



Zero-error production in the automotive industry

Advanced Industrial Automation

OMRON



OMRON - the worldwide partner of the automotive industry

ZERO-ERROR PRODUCTION IN THE AUTOMOTIVE INDUSTRY

With over 24,000 employees and a turnover of 5.5 billion Euro, Omron is one of the largest partners of the automotive industry worldwide.

Operating on a global scale, like the automotive industry itself, Omron has regional branches, production facilities, sales offices and advice centres throughout the world, enabling it to react quickly and individually to local market

needs. Innovative products for the whole range of automation technology, with what is recognised as the highest product reliability, shortest delivery times and a first-class spare parts and repair service are the most important reasons for using our products in the car industry.

The production of more and more new models with ever-shorter product launch times makes the demand for

innovative technologies and new quality concepts a decisive one in vehicle manufacture. Quality is no longer measured in percentages or rates per thousand – the requirement is for the failure rate to be no greater than ppm.

Besides the quality of the products, the quality of the advisory service in particular and local service provision including commissioning support have a major role to play.



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Omron with its global automotive group, active in all the major industrialised countries, stands for professionalism and flexibility in worldwide automotive projects. Our specialists are at home in the automotive industry, we know the technologies, the problems and the trends.

Challenge us!

Reliable assembly

To achieve top quality results in the complex integrated production processes of the automotive industry, enormous demands are made on production planning. Without an integrated approach, reducing error rates to the ppm level is almost impossible.

Only by making the assembly process totally reliable with many individual checks in the process, using measurement and inspection sensor technology and visual inspection systems, is ZERO-error production in the sense of Poka-Yoke achievable.

To enable us to check the presence of components directly in the process, we use optical sensor techniques – from a distance, using laser beams or directly at the assembly point, using micro-photoelectric or fibre optic technology.

Laser measurement sensors are used to measure and check gaps, heights, positions and differences. This reduces rework rates, as inspection during the assembly process means that only correctly fitted parts are released to the next step in production.

The latest generation of intelligent sensors combine high-performance evaluation algorithms with simple operation. Using these, the presence and condition of components can be checked and measurement tasks can be carried out whilst the process continues.

Pattern recognition sensors



F10

Vision processing systems



F150/F160/F210

Laser displacement sensors



ZX

Colour sensors



E3MC

Fibre optic sensors



E3X

Photoelectric micro-sensors



E3T

Photoelectric sensors



E3Z

ZERO-ERROR PRODUCTION - THE STRATEGY

- Extremely fast image processing sensors
- Pattern recognition, teaching at the press of a button

- Advanced image processing functions
- Compact and fast with simple parameter-setting

- Precision measurement of gaps, heights and diameters
- Compact, fast and simple to integrate

- Very precise colour discrimination
- Sensor heads with built-in amplifiers or optical fibre style

- Single and multi-channel amplifiers
- Hundreds of optical fibres, – the right one for every application

- Only as big as a finger nail, suitable for the most extreme installation conditions

- Check the presence, quantity and position of components
- Diffuse, retro-reflective and through beam type photo switches – compact sensors in various shapes and sizes

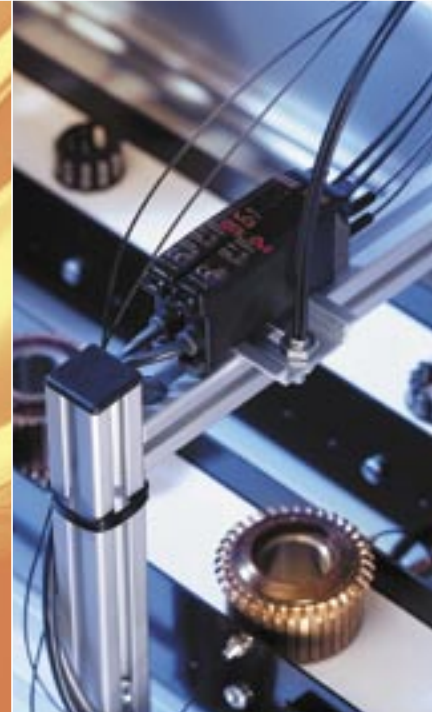


▲ ChasTech Mülheim GmbH manufactures steering systems for the DaimlerChrysler C-class. The F10 pattern recognition sensor checks whether a gasket which has been fitted manually is correctly located.

◀ Measurement of screws and nuts after assembly. Using extremely fast and accurate laser sensors, variations in height and diameter are detected during the ongoing assembly process.

