

Automation of the car body assembly line for the new Audi A3

High availability and improved performance

Summary

- When Audi AG redesigned its Audi A3, the company needed an entire new assembly line in Ingolstadt, Germany
- This third-generation assembly line had special requirements for flexibility, performance, and diagnostics in the automation solution
- The Phoenix Contact RFC 470S safety controller using the Profinet/Profisafe system met the system needs

Customer profile

For the new Audi A3 body assembly line in Ingolstadt, Germany, Audi engineers selected the Profinet/Profisafe system from Phoenix Contact. The assembly line for the production of the third generation of this high-tech, lightweight vehicle body places special requirements on flexibility, performance, and diagnostics in the automation solution.



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Challenge

Audi AG built a new two-level production building to assemble its completely redesigned Audi A3 body. The assembly line uses up to 800 robots. The complete body assembly line is divided into 130 cells. (Figure 1).

Profinet/Profisafe is used to transfer the data, enabling flexible configuration of network topologies. This streamlines the system planning process in the initial project phase. Furthermore, data can be transferred via WLAN. This is the basis for a flexible and fast framer application with safety valve units. Conveyor systems also transport material between cells in different production units. Unlike the cells in car body assembly area, the conveyor systems are distributed over wide areas and across several levels. This places special requirements on the control units and the structure of the Profinet network.

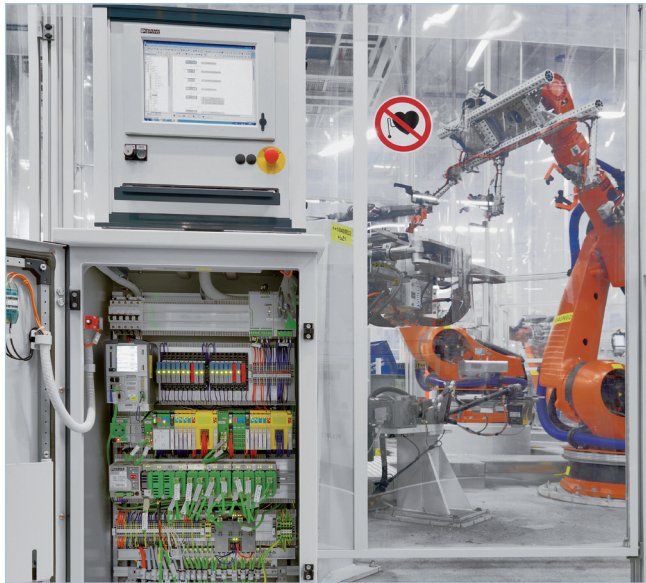


Figure 1: The cell operator control unit has an industrial PC for programming, diagnostics, and visualization. The RFC 470S safety PLC, the network switch, and the safety I/O modules are installed in the lower unit, where they are easy to access.

Solution: high-performance PLCs reduce cycle times

Audi uses the high-performance RFC 470S PLC for its system control. The RFC 470S consists of two independent controllers. One is the standard programmable PLC in compliance with IEC 61131. The second is a SIL 3-rated safety control system. The two control platforms are integrated into one device. While one platform is responsible for the standard application and Profinet communication, the other platform prepares the Profisafe telegrams and executes the safety application. This configuration provides several advantages for the user.

The RFC 470S executes the standard system program and the safety program in parallel and independently of one another. This ensures independent control and timing for each function. This separation keeps cycle times short for the control and the safety program.

Short program cycle times play a decisive role in the production cycle times of the various cells. This is because the complete production cycle of a cell is subdivided into several work steps, or PLC cycles. Furthermore, controlling the individual command devices such as robots or frequency converters requires a

handshake technique, which means that additional PLC cycles are also necessary here. Using the RFC 470S controller helped reduce the PLC cycle times in the Audi production systems to an average of twelve milliseconds. Consequently, the cycle time of the larger production cells could be reduced in total by up to one second.

Password protection secures the PLC safety component

The controls are programmed using two interconnected tools. The PC Worx engineering tool is used to configure the Profinet system hardware and create the standard application according to IEC 61131. The safety PLC integrated in the RFC 470S is programmed using the certified SafetyProg software tool. The safety-related functions of the particular production cell are programmed in the safety controller.

Here, safety functions such as emergency stop, protective door contacts, and loading/infeed areas equipped with safety guards, as well as safety robots and safe drives, must be taken into consideration. SafetyProg also supports the system programmers when it comes to receiving safety approval for the system. Once the safety program has been validated, it is password-protected to prevent unauthorized changes. Access to the safety components of the PLC can also be password-protected, which secures a high degree of system safety during startup.

