnostic system has paid off. I have many more ideas for the system: We have numerous pumps in such plants that should be monitored and very many subsystems and auxiliary drive systems that could be monitored to be able to intervene any time before a standstill is about to occur."*

*Visual status monitoring on site:*
*The light indicators for "pre-alarm" and "main alarm".*


*Gerhard Simon, Maintenance Manager at Hassia Mineralquellen in Bad Vilbel.*

## Pioneer praised

The decision to secure process reliability by means of permanent vibration diagnostics was particularly pointed out at the annual IFS (International Featured Standards) audit, a certification common in the food industry.

**Gerhard Simon:** *"In the beverage industry we are probably the first bottling plant that has started to work with the ifm vibration diagnostics. The final report particularly mentioned that in maintenance we are starting with monitoring such systems in the plant which logically has effects on the product safety. Because if they have a standstill in their plant this plant has to be emptied. This emptying process is necessary to avoid germs in cleaned bottles that are standing on the belts in case of repair or germs in the clean room should work be carried out there. This means that a repair that only takes 30 minutes can cause a standstill of up to 2 hours. This would entail unnecessary costs."*

## Conclusion

The wear of machine parts cannot be prevented. Permanent vibration diagnostics, however, ensures that such damage is reliably detected in time. Maintenance can now be planned. Expensive plant downtime can be prevented with comparably little investment which in the end has positive effects on the product quality.

# Diagnostics in the body shop

**Sensors allow condition-based maintenance**

In the body shop the body is assembled from pressed steel parts with the help of welding robots. Each body must pass along a 100 m production line. A critical spot because a standstill here would stop the whole production.

Therefore IVECO have installed a comprehensive diagnostic system together with the ifm automation specialist allowing condition-based maintenance thus effectively preventing unintended production losses.

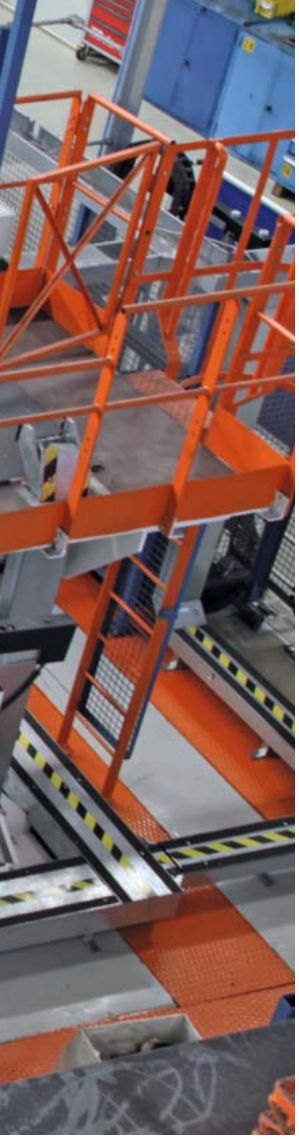
**IVECO is a worldwide manufacturer of for example trucks and utility vehicles.**
**In the Suzarra works near Mantua in northern Italy 250 "Daily" vans roll the assembly line every day.**

An initial analysis was carried out to determine which parts were most susceptible to mechanical wear and failure. Conveyors or lifting platforms: or more precisely on their bearings is where the most intensive mechanical stress arises. Damage at that spot of the plant would entail considerable production stop.

**Amodio Cioffi,** Maintenance Engineering Robot IVECA SPA: *"We have decided to implement condition-based maintenance on the most important line in the body-in-white shop since all versions of the van are produced there. In this production line the side panels are transported to the underbody production. Then the crossmembers are fixed, and finally the roof is attached. Transport to the welding stations is fully automatic. Then the different bodyshell types are sent off for further processing."*

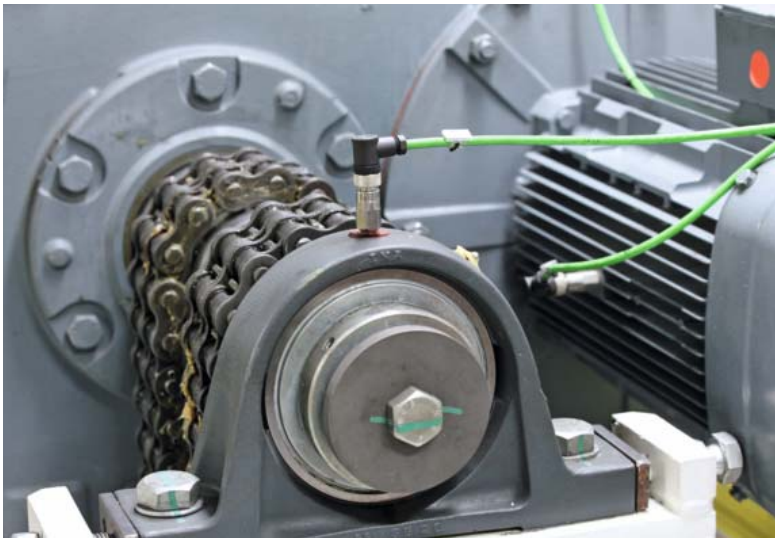
To ensure maximum uptime of the system imminent wear of the machine components must be detected at an early stage.

**Fabio Piccinelli,** WCM Plant Support IVECO SPA: *"We are always looking for new technologies for continuous improvement to increase efficiency and productivity. As far as maintenance is concerned, we have changed from cycle-based maintenance to condition-based maintenance which meant considerable cost savings."*



*Robots weld pressed steel parts to a body.*

> *The ifm software LR SMARTOBSERVER monitors and administers the measured data from all the sensors*



*Vibration sensors monitor bearing and gear. Wear and tear is detected in time.*

## Vibration diagnostics

In practical terms this means: ifm vibration sensors were installed on all mechanical system parts. The cylindrical VSA-type sensors are directly screwed to the housing of the respective bearing or gear. The separate VSE evaluation units permanently analyse the vibration characteristics. They detect imminent damage due to unbalance and send an early warning.

**Guiseppe Sotira,** Body Shop Technical Engineering IVECO SPA: *"The sensors help the maintenance staff to detect the wear status of each component in real time and to introduce any necessary maintenance work before a real damage occurs."*

## Monitoring of fluids

Condition-based maintenance, however, is much more than just monitoring mechanical components. An example is monitoring of the cooling water in the welding guns.

Possible error sources are clogged filters or leakage. ifm SBY-type flow meters for small volumetric flow quantities monitor the flow and PN-type pressure sensors the pressure in the pipes.

The central cooling circuit system is monitored by the SM flow meter. The compressed air system is reliably monitored by an SD sensor. Even tiny leakages are reliably detected.

All sensors transmit their measured values digitally via IO-Link.

*Bottleneck: Malfunction at this spot would stop complete production.*

**Roberto Militello,** Body Shop Maintenance IVECO SPA: *"IO-Link transmits the data digitally for reliable process control. The measured value is converted into digital data in the sensor and forwarded. Moreover, we can program the switching points of the sensor for early warnings and alarm directly from the server without having to approach the sensor locally. We can see the sensor in the server and calibrate it. Programming after replacement is no longer required."*

The LR AGENT is used as software. It collects the sensor data and stores it in a Microsoft SQL database. The ifm software LR SMARTOBSERVER analyses and displays this data.

Once again **Guiseppe Sotira:**
*"The ifm software LR SMARTOBSERVER monitors and administers the measured data from all the sensors. The parameter display shows a clear image of the complete production plant. Each result can be seen clearly. The system sends alerts such as early warnings or alarms by email."*
This ensures condition-based maintenance which is perfectly suited for the concept of Industry 4.0.

> *Thanks to this cooperation with ifm IVECO is ideally prepared for Industry 4.0*

## Conclusion

ifm installed the system for IVECO during operation without the production having to be stopped. The new system could be thoroughly tested in parallel operation. It has proved its worth. Imminent damage is now detected at an early stage and eliminated without any production standstill.

To conclude, **Guiseppe Sotira** puts it in a nutshell: *"Thanks to this cooperation with ifm IVECO is ideally prepared for Industry 4.0."*

*On the left the evaluation units for the vibration sensors, on the right the IO-Link masters which transmit the sensor signals to the higher-level systems.*


*Retrofitted during operation: ifm IO-Link pressure sensors replace mechanical manometers.*


*The ifm software LR SMARTOBSERVER indicates if limits have been exceeded or not reached.*

*The ifm software LR SMARTOBSERVER provides transparency right up to the inside of each individual sensor.*


# A clean job

*Multi-stage ultrasonic cleaner from KLN.*

**Ultrasonic cleaner completely wired with AS-i**

Water set to 30,000 pulses per second removes even microscopically small dirt particles from surfaces or very thin gaps by means of ultra-fine cavitation explosions. And this at locations which are inaccessible from the outside, for example, with a water jet.

**KLN Ultraschall from Heppenheim is a specialist for building such equipment for use world-wide.**

The design of the plant's control system is as clean a job as the cleaned parts. Instead of complex cable harnesses the slim bus system AS-Interface is used.

In numerous production areas ultrasonic cleaning is used. Often after mechanical machining processes to ensure that the part is absolutely free, for example, of abrasive particles or other deposits for further processing or finishing. One example is the removal of the fine abrasive dust in glass processing, for example when optical lenses are made. Ultrasonic cleaning is also used for cleaning equipment itself. The system shown here serves to clean microscopically small nozzles which are used to make plastic fibres.

> *ifm's product range is ideal for our applications*

*All sensors are connected to the bus system AS-Interface (AS-i) using modules.*

The range of equipment is as wide as the area of applications: from small, standardised compact devices to individual equipment as big as a garage.

The cleaning equipment is often an integral part of a production process. A failure would stop the whole process. Therefore, maximum reliability is needed. And in case of a problem quick fault location should be possible. Besides reliable sensors and actuators wiring is also important for reliability and diagnostic capabilities.

Here, the fieldbus system AS-Interface (actuator sensor interface, in short AS-i) shows its strength. Instead of complex and confusing cable harnesses communication is carried out at sensor level using a flat two-wire AS-i bus cable.

**Dieter Bickelhaupt,** Manager Cleaning Technology at KLN: *"For us size, flexibility and very quick decentralised installation at any location of the plant are major advantages of AS-i".*

As with the sensors, KLN also relies on solutions of ifm for fieldbus communication. The automation specialist supplies all components for a comprehensive communication solution with AS-Interface from insulation displacement connectors, I/O modules to master gateways.