ELIMINATE REWORK

▶ Fibre optic sensors check whether all components are present and correctly fitted. Using optical fibres, tasks can be performed today which previously would have required expensive mechanical equipment or complex image processing systems.



▼ Mercedes Benz Lenkungen GmbH in Düsseldorf produces steering systems on the same production line for the DaimlerChrysler A-class and Vaneo. Both steering systems have a colour-coded steering vibration damping cap which the E3MC colour sensor detects with absolute reliability.



▶ The DELPHI works at Flers/France produces more than two million air-conditioning compressors a year. In many production stations Omron's vision processing systems guarantee the highest production quality with less than 20 ppm rejects by monitoring individual assembly steps and performing type-differentiation tasks.

Inspection as part of the production process

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RELIABLE PROCESSES

Even in fully-automated production processes, ZERO-error production is now no longer a problem. The vision processing systems of the Advanced Sensor family check that every single production stage is correct. Inspection as an integral part of the process is decisive in this instance: only after successful inspection does the station clear the route to the next assembly point. This means that production errors are excluded from the outset and expensive final optical inspection is superfluous. Where the presence, quality and correct positioning

of parts or labels, and the inspection of complex assemblies or tasks such as robot positioning and optical character recognition are concerned, easy-to-operate image-processing sensors are indispensable in modern production processes.

Advanced/intelligent sensors fill the gap between conventional sensors and expensive, complex image-processing systems.

Pattern recognition sensors



F10

Vision processing systems



F150/F160/F210

Colour sensors



F400



- ▼ ChasTech Mülheim GmbH produces steering systems for the DaimlerChrysler E-class on modern assembly lines. To differentiate between standard steering systems and speed-dependent steering systems, as well as left and right-hand drive, F-10 pattern recognition sensors are used.

- ▼ F150 intelligent sensors check the presence of the central nut on the axles at the VW works in Brunswick. Only when inspection is successful do the ABB robots receive clearance to fit the dust caps onto the axles.

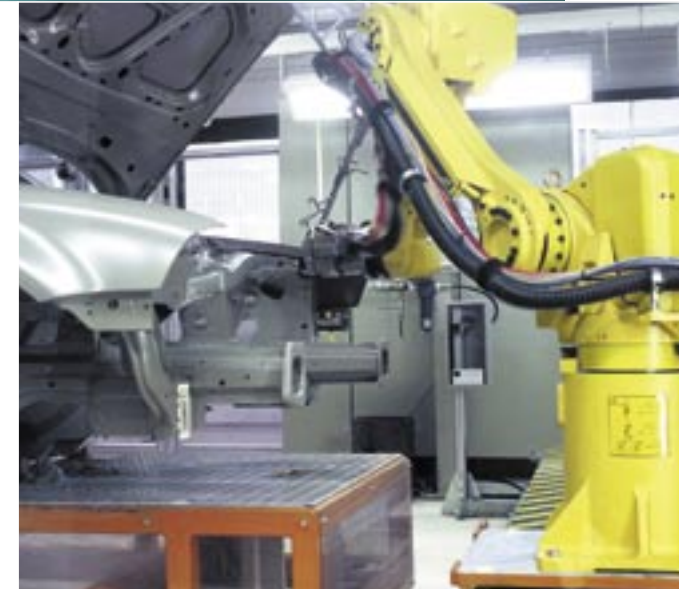
- ▶ At the VW works in Baunatal approx. 12,000 VW and Audi gearboxes are produced daily. The F150 intelligent sensor ensures that there are no protective sleeves left on a shaft before it enters the automatic checking station. To ensure that the different coloured and lubricated protective sleeves are recognised correctly, the F150 uses infrared lighting to screen out extraneous light and therefore ensures that measurement conditions remain absolutely consistent.

