Project:

Municipal swimming pool Plauen

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"Sometime this century a bottle of pure water will cost more than a bottle of wine"

Viktor Schauberger (1885-1958)
Austrian natural scientist and inventor

Cost reduction & energy efficiency
by means of sustainable implementation

Contents:

The historic municipal swimming pool in Plauen

Plauen is located in the valley and at the hillside of the Weiße Elster. Where the Syra flows into the Weiße Elster, the valley widens to form a basin. This is where the city centre is located. Plauen became well-known throughout the world at the turn of the 20th century by the production of Plauen lace. (Source: Wikipedia; http://de.wikipedia.org/wiki/Plauen)

Plauen is home to Germany's once most modern swimming pools. It was built from 1909 to 1912, named König-Albert-Bad. It is situated directly on the banks of the Elster close to the centre of Plauen. With its separate halls for ladies and gentlemen, medicinal baths and sauna, it had a distinctive appearance.

During the Second World War the Ladies' Hall was destroyed by bombs, the sauna area and the Gentlemen's Hall could be saved and were re-opened in the mid-1950s. Due to the bad condition of the building and the outdated technical equipment, the baths was closed in 2004.

"As good as new"

Following old traditions - a baths again shining in its new splendour for sports activities.

The sport baths was converted and extended from 2004 to 2007. During the modernisation as well, the spirit of sportsmanship was an important aspect. Because not only the swimmers are supposed to give maximum performance. Maximum values are to be achieved as well in terms of cost-effectiveness and technical equipment for the operation of the baths.

Figure 1: New sport swimming hall with Vario pool of about 50 m x 16.7 m, with a view of the Weiße Elster

The planning of the building concept by OBERMAYER Albis-Bauplan GmbH clearly shows this by its sustainable energy concept for the reduction of energy costs. The use of an air-conditioning system in combination with solar air collectors and heat recovery sets the trend.

The technology, which is never seen by the swimmers but which is nonetheless of key importance for a swimming pool, was supplied, installed and put in operation by the renowned company WTA Plauen GmbH (Wassertechnischer Anlagenbau Plauen GmbH).

Safe limits

As mentioned before, the main technology of the baths is located in the basement. Protection of this important building part should not be neglected. A flooded technology area causes enormous damage and costs. A good reason to decide in favour of a simple, effective flood water alarm at a low cost.
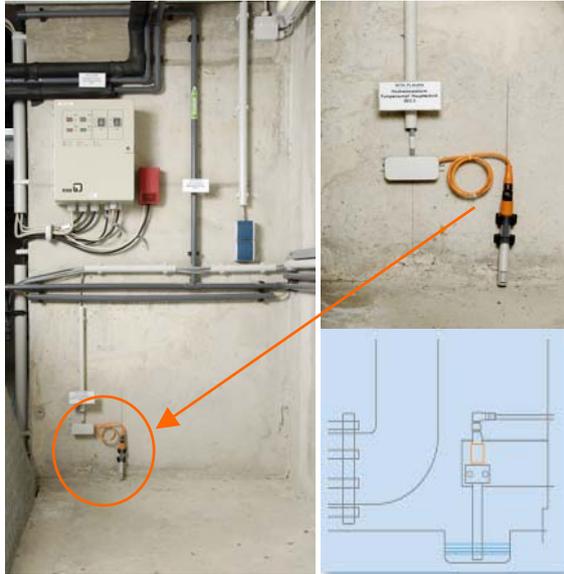
Figure 2: LI5041 level sensor as soil probe

Capacitive level sensors of the LI50xx and LI20xx series can be used in these applications as soil probe or, due to their approval to the German overspill standard WHG, as part of an overflow protection in critical applications. The modular installation concept reduces the usual variety of types. Easy pushbutton setting and a clearly visible operation indication and switching status indication via LED provide the necessary safety for your system.

- Safe medium detection even in the case of soiling and foaming.
- Easy limit level setting via pushbuttons.
- Reliable overflow protection to WHG standard section 19.