*"At the time we were one of ifm's first customers who used AS-i with resounding success. ifm's product range is ideal for our applications,"* said **Dieter Bickelhaupt**.

## Manufacturer-independent standard

AS-i is a manufacturer-independent standard for connection of actuators and sensors of the first field level. It is the only wiring system which is accepted worldwide and based on the IEC 62026-2 standard. With over

15 million installed slaves it proved a low-cost and robust field bus system for all industrial controllers.

Thanks to the standardised system, little wiring and the toolless quick-connection technology AS-i ensures simple "plug & play" for installation and set-up. Another advantage which is not to be underestimated: Fewer terminals lead to much less documentation.

Dieter Bickelhaupt: *"In the past we wired conventionally, i.e. using a terminal box system and directly via the inputs and outputs of the PLC. Wiring was complex and needed much space in the plant and control cabinet."*

With AS-i, however, data and energy for the connected sensors / actuators are transmitted via a two-wire flat cable. The keyed insulation displacement connection technology helps avoid installation errors. The modular design and the freely selectable network structure smoothly fit to the plant structure and provide a maximum of flexibility to the plant developer.

> *"For us size, flexibility and very quick decentralised installation at any location of the plant are major advantages of AS-i*

## Everything via a yellow cable

For the process control different sensors and actuators are installed in the cleaning facility: For example, inductive and photoelectric sensors are used to monitor the position of the trolleys where the parts to be cleaned are inserted and then brought to the cleaning facility. Process sensors monitor the temperature and level of the liquids in the cleaning stations. Binary switching signals and analogue process values, for example, temperature values, are transmitted to the controller via the AS-i bus.

An example of sensors with combined actuators are the safe AS-i door switches with guard locking.
If they receive an "enable signal" from the controller via AS-i, locking is released and the pull-out can be opened. This prevents the user from unintentionally removing the pull-out from the facility while cleaning or placement of the clean parts is in process.

*Thanks to these safety-related AS-i door switches with guard locking the pull-outs cannot be opened unintentionally while cleaning is in process.*

*"Safety at Work": This fail-safe inductive sensor for position monitoring is connected to the controller via AS-i.*

## On the safe side with AS-i

The system also integrates safety-related devices. Besides the door switches with locking actuators these are mainly e-stops and fail-safe inductive sensors for position detection.

Here AS-i plays another trump card: Thanks to the extended AS-i standard "Safety at Work", safety-related signals can also be transmitted via the yellow flat cable. A separate cable for safety-related signals is not needed. Special safety modules monitor the communication on the bus. Safety components up to the highest control category 4 to EN 954-1, SIL 3 to IEC 61508 and EN ISO 13849-1 / PL e can be connected via AS-i.

## From the sensor to the plant controller

The sensors and actuators are connected via the input / output modules, also called slave in the AS-i network. Normally these modules are installed at a decentralised location near to the sensors.
They connect sensors / actuators to the AS-i bus via standardised M12 connections. The bus is inserted into the module lower part in the form of a yellow two-wire flat cable.

The insulation displacement technology ensures a reliable connection. The advantage of this installation:
The modules can be connected to the bus cable at any location, also at a later point in time. Thanks to AS-i additional sensors and actuators can be installed in the plant simply, quickly and at low cost.

*Different AS-i modules for normal (orange) and safety-related (yellow) communication.*

*Passive flat cable insulation displacement connectors for the connection of intelligent AS-i sensors / actuators to the yellow flat cable.*


*Safe AS-i input modules can be used in control cabinets or local boxes for the connection of conventional safety sensors, e.g. e-stops or door switches. All status indications are displayed via LEDs on the front panel.*

ifm offers different modules for control cabinets, field installation or as PCB solution. They are available with different configurations on digital inputs and outputs, analogue inputs / outputs or special connections such as for Pt-100 temperature sensors.

ifm also offers "intelligent" sensors and actuators with integrated AS-i bus connection, e.g. pneumatic valves, inductive AS-i sensors or the e-stops used here. They need no special AS-i module and can be directly connected to the AS-i cable as a slave via a flat cable insulation displacement connector.

## Master / gateway

The heart of each AS-i network is the master. This is a stand-alone controller which manages the "bus traffic". At the same time, it offers a powerful PLC functionality and can be programmed by the user to process sensor and actuator signals, thus operating as a stand-alone decentralised controller.

Also, the master often integrates a gateway functionality to communicate with the higher-level controller or control level via Profinet or Profibus.

Depending on the version one or two AS-i cables with up to 248 binary sensors and 186 actuators can be connected to these masters.

## Conclusion

It's the end result that matters: Thanks to AS-i wiring, documentation and set-up times are considerably reduced. The decentralisation of the AS-i participants leads to smaller and less expensive control cabinets.

Confusing cable trays are avoided. Simple diagnostics and a clear plant set-up lead to high machine uptime, reducing cost for installation and diagnostics.

Dieter Bickelhaupt: *"The connection of the switches and valves with prewired cables saves much time and prevents error sources. The cost saved with AS-i cannot be determined exactly. But I think that all things considered, i.e. also the size of the control cabinet, the space needed in the plant, decentralised installation and flexibility as well as integration of ifm's safety system plus the good creation of the documents 10 to 15 %. Plus less working time during installation, documentation and troubleshooting!"*

*At the time we were one of ifm's first customers who used AS-i with resounding success*

# SINTERFACE

*The heart: Dual AS-i master for two AS-i lines with Profinet gateway.*
*For energy supply ifm offers suitable AS-i power supplies.*

# Zwettler Beer

**Fit for the future**

The private brewery Zwettl invested about 15 million euros to expand and modernise their facility in the town of the same name in Lower Austria. So they are uniquely positioned in the European market for highly flexible and automatic brewing of high-quality beers.

The new energy-saving installations help reduce the need for resources, enabling the brewery to operate in an even more environmentally sound way. Many sensors ensure process feedback and diagnostic data for the brewing equipment up to the control level.

Detailed engineering was implemented by M&L Consulting from St. Gallen and the company Corosys from Hofheim with an individual construction and the complete automation equipment.

As leading OEMs for the brewery and beverage industry the companies M&L Consulting and Corosys rely on the wide product portfolio of sensors and control systems from ifm, guaranteeing maximum process reliability and machine uptime.

This is important to comply with the required standards and directives. In particular in the food industry high temperature, cleaning resistance and protection rating IP 68 / 69K are required.

*Temperatures, pressures or levels:*
*Different sensors monitor the process.*

*Complex valve manifold:*
*Sensors ensure transparency.*

**Founded in 1708 and today one of Austria's most state-of-the-art breweries: The Zwettl private brewery in Lower Austria.**

## Sensors in the cold area

The process chain in the brewery is roughly divided into three areas: brewhouse, cold area and filling. From the point of view of process sensors the cold area is the most interesting part. Countless pressure, flow and temperature sensors are installed on the tanks and pipes.
All valves are equipped with inductive sensors for position detection.
The examples below show how Corosys has solved the application in the Zwettl brewery by means of ifm sensors.

## Electronic manometer in the diatomaceous earth filter

Following the fermentation and storage process the unfiltered beer reaches the diatomaceous earth filter. Here the yeast cells and sediment are filtered out.

The condition of the filter is monitored via difference pressure measurement. The fully electronic PG2894 contact manometer is used for this process. It combines

*2 in 1: The fully electronic PG contact manometer combines a pressure sensor and manometer display in one unit.*

*Thanks to the know-how of many years the sensor specialist ifm offers a comprehensive product portfolio*

the advantages of an electronic pressure sensor and a highly visible manometer display.

The pressure pick-up has a hygienic flush design, optionally with conical G1 thread or Aseptoflex Vario process connection. This process connection also allows hygienic flush installation using the available adapters.

In combination with the ecolink socket of the EVT series in M12 design protection rating IP 68 / IP 69K ensures highest ingress resistance in the wet area. Thanks to its temperature resistance the fully electronic contact manometer is also perfectly suited for CIP (cleaning in place) / SIP (sterilisation in place) processes.

The large pointer display, the integrated digital process value display and the LED bar graph for switch point and trend display provide the operator with user-friendly readout. With its high total accuracy of 0.2 % the device can also be used for sensitive processes.

## Temperature monitoring during the production of mixed beverages

In addition to the pure beer Zwettl also produces mixed beverages such as the popular "Radler" – beer with lemonade. At the mixing station additives from various tanks are mixed. To ensure an optimum process, defined medium temperatures are required.

At the tanks, temperature transmitters of type TA34 transmit the temperature value to the plant controller via an analogue signal (4...20 mA).
The hygienic G 1/2 process connection and the high-grade stainless steel (316L/1.4404) housing material mean that direct contact with the medium is no problem at all. The high-precision Pt1000 measuring elements of accuracy class A provide precise measurement results. Temperature probes of type TM4501 with hygienic G 1/2 process connection are integrated in the pipes. The sensor signal is evaluated and transmitted by the separate TP3231 temperature plug.
It is very compact and has two standardised M12 connections for both the connection of the sensor and the output. This reduces the installation complexity as compared to a common head / DIN rail transmitter to a minimum.

## Self-monitoring temperature sensor in flash pasteuriser

To kill microorganisms and to preserve the beer, it is heated to a defined temperature by means of flash pasteurisation. High precision is of highest priority.

A special sensor is used for this purpose: The ifm TAD991 temperature transmitter uses two different sensor elements monitoring each other in the process. This self-

*Typical tank monitoring: LMT point level sensor and hydrostatically measuring PI pressure sensor on the tank bottom.*


*Position feedback: The IFT203 inductive sensor monitors the valve stem and signals to the controller if the valve is open.*

*Small, compact, cost-effective:*
*The TP temperature plug converts the sensor signal into a standardised analogue signal (4...20 mA).*

*Perfect pump protection:*
*The LMT point level sensor (top) determines if the pipe is full or empty. The PI pressure sensor (bottom) monitors the conveying pressure.*

monitoring system ensures that an occurring drift of the sensor is detected at once and reliably diagnosed.

The deterioration of the sensor accuracy is known as drift.

Drift is caused by thermal stress. Especially in the food industry the regular cleaning processes (CIP, SIP) create extreme temperature shocks that stress the sensor and therefore inevitably cause a drift.