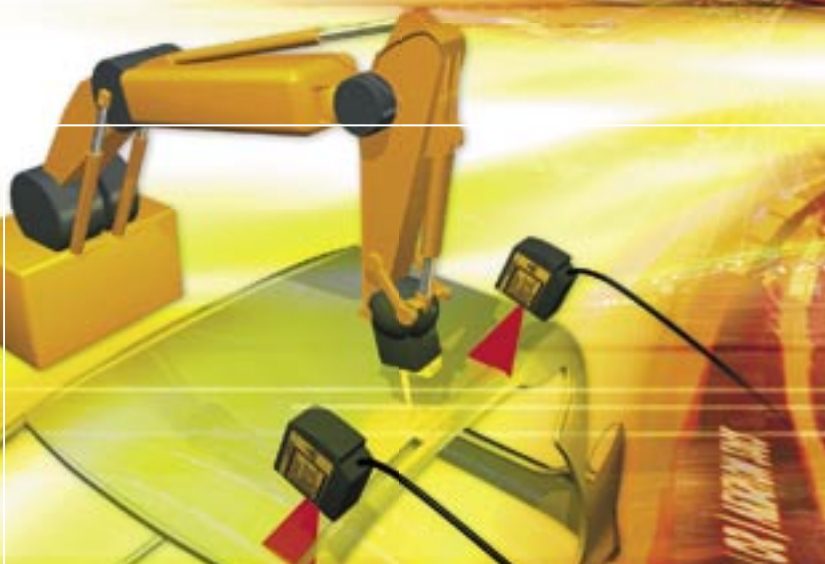


IN-LINE INSPECTION

- Check the presence, completion and correct position of components
- Easy-to-teach image processing sensors for fast pattern recognition
- Object identification, surface inspection, measurement, robot control and monitoring, optical character recognition (OCR), optical character verification (OCV)
- Simple parameter-setting, fast commissioning
- Qualitative inspection and measurement of coloured objects, colour differentiation
- Colour vision processing systems with simple parameter-setting

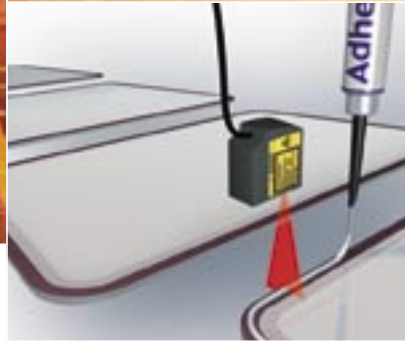
- ▶ F150 intelligent sensors are used at the VW works at Mosel in the painting area and in final assembly for guiding robots. Three cameras determine the current position of the bodywork in each case and transmit this to a Fanuc robot which then applies the sealing agent in precisely the right place.





Laser measurement sensors

Inspection of bonding beads or sealing agents.



Best-Fit-assemblies.



Precise gap measurement.



IN-LINE MEASUREMENT AND INSPECTION

High-precision in-line measurement, inspection and robot guidance is becoming increasingly important in all areas of car production.

Although roofs, doors, bonnets, tailgates and windscreens, the cockpit and the fully pre-assembled front end were until quite recently still fitted manually, or with manipulators, robots with in-line measurement systems are used today. Consistent best-fit assemblies with corresponding robot guidance, or in-line inspection, guarantee the required gap widths and flush fittings. Bonding beads on windows and

cockpit panels, and sealing agent beads in the engine and gearbox assembly are inspected with laser profile sensor systems to ensure correct dimensions.

New production procedures such as laser welding, for example, demand reliable and objective inspection of the welds. Paints of different colours, in particular black, transparent or highly reflective surfaces, black bonding material, welds – Omron's laser measurement sensors make highly precise measurement possible on the most diverse combinations of surfaces.

Laser measurement sensor systems



Z300

- High-precision measurements on difficult surfaces such as black rubber, glass, etc. at distances of up to 950 mm
- Simple parameter-setting without connection to a PC – simple handling, quick and simple integration

Laser profile sensor systems



Z500/Z550

- High-precision profile measurement (2-dimensional) even on difficult surfaces thanks to adaptive laser intensity regulation
- Simple parameter-setting of high-performance measurement tools without software – simple handling, quick and simple integration

Weld inspection system



Z510

- Precise inspection of welds to exclude gap faults, protruding beads, blowholes and pitting, etc.
- Simple parameter-setting of high-performance measurement tools without software – simple handling, quick and simple integration

GET IT RIGHT FIRST TIME



▲ The Golf is produced at the VW Works in Wolfsburg on two assembly lines. The final assembly area of Shop 54 includes fitting the complete pre-assembled cockpit. To achieve a seal between the cockpit mounting plate and the engine compartment, a robot first applies the bonding bead around the entire cockpit plate. A Z300 sensor head is mounted in each case on the robot arm and focuses directly behind the glue nozzle outlet, measuring the height of the bonding bead on a continuous basis during the process.