By using two separate programming interfaces, the system programmers can also program and start the standard component of the system program without requiring any safety know-how.

Faster generation of user interfaces

Audi and Phoenix Contact personnel worked together to create a function block library for PC Worx. The library encompasses all of the software functions required to program the production cells. This includes the control logic, alert management, and the coupling to the operating control units via OPC. This standardization allowed automation of the steps required to generate the system programs.

To achieve this, appropriate interfaces were implemented in PC Worx, enabling the hardware configuration to be transferred from the ECAD planning tool. Specifically, the Profinet names, the device type, and IP addresses are imported into the engineering tool from the hardware diagram. The standardization specifies the PLC program structure in compliance with IEC 61131, so that programs can be automatically imported from the system environment.

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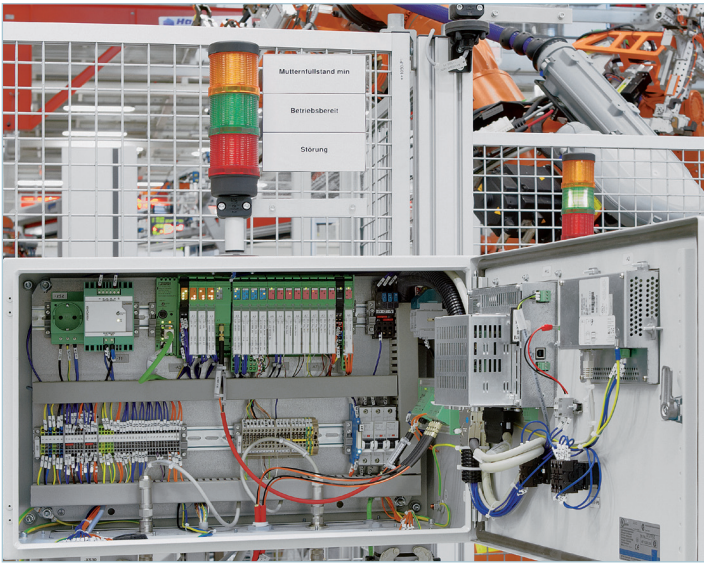


Figure 4: With the ILC 190 microcontroller with integrated Profinet device from Phoenix Contact, encapsulated function units can be easily connected to the system via Profinet.

Fiber optic link monitoring facilitates preventive maintenance measures

In the various systems of the car body assembly line, Profinet devices installed close to welding applications are connected to the controller using fiber-optic cables. The devices measure the optical power received at the incoming fiber-optic cable interface, which is then saved in their Profinet diagnostic registers. In addition, the data link lengths can be read out of the diagnostic registers. Both pieces of data serve as indicators for the quality of the fiber-optic cable data transfer and can also be used as acceptance criteria. To achieve this, Diag+ lists in a report every fiber-optic cable connection between the Profinet devices with the associated optical receive power and the data link length. The report, saved as a PDF file, is used for purposes of comparison when subsequently testing fiber-optic cable connections. Diag+ automatically carries out the comparison and transparently shows users the changes at the fiber-optic cable links.

The RFC 470S controller also regularly reads the optical receive power of the Profinet devices and evaluates this data in the application. If a data transfer link deteriorates, the application detects and signals this to the central process control unit. This means that personnel can initiate preventive maintenance work before the system develops a fault.

Results

The new automation network at the Audi plant presented many challenges, but Phoenix Contact and Audi managers collaborated to meet these special needs. The RFC 470S met the safety requirements of this complicated network. Thanks to the careful network planning, Audi's production facility runs faster, and is more flexible and easier to program. If a failure occurs, it is easier to diagnose the problem, and personnel are better prepared to initiate preventive maintenance before the problem becomes too serious.

Extensive training of suppliers and personnel

The Industry Solutions Automotive Project Group at Phoenix Contact supported Audi staff in the planning phase leading up to the implementation of the body assembly line for the new Audi A3. As the team has comprehensive system know-how and a wealth of experience in this area of automotive production, the system requirements placed on the Phoenix Contact control system were jointly identified at an early stage – and implemented before the project was launched. The suppliers involved in the design, engineering, and commissioning of the individual systems were trained by the project group in the areas of Profinet/Profisafe system technology. The team achieved this goal by providing training courses, planning meetings, and startup support on site – which helped prevent expensive project delays.

The Automotive Project Group collaborated with the training department at Phoenix Contact. They incorporated different training concepts to teach maintenance and operating personnel on the car body assembly line how to use the new technology (Figure 4). This meant that the production systems went into operation smoothly and delivered a high degree of availability.