To detect occurring temperature drift the off-set with the reference has to be automated. This exactly is the approach with the calibration-free TAD temperature sensor.

Standard temperature sensors have a resistance measuring element which in the food or pharmaceutical industry very often complies with the accuracy class A to DIN EN 60751. A resistance measuring element (Pt1000) is integrated into the TAD temperature sensor. This resistance element is specially measured and preselected by the manufacturer and its accuracy is therefore higher by about factor 4 than class A which is normally used.

To have a signal to compare, the probe of the TAD additionally has an NTC measuring element with long-term stability which is matched with the characteristics of the Pt element in the production process of the sensor. By this you understand the matching of two components or characteristics.

So in normal operation the TAD temperature sensor works with two different measuring elements.

As a result of this, the process can be finished safely with the second measuring element (backup function) if one element fails.

The electronics of the TAD temperature sensor calculates the mean average of the measured temperatures and provides a temperature-proportional 4...20 mA analogue output. During operation the difference between the two temperatures is compared with two adjustable threshold values. The first threshold value is called drift warning limit, the second one drift alarm limit.

To guarantee wire break monitoring there is a 24 V signal on the diagnostic output in normal operation. If the drift warning limit is exceeded, the diagnostic output clocks at a frequency of 2 Hz. Via a timer the signal can be evaluated in any controller. If the drift alarm limit is also exceeded, the diagnostic output switches and a 0 V signal is continuously provided.

Advantage: Compared with the common temperature sensors that are cyclically calibrated the use of the TAD temperature sensor increases process reliability.
With cyclical calibration an occurring drift is detected, however a drift-prone sensor had already been used for an uncertain period of time in the production. Since the TAD generates a signal the moment the set drift thresholds are exceeded and you do not have to wait for the end of the calibration interval, process reliability and consequently product quality are considerably improved during the demanding flash pasteurisation process.

*Maximum process reliability:*
*The self-monitoring TAD temperature transmitter for especially sensitive processes.*

## Level monitoring on tanks

Tanks are used in many places in the brewery: For example in the bright beer cellar as a buffer between filtration and filling, in water purification or in the central CIP installation. The exact level of these tanks is needed for plant control; furthermore the permissible min. and max. levels should be detected and signalled.

Pressure sensors of the PI28 series are installed on the tank bottom for hydrostatic level measurement. The exact tank level can be derived from the measured hydrostatic pressure.

The housing of these sensors is completely made of high-grade stainless steel (316L/1.4404). Together with the high protection rating IP 68 / IP 69K and the process-oriented design this series is particularly suited for hygienic applications.

The new G1 process connection Aseptoflex Vario made of high-grade stainless steel (316L/1.4435) provides four reliable sealing options. The metal-to-metal as well as the new PEEK seals are maintenance-free and thus cost-saving during their life time. The latter is distinguished by high resistance to chemicals and temperature.
Elastomer O-rings are another hygienic sealing option (EPDM / FKM). Different process adapters (such as clamp, DIN11851 pipe fittings, etc.) are available as accessories, and are of course also made of high-grade stainless steel (316L/1.4435).

Depending on the sensor type, their pressure range is between 100 mbar and 25 bar. High-purity ceramic measuring cell as well as easy handling via the integrated pushbuttons and the LED display are other features.

Electrically the sensor can be connected as a 2, 3 or 4-wire unit. This makes it easier to exchange units in existing installations. Furthermore the sensors of the PI28 series are distinguished by a high overall accuracy (0.2 %) and electronic temperature compensation. Due to their high temperature resistance they are also ideally suited for CIP and SIP processes.

The second sensor system on the tank is the LMT point level sensor that reliably monitors the maximum and minimum level. As opposed to other solutions such as mechanical tuning fork probes it does not need any mechanical components thus operating without wear. Special feature: It is insensitive to foam and other deposits which it reliably suppresses. Besides the factory preset the LMT can be set to different media and deposits via IO-Link. This also ensures reliable limit level detection even with difficult media.

A variety of adapters allows various installation options. The sensor operates independently of the installation position.

High-quality housing materials such as high-grade stainless steel (316L/1.4404) and the sensor tip of food-grade

> *Its compact sensor tip allows integration of the LMT even in small DN25 pipes*

PEEK meet all hygienic requirements. A lasered type label for durable legibility as well as the high protection rating IP 68 / IP 69K for cleaning processes are natural.

## Applications in pipes

The point level sensors of the LMT series are also used in pipes. They detect if the pipes are full or empty and are therefore used as run-dry protection for pumps. Its compact sensor tip allows integration of the LMT even in small DN25 pipes.

To monitor the conveying pressure in pipes the above-described PI28 pressure sensor is used. It transmits the measured value as an analogue signal to the controller.

## Inductive sensors monitor valve manifold

To guide the medium valves on manifolds of different sizes are used in different places in the brewery. Electromechanical rising stem valves ensure an open or closed pipe thus allowing the controlled distribution of the media. Inductive sensors are used for position detection since they detect if the valve is open or closed by means of the position of the valve stem. The type IFT203 sensors used feature high-quality housing material (high-grade stainless steel, PEEK) and the high protection rating IP 68 / IP 69K so that they withstand regular high-pressure cleaning processes without being damaged.

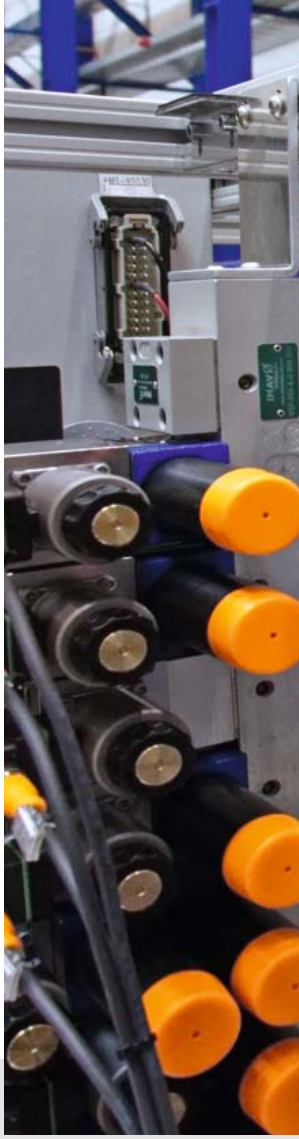
## Manway and cover monitoring

Another application for inductive sensors is position monitoring of manways or covers, for example on tanks. The sensors of type IIT212 provide sufficient sensing range (15 mm) to signal the status "cover open" or "cover closed" to the controller even in the event of mechanical tolerance.

## Conclusion

Thanks to the know-how of many years the sensor specialist ifm offers a comprehensive product portfolio to reliably automate the brewing process and to ensure continuously high beer quality. Due to similar requirements the example application solutions can be transferred to other areas in the beverage and food industries to make them fit for the future.

*Cover closed?*
*An inductive sensor monitors the tank cover.*



# Digital upgrade with IO-Link

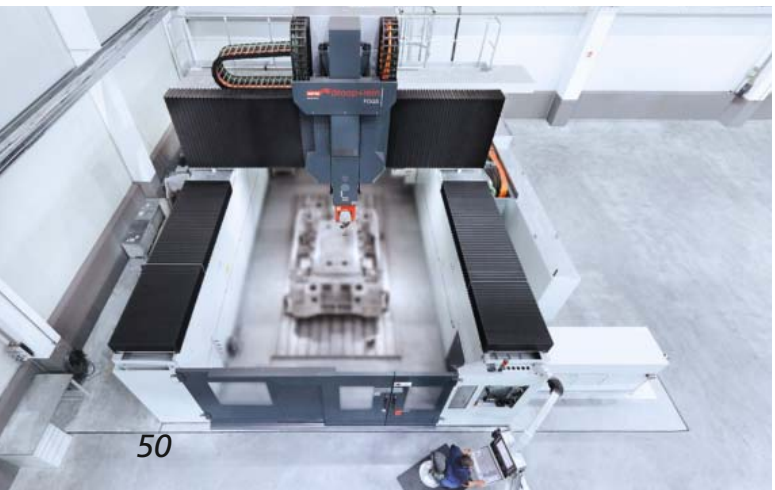
**Starrag Technology GmbH is a company based in Bielefeld that produces machine tools and extensively equips them with IO-Link sensors from ifm electronic.**

## More information from the sensor

The implementation of Industry 4.0 is, among other things, about creating a digital silhouette of a plant, thus allowing for process optimisation.

The essential information is provided by many sensors that are already installed for machine control anyway. Thanks to IO-Link, these sensors provide much more data than mere switching signals or analogue values.

*The Droop+Rein product area of Starrag Technology GmbH in Bielefeld manufactures portal milling machines for the international market.*



The FOGS-series portal machining centre from Starrag Technology GmbH is a machine that has these features. It is used in mechanical engineering and in the aviation and automotive industries, for example, to manufacture body shell parts. The machine in the picture is used to process chassis components (landing gear) in the aviation industry.

These complex machine tools require sensors to monitor all media (e.g. coolants and lubricants, hydraulics, machine temperature control). Tight tolerances are required for medium temperatures, pressure values and volumetric flow quantities to ensure that tools are used with optimum efficiency in fully automated production processes.

## Sensors with digital interface

IO-Link is a robust digital interface based on 24 V signal levels that, in addition to mere switching signals, enables bidirectional communication with the controller via the

*IO-Link sensors provide data for optimum machine control.*

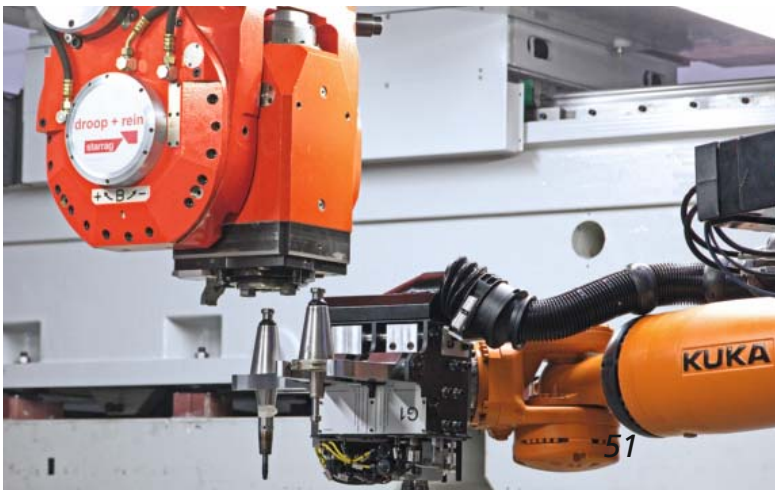
regular sensor cable. The sensors transmit digital measured values and diagnostic information via IO-Link to the IO-Link master, such as an IO module, gateway or a PLC equipped with IO-Link ports. The sensors are connected with standard M12 connectors. Screened cables and associated grounding are no longer necessary.