▲▶ At the VW works in Salzgitter, water pumps for 3 and 4-cylinder Diesel engines are welded on an industrial scale. Welding the aluminium filter assembly into the cast aluminium water pump housing presents a special challenge. The Z510 weld inspection system is an integral part of the machine and checks the quality of the weld for blowholes, pitting and other faults, thereby ensuring that the water pumps are sealed and operating perfectly.

▲ Toyota Motor Manufacturing (UK) Ltd in Derbyshire uses the Z500 laser profile sensor system to accurately measure the depth of the airbag “tear-line” cut made in the covering material which forms the outer “skin” of the dashboard assembly for their Avensis models. This process is safety critical for the correct deployment of the airbag in the event of collision and using this method of in-line measurement ensures zero error production. The results are stored in a computer using an OMRON logging software package, maintaining records for each dashboard produced. The Z500 laser profile sensor system can measure to an accuracy of 0.25 µm.



Ensuring an absolutely reliable differentiation between various components is particularly important in gear and engine assembly. The solution here is to have easily applied identification marks with symbols and colours which can reliably be distinguished by pattern recognition and image processing sensors.

At the DaimlerChrysler AG Bremen works, approx. 1,200 vehicles of classes C, SLK and SL are produced daily. The pin-stamp data-matrix code used for bodywork identification in the cockpit area of the new SLK is read by the V530-R160 in combination with infrared LED lighting. In addition to the pin-stamping, the difficult reflective conditions and reading distance of approx. 500 mm present a particular challenge.

In the DaimlerChrysler AG works in Sindelfingen, data matrix codes are used in final assembly for unique identification of the vehicles. This coding procedure is much simpler to handle than the RFID transponder systems used previously. It is cheaper and means that codes can be read from a greater distance (up to 2 metres).

Latest developments in RFID and SmartLabel technology are opening up new opportunities in production tracking techniques and product traceability.



Product traceability and model identification



MODEL DIFFERENTIATION

A much-discussed topic in the car industry is traceability. Against the background of increasingly stringent product liability requirements, it is vitally important to provide complete documentation for all parts of the vehicle.

Data matrix codes are increasingly used to enable the unique identification of individual components; the marking is applied directly to the surface of the components without a label. In addition to product traceability, this type of coding also opens the door to many more possibilities.

THE RIGHT CODING FOR YOUR PROCESS



Parts and assembly identification in accordance with TS16949 (the new international standard for product traceability in the car industry).

By reading data off the product itself, attaching data media to the production process becomes unnecessary. Choosing the right coding procedure is vital to ensure correct identification within automated production processes. Because of this, in addition to data matrix or bar code systems, symbol or colour codes are also increasingly used. New developments in the field of SmartLabel data technology have made these coding procedures increasingly more attractive for product traceability as well as enhancing the production process.

Identification marking



F10/F150

- A combination of symbols to distinguish between types of components (e.g. in gearbox and engine manufacture)
- Process reliability through reliable type discrimination

Colour coding



E3MC/F400

- Coding using colours for type discrimination and allocation of various related parts e.g. con-rods or bearing shells in engine production

Two-dimensional data matrix codes



V530

- For accompanying the process and product traceability
- Large quantities of data directly on the component surface
- Process reliability thanks to built-in error correction

Data tags and SmartLabels



V600, V690, V700, V720

- Inductive, microwave and SmartLabel data tag systems in a multitude of designs
- Innovative technologies for the most demanding applications in production and logistics



Pick-to-Light systems

Pick-to-Light or operator guidance systems make it possible to rule out errors from the outset in both manual production operations and final assembly of vehicles. This requirement is becoming increasingly essential for production planning, particularly when assembling parts under Just-In-Time conditions.

Using simple and unambiguous work specifications for employees and by using picking sensors to check all process steps means that errors in the assembly or fitting of parts are eliminated. The work piece remains in the assembly station until all steps have been correctly carried out with all parts.

Pre-selection, modularisation and “off-the-shelf” engineering concepts are increasingly replacing the expensive and space-intensive presence of materials on the assembly lines. The continually increasing variety of components makes it necessary to assemble the parts to be fitted in advance and deliver these to the assembly line complete. This by necessity requires fault-free assembly of parts and makes the use of Pick-to-Light or operator guidance systems essential.