Monitoring of pump wells and floor ducts is "only" an additional feature. Preventive actions avoid an exponentially higher damage - at a low additional cost. In this case a binary overflow alarm for the open filters. LI5041 level sensors are used. The level control receives the required analogue signal via hydrostatic level measurement.
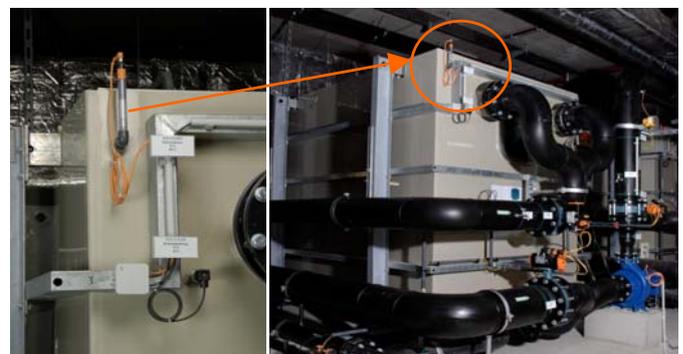
Figure 3: LI5041 level sensor

Figure 4: WTA filter system with overflow alarm

Amortisation time of an overflow protection in the worst case

In case of an average water price of 1.85 €/m³ **(source: BDEW-Wassertarifstatistik 2007)** and a raw water pump with a capacity of about 250m³/h, the following can be calculated (in theory):

Costs €/h if level measurement fails: 250 m³/h x 1.85 €/m³ = 462.50 €/h

The costs per minute are: 7.71 €

The costs of a level sensor, incl. socket, amount to approx. € 105. This results in an amortisation period - in the worst case - of about 14 min (not taking into account the actual **main costs,** caused by the repair of the system and loss of income of the baths, as well as consequential damage).

Installation in minimum time

Time-consuming and cost-intensive factors, in particular in technical systems, are among others installation and wiring times, as well as required cable and installation material. This is where the intelligent wiring system AS-i (**A**ctuator **S**ensor **I**nterface) sets in. It simplifies and minimises the work already when the wiring diagrams and layouts are drawn up. Instead of numerous individual cables, only <u>one</u> **2-wire, yellow AS-i cable** is laid. The standardised insulation displacement technology ensures fast, cost-effective installation without stripping and wiring the individual cores. The minimisation of the amount of cables by the use of AS-i considerably contributes to the reduction of fire loads in public buildings.
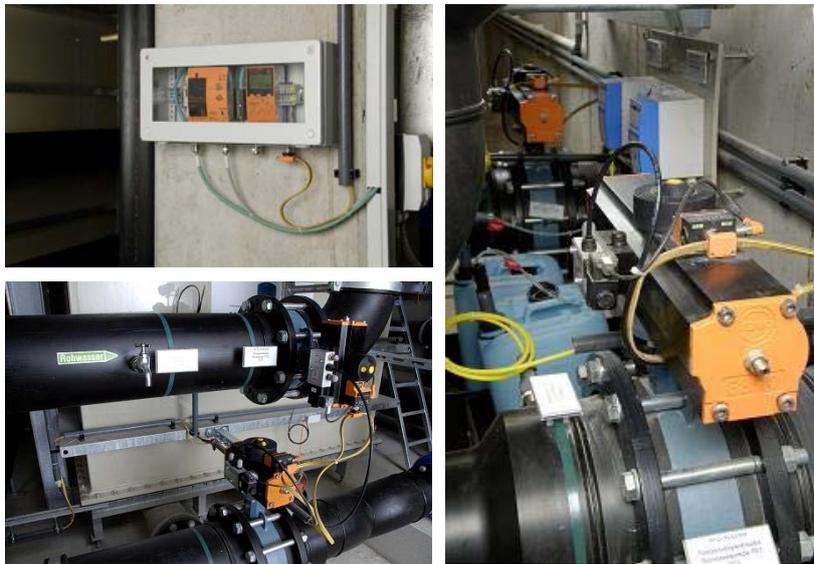

Figure 5: top: AC1335 (SmartLink DP) and AC1218 (AS-i power supply 8 A); bottom: filter technology by WTA with EBRO actuators; right: actuators at the splash containers with AS-i control

A conventional PLC with Profibus DP master was used as central control technology component.