Starrag Technology GmbH opt for fluid sensors from ifm electronic. The reason: The sensor specialist offers the largest product range of process sensors featuring IO-Link.

## Remote sensor parameter setting

One of the greatest advantages of IO-Link is the possibility to transfer all necessary parameter data via the IO-Link connection cable to the sensor. The sensor parameter data (e.g. switch points, switching hysteresis, display colour) can be transferred from the controller to IO-Link compatible sensors, either when the sensors are set up or later during operation and to adjust them to a specific situation. Benefit for the customer: During the commissioning phase of a machine, the previously projected sensor parameters can be transferred quickly, easily and reliably to the sensor. If necessary, for example in case of small lot sizes, IO-Link makes it possible to store different parameter sets for different products separately on the sensor. Moreover, thanks to the controller-based parameter setting, subsequent process optimisation via remote maintenance is easy with IO-Link.

All in all, one can say that IO-Link is a key technology for Industry 4.0 applications.




*If necessary, the parameters of the process sensors can be set separately for each tool.*

> *One of IO-Link's great advantages is the automated backup of the sensor data that takes place in the background*

*The user can access each individual sensor from the control panel.*

## Double data backup

In addition to controller-based sensor parameter setting, IO-Link from version 1.1 or higher ensures double data storage of sensor parameters on the device and the IO-Link master.

**Dietmar Wallenstein**, e-construction and commissioning department manager at Starrag Technologies, says: *"One of IO-Link's great advantages is the automated backup of the sensor data that takes place in the background. Each sensor (device) sends its parameter sets automatically to the IO-Link master. There, they will be mirrored and stored as a backup. As soon as a sensor is replaced, the data is exchanged automatically with the new device. The parameter data will then be transferred automatically from the IO-Link master to the IO-Link device. This makes it a lot easier to replace a sensor and it reduces machine downtime significantly in case of a fault. At the same time, this reduces the workload of the service and maintenance staff."*

Sensor parameter setting mistakes are a thing of the past. Replacing a sensor only requires the mechanical installation. The customer can replace it without needing any support. The maintenance staff does not need to be trained with regard to sensor parameter setting since it takes place automatically in the background. Thanks to this, technical problems can be solved much faster and much more efficiently. This saves costs.

## Error-free digital transmission of measured values

Up until now, analogue sensor signals are digitised via A/D converters and scaled in the PLC. This leads to inaccuracies of the actual measuring value.

IO-Link, however, provides the measured values from the sensor digitally to the controller. Transmission errors and conversion of analogue signals are ruled out.
The digitally transmitted measured values can be directly displayed in the control room. The transferred value is always identical with the measured value. There are no longer any deviations between the local display and the value that the PLC derives from the analogue signal. Thanks to IO-Link, even interference with the analogue signal, for example caused by electromagnetic fields, is a thing of the past.

## Two measured values – one sensor

Modern process sensors from ifm often provide more than just one measured value.

**Dietmar Wallenstein** says: *"Often, a sensor processes more than just one physical value. In addition to volumetric flow quantity or pressure, for example, it is also possible to read the medium temperature via the IO-Link interface. In the past, we needed two sensors for this."*

This saves money for hardware, wiring and mounting since instead of two sensors you only need one.


*The numerous IO-Link sensors enable centralised parameter setting.*

## Diagnostic data

Apart from the process data, the IO-Link sensor can also provide diagnostic data about the status of the device.

Example: The level sensor detects critical deposits and signals them to the controller. Photoelectric sensors detect if a lens is soiled and signal it automatically. Pressure sensors store minimum pressure losses and maximum pressure peaks from the process and totalise the number of times that limit values are exceeded or not reached. This additional functionality supports the user decisively when it comes to condition-based maintenance. This extended information about the condition minimises expensive downtimes while increasing process reliability.

## Conclusion

Sensors offer a considerable additional value if they are equipped with IO-Link.

**Dietmar Wallenstein** summarises the advantages for Starrag Technology: *"Everyone is talking about Industry 4.0, and of course we at Starrag are not ignorant of this megatrend. When it comes to mechanical engineering, we think in particular about digital machine upgrading. This is why we opt for IO-Link. Thanks to low-cost robust interfaces, the sensors provide us with more information about the process which then can be more efficiently evaluated and optimised. This is one of the great advantages of IO-Link and a sensor feature contributing to Industry 4.0."*


*Two measured values (volumetric flow quantity and temperature) with only one sensor.*

**Transparent installation monitoring**

The constant increase of the degree of automation in modern production plants is more and more often supported by identification systems. Their tasks include, for example, the control or release of production steps or the assignment of information about each product. This is particularly easy to achieve if the RFID components communicate via the AS-Interface fieldbus.

# RFID me

*Assembly machine for the production of vacuum cleaner nozzles.*

When it comes to assembly technology, the worldwide leader in the development and production of vacuum cleaner nozzles, Wessel-Werk, counts on solutions from ifm electronic who is a global player for automation technology and the first supplier of AS-i based RFID systems worldwide. The result is lean and transparent installation monitoring of the nozzle production.

## High-quality vacuum cleaner nozzles

A high-quality vacuum cleaner nozzle consists of at least a dozen different components.

The world market leader develops and build its own assembly machines in order to be able to promptly and flexibly implement innovative technologies. Inside these machines, workpiece carriers pass several assembly

*„Setting up the system is much simpler than expected*

**The Wessel-Werk is based in Reichshof-Wildbergerhütte. The company is world market leader in vacuum cleaner nozzle development and production.**

# ets AS-i

stations. On these carriers, different vacuum cleaner nozzles are assembled from chassis, brush strips, rollers and other parts.

Wessel-Werk produces flexible lots of different types in mixed operation. Conveyors transport workpiece carriers to different processing stations. Depending on the nozzle type, different assembly steps and conveying routes are required.

Each workpiece carrier can be clearly identified via a special RFID code. The code is read at each processing station and sent to the controller via AS-Interface. Depending on the nozzle type, the corresponding processing step is carried out and the distribution gates on the conveyor path are set. The clear identification reliably prevents processing failures in mixed operation.

## ■ RFID with AS-i

The industrially compatible DTS125 RFID system from ifm is used for a problem-free process flow. It is a compact and easy alternative for applications where, for example, optical identification cannot be used due to the ambient conditions.

It is also the first RF identification system for AS-Interface worldwide. It allows reading and writing of code carriers (ID tags), benefiting from the advantages of AS-Interface. It can be easily integrated into existing AS-i networks and is immediately ready for operation.

The highlight of the AS-i solution is the easy wiring. Up to 31 read / write heads can be connected to 100 metres of AS-i cable. The cable can be branched as you like and

laid according to the layout of the production line. It is especially suited for modular structures since both data and energy run over only one cable.

For reading, the RF identification system uses the common AS-i analogue protocol 7.4 for data transfer. Special software modules are not required. The read / write head stores transmission errors which can be retrieved for a targeted fault analysis.

Antenna, electronics and AS-i interface are integrated in a compact housing. The voltage is supplied via the AS-i network via a rotatable M12 connector. No additional operating voltage is needed. This facilitates mounting and minimises wiring.

The ID tag is available in different versions and offers flexible mounting options for workpiece carriers, tanks, etc.

Using simple insulation displacement technology, the AS-i module can be connected with the yellow AS-i flat cable. To do so, the cable can be laid transversely or lengthwise through the module. The AS-i module is mounted without tools – for removing it you only need a screwdriver.

Not only RFID read / write heads but other sensors, such as light barriers or inductive sensors can be connected via AS-i modules with the controller. This reduces even more wiring.

Being the head-end, the AS-i master collects all data for all common superior fieldbuses. Because of the integrated PLC functionality it can pre-process the data, supporting the plant controller.

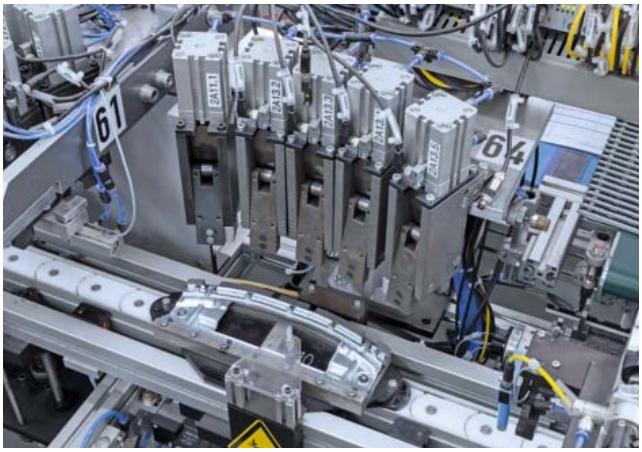
## Conclusion

**Gerhard Feyerabend**, control engineer at Wessel-Werk on the simplicity of the AS-i RFID system: *"Setting up the system is much simpler than expected because the read heads immediately send the data to the PLC after installation and addressing. A further configuration is not necessary!"*

For ifm, RFID in combination with AS-i is ideal for identification tasks in assembly technology which are easy to implement.

*Sensors can be connected to any spot of the AS-i cable via a flat cable insulation displacement connector.*

*The ID tag chip is installed at the bottom of the workpiece carrier. The chip can store up to 224 bits.*



*Fully automatic assembly of a vacuum cleaner nozzle at several stations.*

# Automation experts

WARRANTY 5 years on ifm products

## Automation made easy

Innovative solutions for all areas of industrial automation:
Position sensors and object recognition, fluid sensors and diagnostic systems as well as identification, bus and control systems.
Tailor-made for industry-specific requirements, for example for hygienic applications in the food industry or for especially robust applications in the area of mobile machines.
Thanks to IO-Link the sensors are well prepared for Industry 4.0.
We answer your automation questions. ifm – close to you!