INTELLIGENT OPERATOR GUIDANCE FOR ZERO-ERROR PRODUCTION

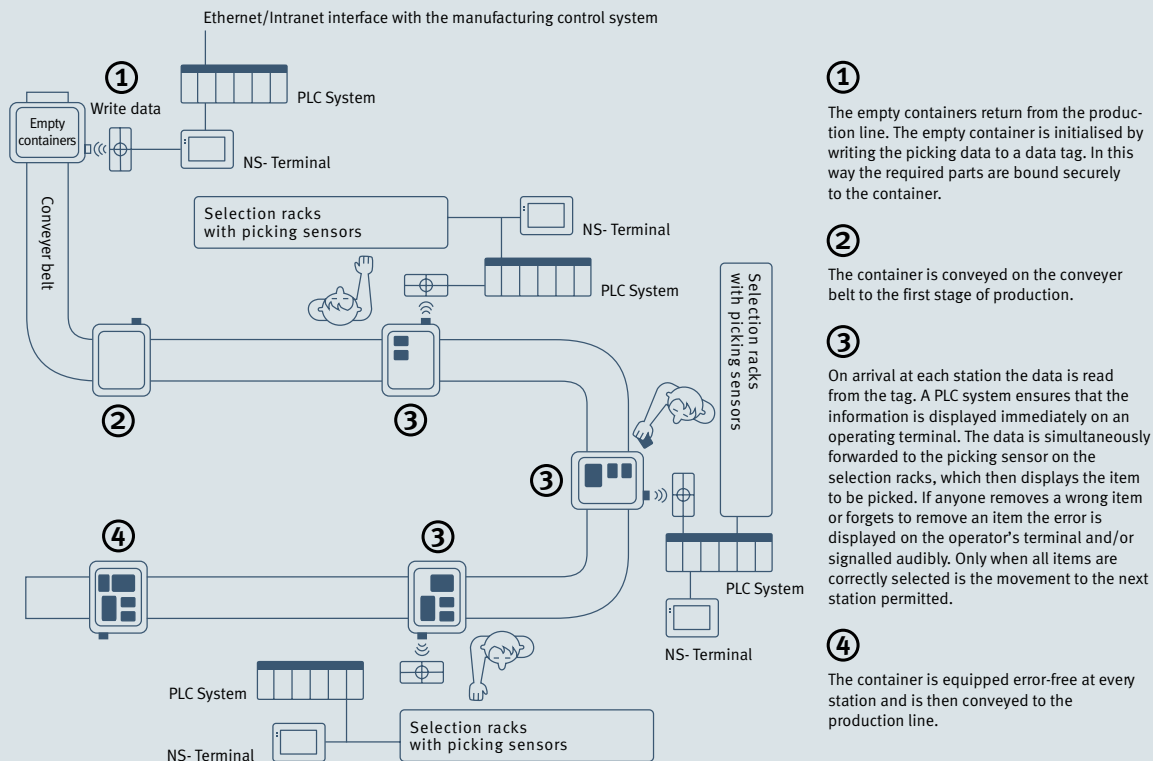
▷ Picking Sensors indicate the correct components required and checks their withdrawal. They are simple to integrate both mechanically and electrically and can also be retro-fitted into existing parts selection systems.

▷▷ Reliable assembly with illuminated guidance and retrieval control using Picking sensors. These prevent mistakes in assembly caused by distractions, job rotation or inadequate training.



EXCLUDE PICKING ERRORS

Operator guidance with pick-to-light systems



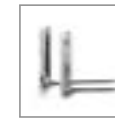
① The empty containers return from the production line. The empty container is initialised by writing the picking data to a data tag. In this way the required parts are bound securely to the container.

② The container is conveyed on the conveyor belt to the first stage of production.

③ On arrival at each station the data is read from the tag. A PLC system ensures that the information is displayed immediately on an operating terminal. The data is simultaneously forwarded to the picking sensor on the selection racks, which then displays the item to be picked. If anyone removes a wrong item or forgets to remove an item the error is displayed on the operator's terminal and/or signalled audibly. Only when all items are correctly selected is the movement to the next station permitted.

④ The container is equipped error-free at every station and is then conveyed to the production line.