An AS-i Smart Link DP (AC1335) from ifm electronic was used for communication on the AS-i side and as interface with the Profibus DP environment.

Software integration as Profibus DP node in the PLC is carried out via GSD files. These GSD files have been tested by customers in different applications and are available for download on ifm's homepage.

The SmartLink DP (AC1335) with integrated AS-i master acts as gateway to Profibus DP and is installed in combination with an AS-i power supply (AC1218) at a decentralised position in the field. The company EBRO Armaturen GmbH provides a "plug-and-play" field solution with the above-mentioned components from ifm electronic gmbh. AS-i SmartLink DP acts as a node in the Profibus DP network. Due to the decentralised arrangement of the Profibus DP node (SmartLink) and the AS-i modules, part of the intelligence (I/O modules) of the system has been transferred to the field. So, savings - in particular due to smaller control cabinets - are clearly visible. Extensions to the system can be easily implemented without changes to the control cabinet. The intelligent wiring system AS-i can not only be used for processing digital signals and controlling binary actuators. It can also be used for collecting analogue process data in the field.

Figure 6: Filter by WTA with AS-i modules AC2516 and AC2507

General networking of actuators in swimming pool technology
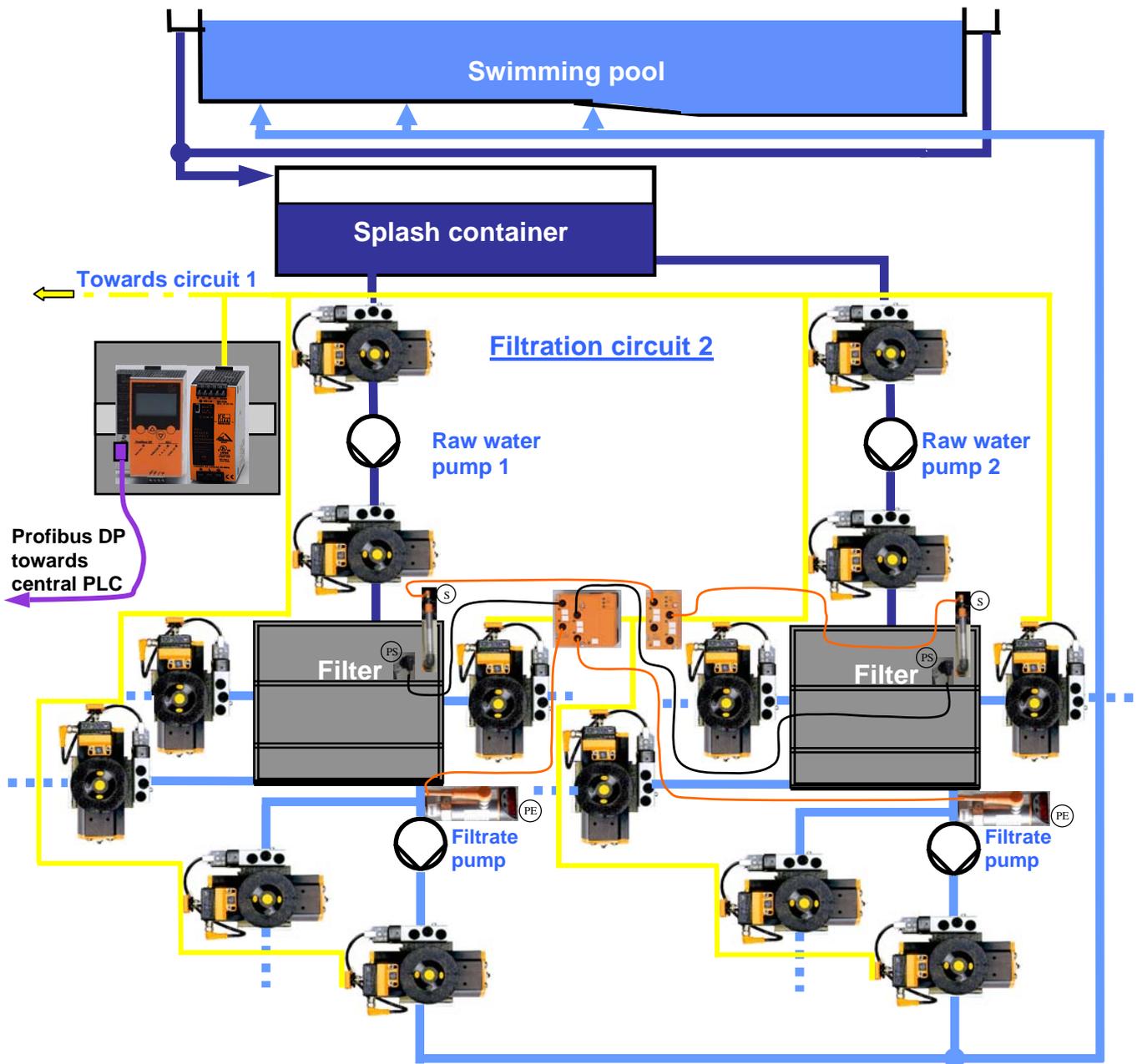
Diagram of circuit 2 of the filtration of the swimming pool. The SmartLink DP unit (AC1335) used manages - in circuits 1 and 2 of the processing system - a total of 29 pneumatic actuators equipped with the AS-i dual sensor T5. In addition, the analogue values of the pressure sensors (e.g. PE3004) and the limit level signals of LI5041 are collected via the AS-i field modules.