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# Systematic excavation

**Gritzke Lasertechnik is based in Lemgo. Among other things, the company specialises in dredging depth monitoring systems.**
**Together with ifm electronic, one of the leading manufacturers of sensors and automation solutions for mobile applications, an innovative solution for exact relative height determination of the excavator's bucket blade was developed.**

## More information from the sensor

The height of the excavator shovel edge at a glance to the nearest centimetre – this enables the excavator's digging depth control system from the company Gritzke.

The special feature: It can be retrofitted to any hydraulic excavator without having to tamper with its controller.

This is made possible by ifm's high-precision inclination sensors on the individual excavator arms and the shovel.

Precise inclination sensors, a compact BasicController and a programmable dialogue display together with the software developed for this purpose combine into an efficient system and give the excavator operator absolute control over his tasks.

*The BasicController helps calculate the reference height.*

First of all the reference height is levelled by means of the rotation laser and the laser receiver on the adjustable boom of the excavator. Then the planned heights can be determined at any position of the earthworks.

## Exact inclination angles

Six ifm inclination sensors of type JN – spread across the excavator boom, in the upper structure and on the tilt bucket – precisely measure the angle of inclination in the x and y direction.

The intelligent software calculates the height position of the bucket blade to the centimetre from the measured results of all six inclination sensors and the known excavator arm length.

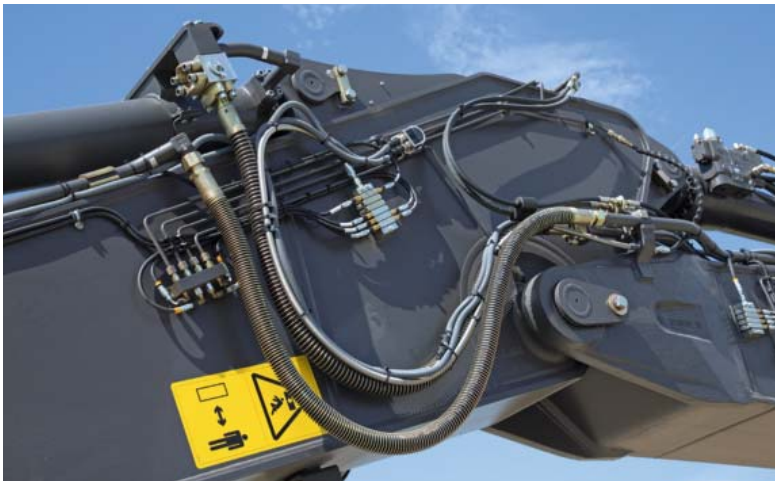
Of particular relevance is the three-dimensional straight line between the left and right bucket edges that allows exact flat levels and any angle for earthworks by means of the inclination sensor on the bucket.

The signals are processed and the complex calculations are made in the dialogue module which contains the display, the operating keys and a powerful controller. The display graphically shows the excavator operator the excavator bucket and the current height of the cutting edge. A clearly visible traffic light also signals the excavator operator if the required depth has been reached.

Setting height markings, angle meters and direct visual contact are no longer required. This makes it possible to work at night or if vision is obscured.

**Dipl.-Ing. Rolf Oschatz, managing director at Gritzke Lasertechnik**: *"What is special about our solution is that it can be easily adapted to different excavators from different manufacturers by easy modifications of the parameters."*

*One inclination sensor determines the exact angle per excavator arm.*




*A traffic light within the sight of the excavator operator indicates if the shovel is too high or too low.*

> *The dialogue module with operating keys and graphic display provides an overview of the most important settings at any time*

*The lateral inclination of the excavator bucket is also taken into consideration for the calculation.*

## For robust applications

Further benefits of the system: The outdoors sensors are designed for a broad temperature spectrum (-40…85 °C). Active temperature compensation ensures exact values measured by JN – irrespective of the ambient temperature. They have a precise measurement accuracy of 0.1 ° across the whole measuring range of 0…360 degrees without annoying jump characteristics. They are connected via a vibration-resistant and sealed M12 connector.

The dialogue module with operating keys and graphic display provides the excavator operator with an overview of the most important settings at any time. The relevant settings such as the required relative depth can be made conveniently and accurately via pushbuttons, touch display and control dials. The change to the basic coordinate system (perpendicular / Euler / gimbal angle) is possible by pressing a pushbutton.

## Conclusion

Experience of long years with construction machine controllers and first-hand automation know-how: The customers benefit from the excellent quality and reliability of the unique digging depth control. In short: When competences complement each other, earth can be moved correctly!


*ifm's dialogue module (CR1082) serves as the display and data entry. Furthermore, the integrated PLC calculates the height.*

# Decentralised signal detection and processing

WARRANTY 5 years on ifm products

## I/O module designed for mobile applications with integrated PLC

The ioControl module can either be used as a configurable I/O CAN slave in a decentralised control system or as a compact PLC in the field.
The high protection rating and robust housing make it suitable for installation in wet and dirty areas of mobile machines. Programmed with CODESYS.
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# Automation at a high level

*Grading with millimetre precision thanks to laser level monitoring and automatic blade tracking.*

## GRi-P1 automatic levelling system for graders

In no other industry, competitive stress is as severe as in the construction industry. To maintain a position on the market, economic efficiency needs to be constantly improved. In other words: More efficiency through increased working speed and improved quality.

**Gritzke Lasertechnik OHG is based in Lemgo, Eastern Westphalia. One of their main activities is the development, production and distribution of positioning systems for construction machines.**

The unique GRi-P1 Gritzke automatic levelling system for graders increases the flexibility and productivity of the machines significantly. This helps save material costs for earth moving and fine grading.
The system can be equipped with several sensors; it combines easy handling with a self-explanatory user interface.

Each millimetre counts when, for example, miles of road sections under construction need to be graded to the same level. A grading that is only one millimetre higher than required can easily cause several truckloads of additional material.

*"The cooperation with ifm was passionate and successful*

## Laser levelling

Levelling long stretches with millimetre precision is only possible by applying efficient modern technology. Here, laser-based systems have proved to be particularly accurate, cost-efficient and reliable. Function principle: A laser fixed to a tripod rotates around its own axis to create a laser level. This level can be adjusted in parallel to the required surface. A vertical photoelectric receptor cell mounted to the grader blade receives the laser beam.

An intelligent controller tracks the laser receptor and the grader blade to make sure they are always at the exact height with the laser projection level. So the driver can focus on the horizontal movements of the grader while the blade is automatically kept with millimetre precision at reference height.

To level sloped surfaces, the laser can simply be adjusted in parallel to the required slope. Depending on whether the grader movements are longitudinal, transverse or diagonal to the slope, different lateral blade inclinations are required. With laser-based systems, the blade inclination can be controlled automatically. For this purpose, a second laser receiver is installed on one side of the grader blade. Alternatively, an inclination sensor and / or an ultrasonic sensor is used on the blade.

Gritzke Lasertechnik OHG is based in Lemgo, Eastern Westphalia. They are specialised in the development, production and distribution of construction machine control and positioning systems. Their customers benefit from the excellent quality and reliability of the systems and the company's service standards.

A central credo: Circumventing the product monopoly constraints of the market leaders, i.e.: The Gritzke systems can be installed on any machine, even if it is already pre-equipped with cables.

To distinguish themselves from common systems, Gritzke has considered the advantages and disadvantages of all systems while putting their own ideas into practice.

## A new flexible system was needed

In the past, Gritzke used programmed controllers from different manufacturers to control the levelling systems. Disadvantage: Gritzke could not carry out customer and machine-specific adjustments or software modifications as the system integrator. The hardware manufacturers had the ownership of the software. Individual adjustments or modifications were very time-consuming and cost-intensive or were refused.

**Dipl.-Ing. Rolf Oschatz**, managing director at Gritzke: *"About 2 years ago, I decided that we would develop our own laser-based levelling system for construction machines. The aim was to offer our customers a combination of special user-friendliness, high accuracy and best-possible competitive price. With our development we basically did not reinvent the wheel, but combined all advantages of the competitive systems with our ideas and requirements."*


*Working surface with following setting options: "Mast installation" e.g. "search laser" or "park mast", automatic mode for the right or the left mast "on / off", "mast adjustment on both sides" as well as current height indication in 1/10 mm.*

> *Often we tested the software and hardware outdoors on the machines till late at night*

## ifm as partner

Application know-how is one thing, but when it came to the heart of the system, the controller and its software, Gritzke found their present partner, the ifm group of companies, more or less by accident.

Dipl.-Ing. Rolf Oschatz: *"The development together with the earlier hardware suppliers was rather slow. The initially promised support was very hesitant and consisted of target figures rather than technical support. In April 2013, at ifm stand at BAUMA (the world's largest trade fair for construction machine, editorial comment) I was asked in an informative conversation if we needed help. Mutual interest arose quickly. What impressed me in particular: They did not ask about possible quantities but promised comprehensive project support."*

*The heart of the system is a 32-bit controller from ifm for mobile applications.*

This was the beginning of the close partnership between Gritzke and ifm.

In cooperation with the automation specialist ifm (hardware), Gritzke Lasertechnik developed, built and sold the first German CANbus-based GRi-P1 levelling system for graders.

## Implementation

The following months were characterised by intensive cooperation.

Dipl.-Ing. Dennis Blume, sales specialist for control technology at ifm, had the lion's share in supporting the project. This was done in close cooperation with Gritzke because one important requirement on the new system was to have Gritzke's in-house software know-how. The heart of the installation is the CR0033 CAN-compatible ifm controller for mobile applications. ifm's CR1084 display with graphics capabilities is used as the operating unit.

Dipl.-Ing. Rolf Oschatz: *"The cooperation with ifm was passionate and successful. Often we tested the software and hardware outdoors on the machines till late at night. Many thanks in this respect to the company Stork Tongruben und Transportunternehmen in Hiddenhausen who provided us with a caterpillar (Cat D6T) and the site, a clay pit, for thorough testing. And it paid off: After 18 months we could implement the system until it was ready for the market. Without Mr Blume's exceptional personal commitment we would never have achieved this in such a short time."*

## Flexible in the application

The levelling system is the first of its kind to be developed, programmed and built by only one supplier.


*Gritzke developed and built the marketable system in cooperation with ifm.*

The customer benefits from the fact that adaptations, special customer requests or improvements can be implemented rapidly.