Picking sensors



F3W-D

- Parts indication and access control in an extremely flat and compact housing
- Simple integration into mechanical, electrical and software systems

Coding containers and products



F150, F160, F210



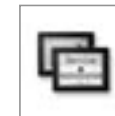
V530



V600, V690, V700, V720

- Coding of the product or parts container using plain text or data-matrix codes
- RFID systems for reliable, non-visual data storage on product or parts container

Operating systems



NS-Series or CX-Supervisor

- Flexible input of order requirements/management of JIT systems
- Highly functional Touch Displays or Visualisation using SCADA-PC software

Control systems



C-Series

- Reading of contract-specific production data from the container coding or via Ethernet from the production information system
- Control technology for data preparation/management, specialised control and assembly statistics



Preventative maintenance

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Power supplies



S8VS

Safety light curtains



F3SN

Field buses



DRT2

Drive technology



3G3MV, 3G3RV

INNOVATIONS FOR THE HIGHEST PLANT AVAILABILITY

In the complex production plants of the car industry, even the smallest shutdown can result in immense costs. Although these production systems are nowadays equipped with many different emergency strategies, a fault in a single component can in the worst case scenario lead to the shutdown of the whole plant.

Faults in automation components, in particular mechanical defects, frequently lead to station or plant shutdowns. In addition to the ever increasing production quality

demands, the topics of preventative maintenance, TPM and elimination of downtime are becoming more important.

Modern automation technology supports this with functions that indicate if a component is likely to fail so that it can be replaced as a preventative measure. This minimises the downtime of machines or entire plants and improves overall availability figures. As a spin-off, it also enables stock control and the purchasing of spare parts to be undertaken in a much more focused manner.

EARLY WARNING SYSTEMS

- Switching power supplies with lifetime monitor and current monitoring
- Alarm outputs indicate when pre-set maintenance intervals have been reached and/or when undervoltage conditions have occurred
- Safety light curtains with intelligent alignment indication
- Alarm outputs indicate if the light curtain is incorrectly aligned or dirty
- DeviceNet I/O slaves with integrated functions such as hours run meter, network voltage monitoring, I/O operation counter and execution time monitoring
- Frequency inverters with automatic monitoring functions for torque and power with DeviceNet connectivity options

▷ Preventative maintenance in practice: intelligent automation technology with integrated functions for preventative maintenance. Modern automation technology does not merely take on automation functions, but also functions relating to the preventative maintenance of the production plants, thereby guaranteeing the highest possible plant availability figures overall.



WARNING: change the power supply during the next maintenance shift!!!

Power supply - S8VS

An additional output from the power supply informs operators when pre-set values of time have been reached which estimate the life expectancy of the built-in electrolytic capacitor.



WARNING: check alignment of the F3SN during the next maintenance shift!

Safety light curtain - F3SN

An additional output from the light curtain informs operators of poor adjustment or dirt on the lens.



WARNING: check and service the valves during the next maintenance shift!

DeviceNet - DRT2 I/O slaves

Integrated functions inform operators about the condition of the network and the mechanical, pneumatic and hydraulic components connected to it.