(S) = limit level signal   (PS) = hydrostatic filter pressure   (PE) = pump pressure suction side

Processing of analogue and binary signals

Standardised analogue and binary signals, e.g. continuous level measurement, temperatures or binary overflow alarms can be detected at a low cost on site and transmitted to the PLC via the intelligent wiring system AS-Interface. The high protection rating IP67 of the AS-i ClassicLine field modules for example enables direct use at the filter without additional mechanical protection. A/D conversion takes place directly in the AS-i module and considerably facilitates system programming. Savings with respect to wiring of the sensors and actuators are made possible by means of standardised connection cables.

Figure 7: AS-i field module AC2516 with 4 analogue inputs

Cost comparison AS-i / conventional wiring:

If we take a look at the pneumatic actuators from EBRO ARMATUREN GmbH, the savings potential can be easily determined.

Number of actuators	29,00	
Total AS-i cable length	100,00	
Average cable length (konv.):	15,00	
Hourly wage in euros:	29,11	

Services	**AS-i**	**Conventional**
Laying of cables: cable with PVC sheath DIN VDE 0250 supplied and laid incl. fixing:		
Time required per metre of cable		
AS-i cable	2,90 min	-
End position detection	-	2,90 min
Costs per metre of cable		
AS-i cable	1,41 euros	-
End position detection	-	1,41 euros
Calculation of time expenditure for project:	2,9 min/m x 100m =	2,9 min/m x 15m x 29 pieces =
Time expenditure for the project	**5 h**	**21 h**
Calculation of costs for the project:	1,41 euros/m x 100m =	1,41 euros/m x 15m x 29 pieces =
Costs for project	**141,00 euros**	**613,35 euros**
Terminal connection stripping of the cable, insertion and connection according to wiring plan:		
Time expenditure per actuator		
AS-i cable	5,00 min	-
End position detection	-	13,30 min
Costs per actuator		
AS-i cable	2,43 euros	-
End position detection	-	6,45 euros
End position detection	5 min/piece x 29 pieces =	13,30 min/piece x 29 pieces =
Time for project	**2 h**	**6 h**
Calculation of costs for project:	2,43 euros/piece x 29 pieces =	6,45 euros/piece x 29 pieces =
Costs for project	**70,47 euros**	**187,05 euros**
Connection in the control cabinet: stripping of the cable, insertion and connection according to wiring plan:		
Time expenditure		
AS-i cable	10,00 min	-
End position detection	-	13,30 min (per actuator)
Costs		
(AS-i cable)	4,85 euros	-
End position detection	-	6,45 euros (per actuator)
Calculation of time expenditure for project:	10min =	13,3 min/piece x 29 pieces =
Time for project	**10 min**	**6 h**
Calculation of costs for project:	4,85 euros =	6,45 euros/piece x 29 pieces =
Costs for project	**4,85 euros**	**187,05 euros**
Total time services	**7 h**	**34 h**
Total costs services	**216,32 euros**	**987,45 euros**
Cable material	**AS-i**	**Conventional**
AS-i cable per metre	1,34 euros	-
End position detection per metre	-	0,43 euros
Total costs cable material	**134,00 €**	**187,05 €**
Total costs laying of cables	**350,32 €**	**1.174,50 €**