Due to its modular concept the GRi-P1 Gritzke system can be used for any kind of laser-based height monitoring and control for different applications as well as for construction machines.That means that it can also be used on excavators for depth monitoring, on height and / or pivoting angle limitation, on wheel loader levelling systems, on piling and drilling rigs, on agricultural machines or on container lifts. Advantage: The customer does not need expensive software updates since the different applications are already stored and selectable in one software program. The controller can also be used on different machines, if required. The customer saves the purchase of double components such as operating unit, central processing unit or sensors.

By integrating selectable application programs in a modular device the development and hardware costs were reduced to a minimum. The result: The Gritzke system costs about one third less than the common systems.

## High speed – thanks to CANbus

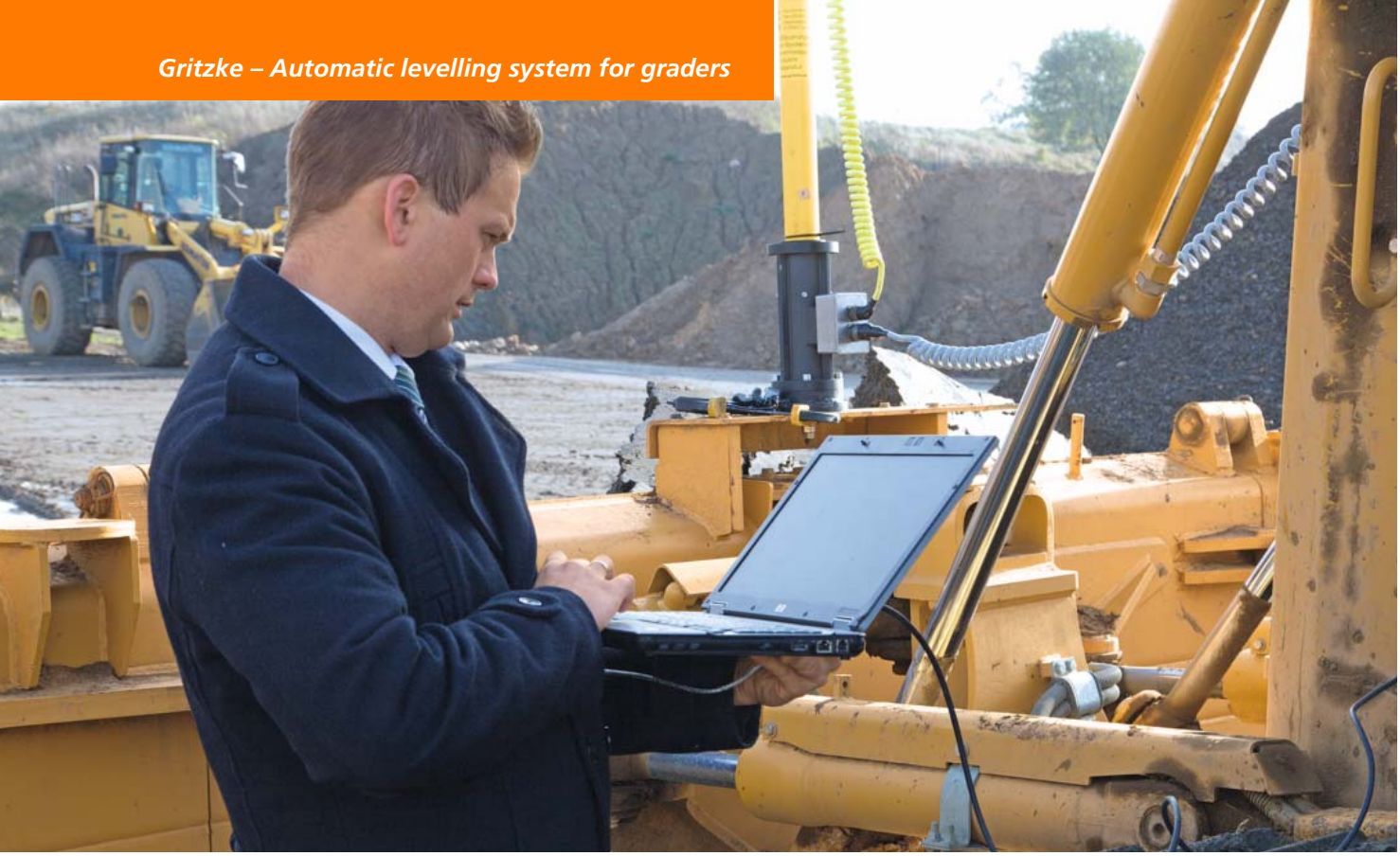
It is the first system to use the CANbus interfaces for data transfer. The data can be transmitted up to five times faster from the laser receiver or from the inclination sensor / ultrasonic sensor to the controller. This fast data transmission and processing in the controller is necessary to ensure a fast signal chain from the laser receivers to the controller to the valve control of the caterpillar blade. This is the only way to enable work with millimetre precision, even at high speeds.

Also the joysticks, switches and buttons of the construction machine are polled and transmitted via CANbus to the process control.

If necessary, the user can manually alter the automatic zero adjustment on the graphic operating unit. Switching – for example to inclination sensor or ultrasonic sensor (for grading according to a ground reference, e.g. kerb) – can easily be done on the operating unit.

## The heart: the controller

It has up to 16 multifunctional inputs and outputs as well as 4 CAN interfaces. The heart of the controller is a modern and fast 32-bit processor integrated into a compact IP 67 metal housing. Its monitoring and protective functions enable reliable operation even under extreme operating conditions. The high number of multifunctional inputs and outputs allows easy and precise adjustment to the respective application using application software (IEC 61131-3 with CODESYS). Depending on the type of input, a configuration as digital, frequency or analogue input with diagnostic function or as input for resistance measurement is possible.



*Dipl.-Ing. Dennis Blume from ifm on site: The controller was tested on the machine and the programming adjusted again and again on site. The customers only get products guaranteeing flawless functioning.*

The 4 CAN interfaces to ISO 11898 support all important bus protocols and different baud rates as well as the transparent or preprocessed data exchange. The new controllers were specially designed for robust applications in vehicles and for mobile automation and can carry out complex and proportional functions reliably.

## Graphical operating unit

Thanks to the closed diecast aluminium housing with the protection rating IP 67 the PDM360 NG dialogue module can be used outside and inside the cabin – by means of surface or panel mounting.

*The CR1084 dialogue monitor from ifm for visualisation and data entry.*


The scratch-resistant 7" TFT colour display with a resolution of 800 x 480 pixels and a colour depth of 18 bits provides brilliant graphical representation. For operation the PDM360 NG has 9 backlit function keys with tactile feedback. In addition, an encoder with pushbutton or a navigation key is available depending on the model.

The powerful 32-bit controller is programmable with CODESYS according to IEC 61131-3. In addition to the internal 1 GB memory the user can connect external media to the integrated USB 2.0 port.

Four CAN interfaces to ISO 11898 support the CANopen, SAE J1939 or a free protocol. Together with a 100 Mbit Ethernet interface and the Linux operating system, a universal platform for networking and communication with other vehicle components is formed. Connection is made via robust and safe M12 connections.

## Conclusion

The project benefits from the application know-how of many years, powerful hardware and, above all, the will to bring about something special together. Once again, "Made in Germany" has set new standards.


# Reliable mobile machine control

WARRANTY 5 years on ifm products

## Standard and SafetyController in one unit

Modern vehicles and mobile machines require powerful control electronics.
The new ecomatController has two independent, powerful 32-bit PLCs – one of them an independent safety controller (SIL2 / PI d).
In addition to a variety of configurable I/O ports, two Ethernet and four CAN interfaces with CANopen, CANopen Safety and J1939 protocol are available.
Robust, reliable and powerful. ifm – close to you!

**www.ifm.com/de/en/ecomatcontroller**
**Phone +49 800 16 16 16 4**


# Cool and slim

**Efficient, new power supplies in the control cabinet**

In order to eliminate bacteria and fungi, environmental parameters such as the number of particles in air, ambient temperature and air humidity are strictly controlled.

The optimum ambient temperature in the clean room is 21° C. If the temperature is too high, it is cooled down using chillers.

Maximum hygiene is given top priority in the clean room when dressings for medical purposes are produced, packed and then sterilised.

*Really cool:*
*Thanks to the high degree of efficiency the new generation of power supplies from ifm does not heat up the control cabinet.*

To keep energy costs for air-conditioning low, the company plans and builds their production equipment so that the components used in the clean room give off as little heat as possible.

**Michael Rohe**, Technical Manager at NOBA: *"It is particularly important to use low-loss devices in the clean room because heat in the clean room must be cooled down again with chillers to keep the temperature constant, which is very expensive. Furthermore, low-loss devices in control cabinets usually eliminate the need to cool control cabinets using ventilators, so there is no turbulence any more in the clean room caused by control cabinet ventilators or such like."*

## Heat in the control cabinet is expensive!

In control cabinets the power supplies are the main heat producers. Conventional electronic switched-mode power supplies are very efficient compared to the transformer power supplies used in the past. However, they will never reach the ideal degree of efficiency of 100 per cent. The difference between the actual degree of efficiency and the ideal 100 per cent is converted into heat energy which heats up the control cabinet.

In many industrial installations heat in the control cabinet may be of minor importance. In defined clean room conditions as with NOBA, however, heat loss costs twice as much: On the one hand, energy costs incur, on the other hand heat loss must be compensated for by means of energy-intensive air conditioners.

## Low temperature = long lifetime

Therefore NOBA relies on the new power supplies from ifm. They are distinguished by a very high degree of efficiency of up to 94 per cent. This degree is one to two per cent higher than that of comparable modern switched-mode power supplies of other manufacturers.


**The company NOBA Verbandmittel in Wetter on the Ruhr makes all types of bandages and dressings for hospitals, doctors' offices and pharmacies worldwide.**

At first sight, this does not seem to be very much. But calculations show that this 1 or 2 per cent adds up to noticeable energy costs over the year. Particularly in this application with the extra cost for the compensating air-conditioning.

In practice, this heat loss may result in an additional temperature increase of 10 degrees in the control cabinet. But for some electronic components, e.g. electrolytic capacitors, this temperature difference of 10 degrees results in halving the lifetime.