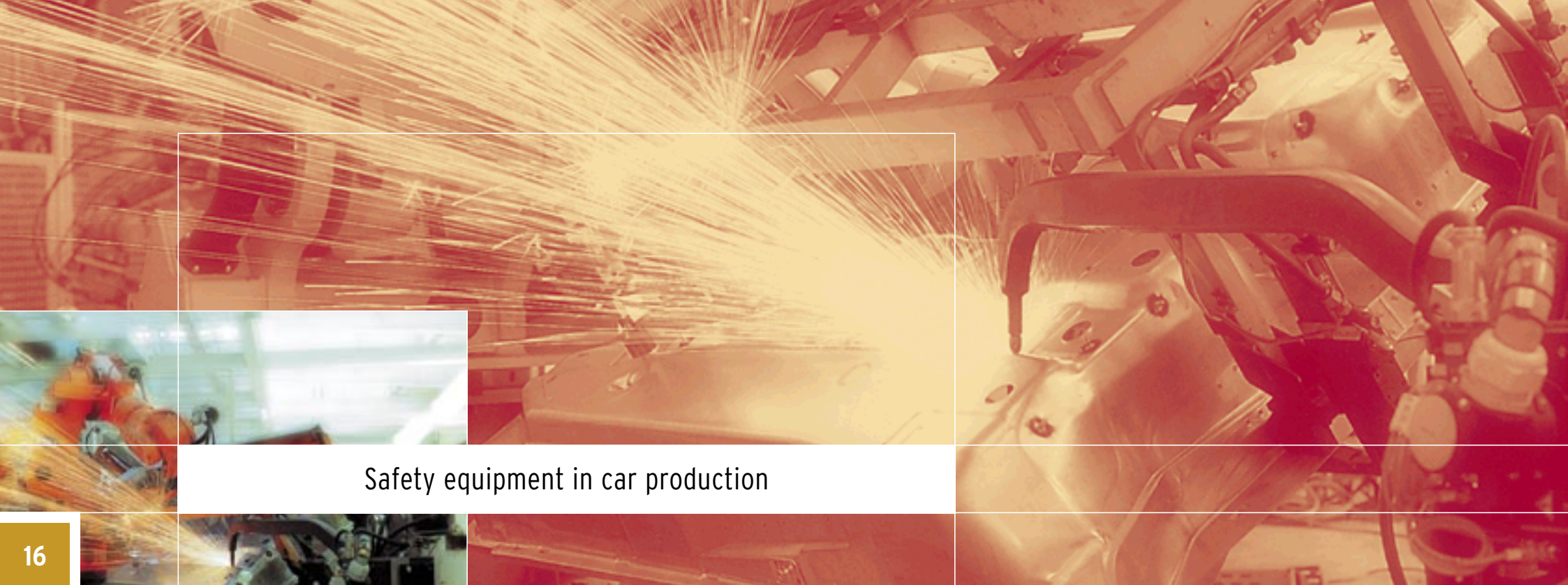


WARNING: check the mechanics of the operating unit during the next maintenance shift!

Frequency inverter - 3G3MV

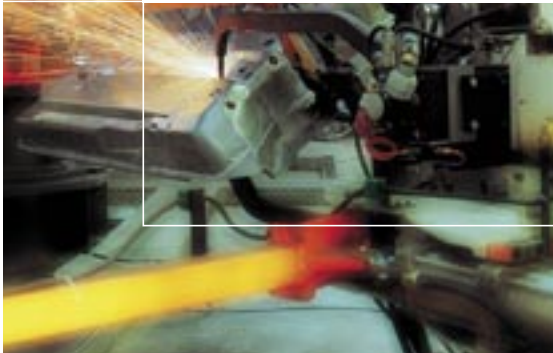
Additional outputs from the frequency inverter inform operators of torque and current values, providing information on the state of the mechanical equipment.





Safety equipment in car production

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MACHINE SAFETY

In the complex production processes used in the car industry, safety systems are essential. Production lines which include both fully automated and manual stations have to be based on well thought-out machine safety concepts. The trend here is clearly in the direction of intelligent and compact safety components and systems right up to the level of safety networks.

The latest safety light curtains are compact and their height corresponds exactly to the height of the protection field. Functions such as Fixed or Floating Blanking and Muting can quickly be adjusted from a hand console.

Examples of intelligent concepts include safety relays available in the form of a PLC module which helps reduce the wiring cost in plant control.

The latest developments enable the use of Safety Network Controllers to operate the plant field bus additionally as a safety bus. This reduces wiring and installation costs as well as fault finding time, which is always particularly important in the car industry, making safety systems simpler and more reliable.

SAFETY FOR HUMAN AND MACHINE

Safety signal processing Safety networks



DeviceNet
safety, G9SX

- Flexible safety concepts
- Transparency and diagnostics
- Clear scalability of safety functions