For comparison, we take an actuator with control cabinet and integrated mechanical limit switches, as compared to an actuator with AS-i connection, an AS-i dual sensor T5.
Both versions are offered by EBRO ARMATUREN GmbH ex works with solenoid valve and preinstalled to an actuator.
Both versions are tested prior to delivery.

Figure 8: Filtrate water pipe with T5 connection

Explanation of the calculation: The pure "wiring times" and the resulting costs are compared (figures from the association Zentralverband der Deutschen Elektro- und Informationstechnischen Handwerke).

Stop it vanishing into thin air

29 pneumatic actuators are installed in the two circuits of this project for water treatment. These are required in the first filtrate pipes, at splash containers, for the control of overflow gutters and the 4 open filters of WTA. As already described, these actuators are pneumatic actuators, driven by compressed air. The required pressure is generated at a central point in the main technology, by means of a dual compressor. Here - as implemented by WTA - energy efficiency can be achieved.

The energy required for the generation of compressed air is a precious commodity and should therefore be used and dosed with care.

Figure 10: Compressed air generation via dual compressor with pressure sensor PK6524 and compressed air meter SD6000.

What does leakage cost?

Loss of air in the compressed air system, caused by a leakage of only 1 mm, causes energy losses of 0.3 kWh in case of a pressure of 6 bar. This corresponds to an amount of approx. €144/year (kWh x €0.06 x 8,000 operating hours/year).

In a 12 bar compressed air network, costs amounting to €480/year are incurred in an above-mentioned situation.

(Source: www.druckluft-effizient.de)

Figure 11: Pressure sensor PK6524

Figure 12: Compressed air meter efector metris SD6000

The ifm **efector metris compressed air consumption meter** provides the user with a low-cost opportunity for precise measurement of the current compressed air consumption as well as the total consumption. The sensor is installed and adjusted in a pipe length at the factory. Costs can even be broken down to the process level when looking at the total building cost. Due to the high sensitivity even smallest quantities, like those which for example occur in case of leakage, are detected at an early stage and can be remedied. Out of its own interest, the company WTA Plauen decided to optimise the system. An electronic pressure sensor type PK6524 monitors the system pressure. The compact ifm PK pressure sensor series is the first electronic pressure sensor to feature a successful combination of very easy setting and high long-term stability. The ease of handling is fascinating: due to the radial setting rings with a unit scale for optimum readability, every user can adjust the set point and reset point quickly and precisely even without pressure being applied.

Modern pump diagnosis

There are different approaches to contribute to smooth operation of the pumps and trouble-free processes. Run-dry protection or the avoidance of bearing damage to the pumps used is another important aspect. This quickly leads to failures and, so, to maintenance costs and loss of income. One possibility is the use of common flow monitors, e.g. the SI5000 series by ifm electronic, for run-dry protection.

Figure 13: 4 raw water pumps at the splash containers

Figure 14: Filtrate pumps at the filters

Using established and sophisticated technology, WTA Plauen GmbH has gained a very high reputation in the sector of swimming pool technology over many years. But not only tried-and-tested products were to be used - innovations were to be offered to the operator as well. So, the decision was made to equip the raw water pumps from the company Fluvo, as well as the filtrate pumps from HERBORNER PUMPENFABRIK with low-cost vibration sensors and evaluation units from ifm electronic.

Vibration diagnosis with ifm sensors

The VSA001 vibration sensor serves for measured data acquisition especially for the octavis diagnostic electronics VSE002. The compact and highly robust design provides good long-term stability even under adverse environmental conditions.