The machine controller is often installed directly beside the power supplies. So the higher degree of efficiency particularly impacts the lifetime of the PLC installed in the control cabinet. In short: The lower the temperature in the control cabinet, the higher the lifetime of the plant controller.

## New power supplies from ifm

In 2013 ifm redesigned their family of power supplies. The new generation includes 24 V DC switched-mode power supplies with output currents of 3.3 to 20 A as well as AS-i power supplies of 2.8 to 8 A. All these devices integrate components and circuits rated for maximum efficiency, longevity and powerful performance.

The heart of the devices is a highly efficient compact circuit design. So ifm's power supplies are much slimmer and require less space in the control cabinet than devices from other manufacturers with equal power rating. With this, ifm makes an important contribution in the machine building industry which requires ever smaller control cabinets.

One could think that this compactness would be at the expense of component dimensioning and a reduced functionality. But developers managed to prove the opposite: The components are dimensioned so that the power supplies can be operated permanently at the upper limit of the specifications. They provide the specified nominal power almost over the whole temperature range. Therefore, the usual "overdimensioning" of power supplies to provide a reserve for a longer lifetime is not necessary for ifm power supplies. This saves space and money. The excellent MTBF value of 0.89 to 1.4 million hours (depending on the variant), which corresponds to a lifetime of 100 to 160 years, confirms this. A minor derating (reduced power) only occurs from an ambient temperature of 60 °C.

## Strong extra features

Thanks to ifm's application know-how of many years we exactly know the requirements for energy supply in automation technology. Therefore many extra features were integrated, ensuring a reliable function in all operating phases.

Instead of an inrush current limitation with a simple NTC resistor, charging the capacitors of the new switched-mode power supplies from ifm is microprocessor-controlled. This "soft" start of the voltage supply ensures that the fuses upstream of the power supply do not have to be dimensioned for a higher inrush current. This creates additional safety on the primary side of the power supply.

Additional power reserves on the secondary side ensure that the power supply still provides enough current to reliably trigger the downstream circuit breakers in case of a short circuit.

The ifm power supplies feature an additional power reserve of 20 % which allows the installation to be expanded at a later point of time.

The power supplies compensate short voltage dips caused, for example, by switching operations in the supply network for several milliseconds.

## Conclusion

What is often hardly noticed in data sheets may have a considerable impact on lifetime and reliability of the equipment. NOBA realised the advantages of the new ifm power supplies. Thus they save operating costs and create ideal climatic conditions to reliably meet the high production requirements.

# Sensors for clean water

**The crossflow filter system Aquacross W675 from Romfil GmbH filters up to 300 cubic metres of water per hour – this corresponds to about the volume of a 100 m² flat.**
**It produces drinking water from pre-treated but still contaminated water.**

## Process monitoring for water filtration

Water purification is increasingly becoming an important production factor. Modern fluid sensors ensure efficient and energy-saving processes.

The principle of crossfiltration is particularly efficient: Waste water is pressed into a circuit through thin, porous capillary tubes. Only pure water can penetrate this membrane. Water which is infiltrated with pollutants continues to circulate until it is also purified progressively.

Hundreds of such capillaries are combined in a filter module of a height of approx. 1.5 m. That results in a filtration area of 75 square metres. Depending on the requested throughput several modules operate in parallel. This system is equipped with two lines of 9 modules each which corresponds to a filter area of 1,350 square metres. It enables to clean 300,000 litres of waste water per hour.

Modern sensors help to monitor various processes of the installation and to operate them in an optimum range. This is the only way to achieve the maximum filter performance with a minimum of energy input. For their installation Romfil fully rely on sensors from ifm which have proved to be particularly reliable.

*A flow sensor monitors the feed flow of detergents downstream of the pumps.*


*The crossflow filter system filters up to 300 cubic metres of water per hour.*

## Inflow monitoring

Exact pressure values are needed to let the waste water circulate through the filters so that the filter capillaries reach their optimum degree of efficiency.

Therefore, an ifm pressure sensor type PF2654 is installed in the inflow line to the filter elements. The flush-mount sensor is rated for a measuring range of -0.5 to 10 bar and features very high precision of 0.6 per cent. In combination with the O-ring-free sealing concept the overload-protected and drift-free ceramic measuring cell ensures maintenance-free long-term operation.

The pressure sensor has two switching outputs. The second output can also be configured as analogue output (4…20 mA or 0…10 V). The alphanumeric LED display helps with parameter setting and also serves as display of measured values.

Apart from pressure, the system temperature is also monitored in the inflow line.

The TA3437 unit is a universal temperature transmitter with a 4...20 mA analogue current output. A high level of accuracy is achieved using a class A accuracy Pt sensor element and in-house calibration. Furthermore, the tried-and-tested ifm film technology ensures excellent response times of T05 = 1 s and T09 = 3 s. In addition to the protection rating IP 69 K, the completely sealed and welded stainless steel housing also ensures high mechanical stability. The housing design reduces build-up of dirt and can be cleaned all around.

## Level in the filter

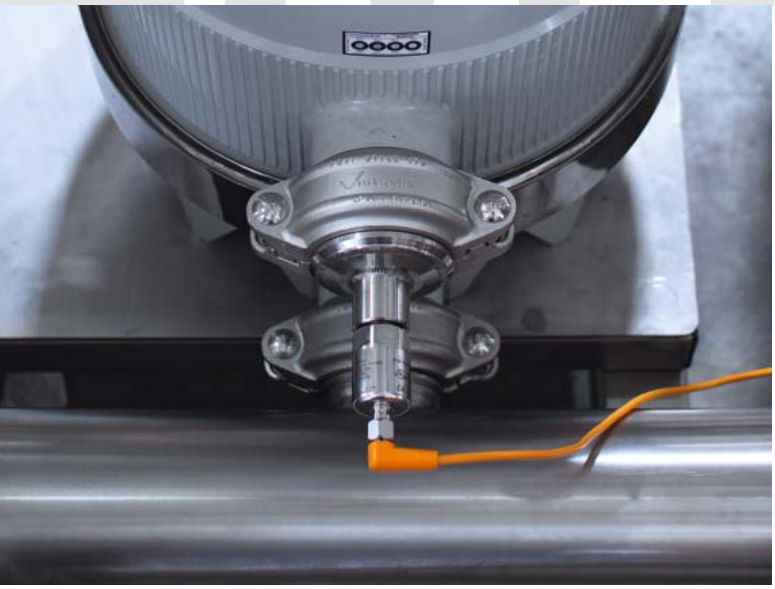
An LMT100 point level sensor from ifm is mounted at the base of the first filter module. It monitors whether the filters actually contain water for filtration.

The particularity of the LMT series is its insensitivity to deposits.

The extremely smooth surface characteristics of the PEEK tip of the sensor is Ra < 0.8 µ. Adherence of dirt and residues of media is hardly possible. The level is reliably detected even with foam or viscous media.

LMT100

*"Romfil have been using ifm sensors for a long time*



*Level monitoring in the filter module: Even in case of deposits or foam the LMT100 reliably monitors the limit level.*

*A pressure transmitter monitors the emptying process of the installation using compressed air*

Set-up is also easy. Media adjustment is not necessary since the sensor is preset in the factory. The level is detected independently of the orientation. Its compact sensor tip allows integration of the LMT even in small DN25 pipes.

The sensor with its high-quality housing materials such as high-grade stainless steel (316L/1.4404) and PEEK meets all requirements for hygienic areas. This also includes a lasered type label and the high protection rating IP 68 / IP 69K.

## Emptying

Occasionally, the complete installation must be emptied, e.g. before or after cleaning operations. A pressure transmitter monitors this emptying process using compressed air.

The PP7554 sensor is distinguished by a high total accuracy of 0.5 %, a compact stainless steel housing and a switch point accuracy of 0.5 %.

The pressure sensing principle using a ceramic-capacitive measuring cell ensures reliable and long-term stable measured values. The user can choose between two switching outputs or one switching output and one diagnostic output. The sensor also has IO-Link capabilities. That ensures not only digital process data transmission but also parameter setting or diagnostics from a controller or a PC.

## Flow monitoring of the detergents

The filter membrane must be cleaned regularly to ensure a long life. This is done using different detergents which are exactly dosed. During the automatic cleaning process an ifm flow sensor is used for flow monitoring.

The SI5000 sensor operates to the calorimetric principle and therefore needs no mechanical moving parts. This guarantees reliable monitoring even in cases of difficult media over a long period of time. Using microprocessor technology the units are easy to handle. Flow and switch

*Feed flow monitoring: temperature transmitter and pressure sensor in the inflow line.*

points are simply set via pushbuttons. A multi-colour LED bargraph displays measured values and switch points. Various adapters available as accessories ensure fast and reliable process connection.