Emergency stop switches



A22E

- Rapid screwless assembly thanks to integrated attachment clip

Safety switches



D4NS, D4GS

- For safety doors in production facilities and on machinery

Locking switches



D4BL, D4NL, D4GL

- Safe locking of mechanical guards and protective equipment

Safety relays



G9SA, G9SB

- Ultra-slim and expandable for safety monitoring up to category 4

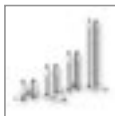
Safety relay modules



CQM1, CS1

- Integration of safety relay circuits in PLC systems

Safety light curtains types 2 and 4



F3S

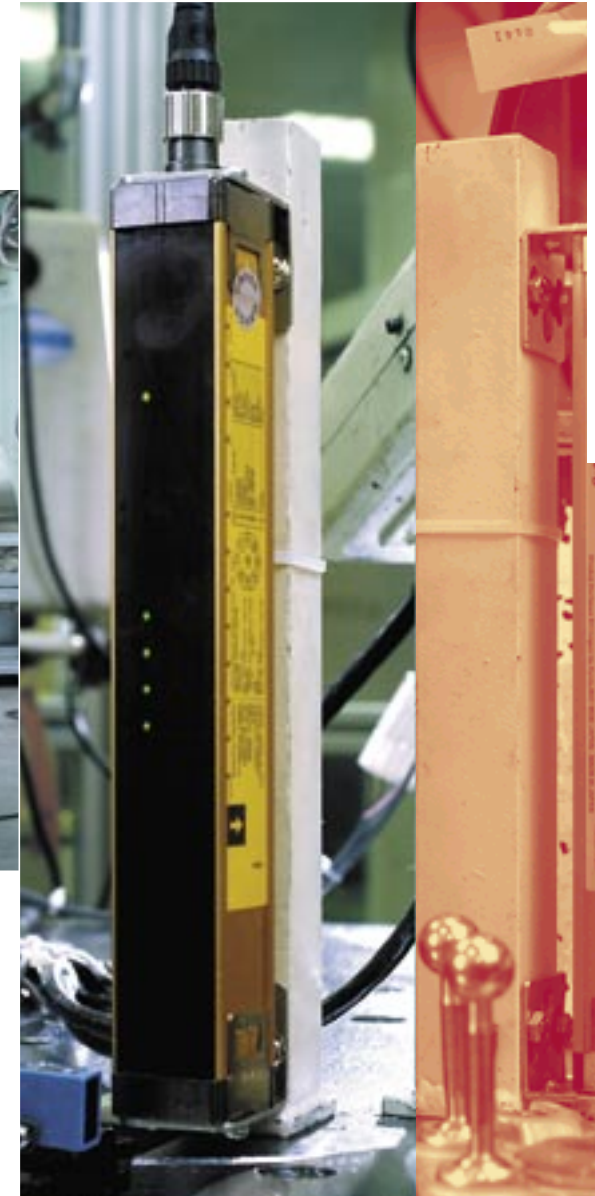
- Non-contact personnel detection

- ▶ Floating Blanking is used when robot's arms have to pass through the light curtain for particular operations. Safety is guaranteed, as the operation stops as soon as a larger than specified number of beams are interrupted by unauthorised access.



- ▲ Safety light curtains offer protection over a large area and allow an uninterrupted view of the production process possible at the same time.

- ▼ The DELPHI works in Flers/France produces more than two million air-conditioning compressors a year. Because of their simple implementation and compact dimensions, they decided to use F3SN safety light curtains.





Factory automation for car production

SIMPLE SOLUTIONS FOR COMPLEX PROCESSES

Looking at complex production processes as a whole with the aim of ZERO-error production requires universal automation concepts. It is not individual automation components, but the architecture, interplay and communication possibilities of the whole system that are decisive for the flexibility, openness and reliability of a production system. Omron can provide the benefits of a single source solution with automation systems that can meet these high-level demands.

Trends such as digital factories, easy operation and visualisation of production systems via Standard Web Browsers, fault reporting by e-mail and remote maintenance via the internet feature prominently amongst the requirements for automation systems in complex production processes.

- ▼ At Valmet Automotive in Finland more than 980,000 cars have been produced to date including models such as Chrysler-Talbot, Opel Calibra, Saab and since 1997 more than 100,000 Porsche Boxsters. Bodyshop, paintshop and also final assembly are all extensively equipped with Omron PLC Systems which are networked via Ethernet, ControllerLink and DeviceNet. In addition to control technology, Valmet also uses a multitude of Omron sensors, frequency inverters, RFID and vision processing systems.



PLC systems



C-Series

- High-performance PLC systems – used worldwide
- Ethernet, DeviceNet, PROFIBUS-DP, ASi: open networks to create flexible production systems

Operator interfaces



NS-Series

- High-function Touch Screen Displays for direct use in production processes
- Simple integration of production data in office applications
- Control and monitoring of production processes using Web Browsers

Drive technology



3G3- and R88-Series

- Frequency inverters, servo and linear drives for handling and positioning applications
- Top class drive technology for flexible production systems in the car industry

- ◀ At DSO in Bopfingen, AEM Elektrotechnik GmbH and Inotec Anlagenbau GmbH, have built one of the most modern EDP immersion paint plants for car components. As well as PLC technology based on the CSI series with networking via Profibus and DeviceNet, using CX Supervisor for process visualisation, all the conveying systems are equipped with Omron frequency inverters.

- ▶ In addition to its home-grown car models, SAIPA Car Manufacturing Group in Iran also produces models such as the Kia Pride, Renault 21 and Citroen Xantia. In 2000 Saipa decided to use Omron CSI series PLC systems with a ControllerLink Network in body production and final assembly of the Kia Pride and Citroen Xantia. PAYKAR BONYAN Co., the leading system integrator, installed the control system as well as a multitude of other Omron products such as frequency inverters, shaft encoders, contactors, limit switches, etc.



FLEXIBLE MANUFACTURING

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