- By means of permanent monitoring, component damage is detected when it arises.
- Maintenance tasks are only carried out when required and can be planned in time, according to the principle of RTM (Real Time Maintenance).
- As compared to preventive maintenance, cost savings of about further 18 % are possible. Standstill is reduced.

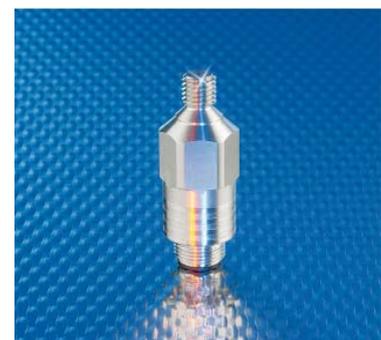**Figure 15: Filtrate pumps with efector octavis**

Figure 16: Vibration sensor efector octavis VSA001

efector octavis diagnostic electronics

Figure 17: efector octavis diagnostic electronics type VSE002

By means of the efector octavis diagnostic electronics it is possible to continuously and simultaneously analyse and evaluate the measured signals of up to 4 vibration sensors with the octavis technology. Pre-alarm and alarm are electrically signalled via switching outputs. Up to 2000 values are stored in the diagnostic electronics.

Using the Ethernet interface the decentralised diagnosis can also be integrated into higher-level systems. Due to the compatibility of the data (OPC), the diagnostic values can be easily integrated into all usual visualisation environments and can be made accessible to remote diagnosis within the framework of teleservice concepts.

Figure 15: Use of the VSE002 diagnostic electronics, on-site diagnosis via laptop

The modern swimming pool technology by WTA Plauen GmbH shows how the diagnostic data of the ifm electronic vibration sensors can be used twice. Using the menu-guided parameter setting software and the integrated rolling element bearing database, set-up for bearing monitoring of the pumps only takes a few steps. Run-dry monitoring requires certain know-how on vibration analysis. Here, the corresponding settings were made using the combined knowledge of WTA Plauen GmbH and ifm electronic gmbh. The possibility of installation directly on the pump housing enables use without additional mechanical means.

Let us once again emphasise the dual use of this technology. The run-dry protection with simultaneous rolling element bearing monitoring of the pumps is not restricted to pumps from certain manufacturers. Retrofitting to existing pumps is possible. The system becomes more transparent for service staff and operators. If remote diagnosis is used, the service staff for example can directly bring the required replacement parts when driving to the customer for a service call. The extensive diagnosis and the advantage of system monitoring were implemented by WTA Plauen GmbH in this system. WTA Plauen GmbH stands for innovations and state-of-the-art industrial equipment.

Conclusion

Advantages for the system designer:
- Reduction of the wiring complexity
- Short installation time
- Quick set-up
- Possible wiring faults are minimised
- Reduction of installation and wiring material
- Good diagnostic capabilities, up to pump diagnosis

Advantages for the system operator:
- Less staff required for operation and maintenance
- Minimised downtimes thus higher system uptime
- Clear system design
- Reduction of fire load
- Easy maintenance
- Excellent diagnostic capability = early detection of damage and timely maintenance
- Detailed cost breakdown, also for the system technology

Profile of ifm electronic gmbh

ifm electronic gmbh is one of the leading manufacturers of automation technology world-wide. More than 3,000 employees in more than 70 countries develop solutions for 80,000 customers in the manufacturing industries. By optimising technical processes in the automotive, food, chemical and cosmetics industries or in environmental technology and building system automation ifm electronic has consistently set new standards and thus ensures tomorrow's production processes.

Products and systems from ifm electronic

Position sensors and object recognition
>   inductive sensors, capacitive sensors, magnetic sensors, cylinder sensors,
>   safety technology, valve sensors, photoelectric sensors, object recognition, encoders

Fluid sensors and diagnostic systems
>   level sensors, flow sensors, pressure sensors,
>   temperature sensors, diagnostic systems

Evaluation systems and power supplies

Bus systems
>   (communication and control systems for process and industrial applications)

Identification systems

Control systems (controllers for mobile and robust applications)

Connection technology

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System partnership:

EBRO ARMATUREN®

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