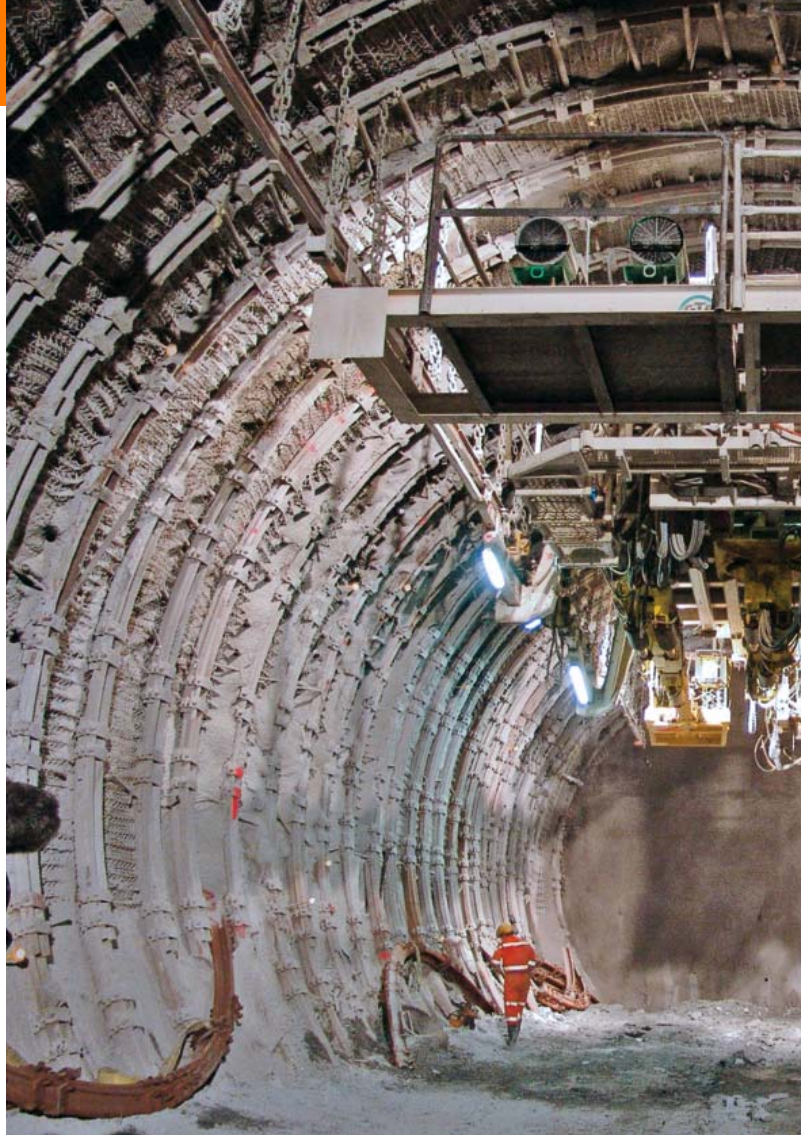
## Monitoring the pneumatic system

All valves of the installation are operated pneumatically. The necessary system pressure of 6 bar for valve control is monitored using an ifm PQ3834 pressure sensor which is installed in a control cabinet. The piezo-resistive silicon cell measures between -1 and 10 bar. It is insensitive to liquids (e.g. condensed water) and deposits that might occur in the system. Furthermore, it guarantees very high accuracy.

The display colour is selectable: red or green. For example: In the acceptable range, the measured value is displayed in green, it turns red when a selectable switch point is exceeded or not reached. This provides optimum overview. Two programmable switching outputs or one switching output and one diagnostic output provide flexible adaption options.

## Conclusion

Numerous process parameters are important for water filtration. For these applications ifm offers a complete range of sensors. The precise and maintenance-free sensors with long-term stability enable an efficient and reliable operation of the plant. Therefore, Romfil have been using ifm sensors for a long time.



# Safety is not magic

**Safety first for tunnel lining**

Almost everybody knows the scenarios from TV in which tunnel sections are blasted out of the rock deep underneath mountain ranges or are bored out using huge tunnelling machines, as is the case with the Gotthard Tunnel with its incredible length of 57 km.

However, the real action actually starts after blasting or drilling because that's when the dangerous work starts of lining the tube that has been driven into the rock.

Absolutely reliable mobile control systems suitable for even the harshest of environments are essential for the highest levels of safety and efficiency. To fulfil this challenging job and to meet the requirements, the medium-sized company, which was established in 1979, relies above all on the systems and products of the automation specialist ifm electronic in Essen.

## Capabilities of the vehicle

To master even huge tunnel cross-sections GTA have developed special vehicles such as the NormLifter 1600 T which is equipped with three flexible telescopic booms at the front. The outer pair are extendible with independent platforms for the operators that cover a wide reach. In the centre there is a working boom with a telescopic manipulator. This holds various steel supports weighing up to 1,200 kg against the ceiling to take the enormous pressure. Using the two working platforms the miners can install arch sections and the complete support construction to clad the rock walls and roof precisely where they are needed. Then fixing mats and cable trays are installed. Together as a "team" the three telescopic arms easily cover working areas up to 12 m high and 16 m wide.

**The company GTA Maschinensysteme GmbH from Hamminkeln specialises in building utility vehicles for lining tunnels, which are used worldwide.**

*"Everything that is safety-related is from ifm*


*Extendible and independent platforms.*

## The dangers

Particular attention must be paid to monitoring the pivoting range, because with certain vehicle loads dangerous tilting moments are possible, depending on the reach and the lifting height, which can cause the vehicle to tip over.
Therefore permanent stability monitoring is required. These comprehensive monitoring functions on the vehicle cannot be carried out by the machine operators alone. The latest technology has to ensure that all safety-related European standards are complied with regarding functional safety in the machine so as to guarantee the protection of the operators at any time.

## SafetyControllers perform controlling tasks to ensure safety

GTA rely on the reliable and certified ecomat*mobile* safety controllers and the tried and tested fail-safe sensors from ifm electronic to coordinate and monitor tasks such as the stability of the vehicle, the reach of the elevating platforms and telescopic arms, and the dynamic load of the entire machine. These powerful and robust sensors were especially designed for the extreme use on mobile machines. Even with complex requirements under harsh application conditions the interaction between the entire safety and control technology from ifm functions perfectly.

*"Everything that is safety-related is from ifm"*, says **Benedikt Klump,** mechatronics engineer from GTA's design department.

## Four stabilisers – the basis for safety

The stabilisers play a very important part in ensuring safe operation of the vehicle. The operators take the vehicle out of its safe condition at the start of each shift. Firstly, all telescopic booms and stabilisers are retracted. The support for the NormLifter consists of four stabilisers, one in each corner; the front two can also be extended horizontally to widen the support base.

Four type IGS204 inductive sensors installed in each of the front horizontal and vertical stabilisers provide a signal to the small CR0403 BasicController and indicate if all cylinders are completely retracted. The same sensor type is installed in the rear stabilisers that can only be extended vertically. These sensors indicate their position to the CR7032 main controller via the CR2033 I/O module. The vehicle cannot move unless all these signals have been received. During the stabilising process, the end positions of the horizontal cylinders are detected via two safety-related inductive position sensors (GI701S) via a 32-bit SafetyController (CR7032). They provide a safe signal that the front support has been extended horizontally. The outer vertical stabilisers can only be lowered once the position sensors indicate the correct end position of the horizontal cylinders.

The hydraulic pressures in the front stabilisers are detected using pressure sensors from ifm electronic. If a defined pressure increase is exceeded, the lowered status of the stabilisers and the signals from two load cells are reported back to the 32-bit SafetyController (CR7032 with 32 inputs / outputs from the ecomat*mobile* series). This ensures safe switching-off of various valves and relays, such as E-stop valves or the parking brake. Moreover, the dynamic forces of the front stabilisers are evaluated via one power measurement system each in the safety controller to ensure that the leg is sufficiently loaded and is not extended over a hole or an uneven surface.

## Two SafetyControllers in harmony

When the powerful CR7032 SafetyController registers the safe state of all stabilisers, it enables operation of the telescopic booms. A system reserve duly checks the correct activation of the safety function "stabilised" during vehicle set-up. It controls the vehicle and permanently communicates with the other SafetyController (CR7132) with its 80 multifunctional and configurable inputs / outputs controlling the working platforms and the manipulator boom. Both 32-bit SafetyControllers can effect a stop in case of serious errors and bring the machine into a safe state. In case of less serious errors, previously defined parts of the vehicle can still operate. Not all components have to be switched off. Predefined functions already exist for this.

## Telescopic booms, working platforms and manipulator control

Eight movement functions such as lifting, lowering, swivelling, retracting and extending the telescopic booms and tilting are performed by the two elevated platforms of the NormLifter. The manipulator with its open and close gripper functions and the platforms are both fixed to one telescopic arm. One IM5124 magnetic-field immune inductive sensor (with correction factor K=1) is fixed to all three booms. Since the partial segments of the reinforcement arches are welded together, the


*CR1083 touch screen installed at the top of the cab gives a quick overview.*

*The powerful type CR7 SafetyController from the ecomatmobile series from ifm electronic built into the vehicle ensures safety in mobile applications.*

*CR2033 robust decentralised I/O module transfers signals to the controller via the CANbus.*

*Vertically extending cylinders at the front and two horizontal telescopic arms ensure the required stability of the vehicle.*

enormous magnetic fields of the welding electric arc may result in interference to sensors. This resistant sensor is used especially in such environments. It provides a switching signal to indicate a lifting height lower than three metres. The two telescopic booms for the access platforms are in addition equipped with one IFM204 sensor each providing a switching signal when the boom has reached its central position. Furthermore one GM504S wear-free fail-safe inductive sensor operates in the two booms. It provides a signal to confirm that the boom has been retracted.

The CR7132 SafetyController only passes control of the lower stabilisers to the CR7032 SafetyController after both telescopic booms have been completely retracted. This ensures that the stabilisers can only be retracted when the work booms are in their transport position and guarantees the stability of the vehicle.
The SafetyController CR7132 also provides the PWM control of altogether 32 proportional valves to control the three boom functions. Furthermore the access platforms are automatically levelled during operation. The joysticks on the platforms are linked to the higher-level PLC via the CANbus.

## IO compact module supports decentralisation

GTA use the particularly robust CR2033 IO compact module from ifm for the decentralisation of sensors and actuators via the CANbus via which it transmits the hydraulic level and temperature, diesel fuel level, drive oil pressure and drive temperature to the controller. This also takes inputs from the inductive sensors (IGS204) in the rear stabilisers. Universal use of the module is possible because of its flexible inputs / outputs configuration. There is also a compact and powerful 24 inputs / outputs CR0403 mini controller from ifm electronic in the driver's cab of the NormLifter 1600 T. This carries out several functions such as evaluating various operating and display elements on the dashboard. It also acts as CAN gateway to control the diesel engine via the J1939 protocol.

## Operational data display and diagnostic function

The CR1083 latest generation PDM NG process data monitor is used to clearly visualise the large amount of process and diagnostic data for the vehicle operator. All relevant data is shown on the easily read 7" colour touch screen display. This user-friendly device also has backlit function keys with tactile feedback. It contributes to the safe operation of the NormLifter.

*"A controller including real-time clock is integrated in CR1083 – this was the aim to give both installers and operators reasonable diagnostics",* says **Benedikt Klump.**

## Conclusion

GTA rely fully on intelligent, reliable sensors and systems from the ecomat*mobile* series that have been developed especially for the safety-related mobile use for such demanding works for tunnel lining that are carried out to a very high safety level. Even under extreme operating conditions they perform their monitoring and protection functions without any problems.

*„Everything from one supplier, the devices are designed to work together and they function flawlessly"* concludes **Benedikt Klump** summarising the products from and cooperation with ifm in Essen.

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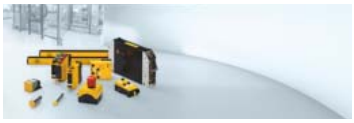

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