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Automation in Motion

Smart Factories promise operators high flexibility – such as through the use of automated guided vehicle systems or mobile robot solutions. The automation of these subsystems requires extremely compact control and drive concepts.

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The production facilities of the future are no longer homogenous. Increasingly smaller functional units are configured as independent modules and only connected when needed. Since stationary handling and conveyor systems are not flexible enough, automated guided vehicle systems (AGV) will be gradually assuming internal transport tasks in the future. You can flexibly react to changing requirements and close the gap in the automated processing chain within a factory. In short: AGVs are a permanent part of Smart Factories and must therefore be included in the total automation.

AGV as an Automation Benchmark

The control and automation technology used in the mobile system components must therefore meet high demands. In addition to the process control, must often master mathematical tasks to implement the motion commands from the master control. With freely navigating systems, this includes the continuous testing of the course traveled using magnetic points, laser reflectors or optical features of the surroundings. The drive technology not only controls the drive motors, but also auxiliary drives such as lifting, rotary or sliding units for material transfer as well. Often, visualization directly on the vehicle is also required – including accessibility for special operating cases and maintenance. Not to be forgotten – functional Safety. Since especially with free-moving systems, minimizing the risk of accidents is essential. Whether lane-guided as a mobile platform carrier in assembly lines or free navigation for flexible material supply: Internally, most compact automated guided vehicles have extremely limited space available and this often not continuous. Rather, distributed over several small hollow spaces. In the battery-operated vehicles, the permissible current consumption is also tightly limited. Finally, due to their size and power usage, serial units were poorly suited in the past for such applications in industrial automation.

The Communication – A Unique Challenge

The communication presents an additional, as well as unique challenge – it must be wireless. Today, mostly WLAN is used. Due to the lack of wiring options, Safety-relevant signals must also be transmitted wirelessly. This is an issue wherever automated guided vehicles dock onto machines or production cells to transfer material. The Safety installations of the cell, as well as the vehicle, must therefore allow exceptions to their rules. At the same time, personnel must be protected from injury. To explain: When required by the AGV, the Safety control of a production cell must prevent safe actions, for example, when penetrating a light grid so that the vehicle can enter. Ideally, it knows the contour of the vehicle, so that after this request, it ‘allows’ the safety violation as long as the appropriate light

(Photo: Melkus Mechatronic)

barriers are suppressed in the entire light grid. If other elements are suppressed – such as when a person happens to pass through a light grid at another location after such a request but before the vehicle has entered – the Safety violation must then be triggered. Such a situation occurring is mechanically prevented whenever possible, but it cannot be ruled out completely. And that is not enough: The floor of a production hall is not completely smooth or even. The behavior of the motor is therefore never so uniform and predictable as in a machine tool, for example. As a result, the control and visualization must be able to handle vibration and impacts well. For all these reasons, AGV manufacturers have in the past, mostly developed the control system for their vehicles for a specific task. The very small quantities of these vehicles, which are often designed for a specific facility, is not only an enormous cost factor for new systems. It makes maintaining long-term replacement part inventory difficult and expensive, which therefore has a negative effect on servicing and total cost of ownership. In addition, it also brings the need for individually programmed interfaces with it, which complicates the seamless integration of automated guided vehicles into complete solutions and prevents connecting AGVs to existing systems after their modernization.

Mobile solutions such as the self-driving 'Packmann 200' from Probotics (left) or the AGV (automated guided vehicle) from Directech will be more common in the future, for example, in shelving alleys or in assembly lines.

(Photo: Directech / Thorsten Sienk/Kollmorgen)

Miniaturization Makes It Possible

Against this backdrop, the demand from the AGV manufacturers to move away from the current special designs is more than understandable. To take this into account, one thing is first necessary: The consistent miniaturization of serial automation, like the I/O series S-DIAS from SIGMATEK for example. The module family in pocket format is, with up to 20 I/Os within a width of only 12.5 mm × 103.5 mm × 72 mm, not only especially compact. They also combine fast signal processing (bus cycles under 100 µs) with comfortable handling and high vibration resistance as a result of mechanical interlocking, as well as robust connectors using the two-point contact principle. Depending on the application, various CPU modules expand the I/O system with Edge technology, which is ideal for multi-CPU con-

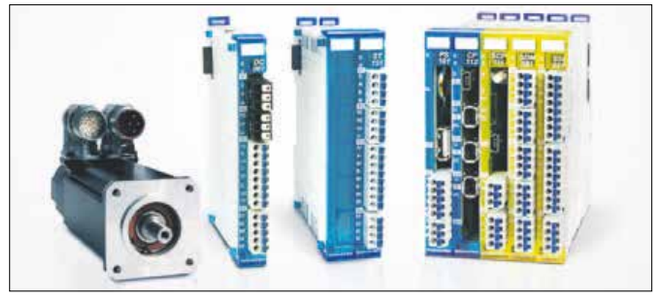
(Photo: Thorsten Sienk/Kollmorgen)

A look inside the Packmann 200 reveals the vibration-proof S-DIAS system with motion control, as well as Safety and two AKM low-voltage DC servo motors.

cepts. During their development, not only is the performance in focus but also the consumption data: The CPU DIN rail module CP 111 for example, with an 800 MHz clock frequency and just 2 W power loss, is predestined for use in battery operated applications. And since open data exchange is an absolute must in 'machine concepts 4.0' – whether horizontally in a machine network or vertically in an overlying system such as MES, ERP or Cloud solutions – all CPUs and HMIs with Edge2 Technology processors from SIGMATEK support OPC UA. S-DIAS communicates via the hard real-time capable Ethernet bus VARAN with 100 Mbits/s. Ethernet and USB interfaces are also provided, and for the wireless connection of external system components a WLAN connection is available.

Safe Signals via WLAN

As previously mentioned, functional Safety is especially important in mobile applications and is therefore integrated into S-DIAS from the start. The corresponding Safety components comply with SIL 3 or SIL CL 3 in accordance with EN ISO 13849-1/-2, Category 4 and PL e and IEC 62061. In addition to the Safety controller, various safe input and output modules are available in the compact I/O format. Of particular note, are the SRO 021 with two safe relay outputs, the SSI 021 for the safe analysis of two SSI absolute value encoder signals and the SNC 021. The latter allows the analysis of two incremental encoder signals for the safe monitoring of speed, position, direction and acceleration. The integrated Safety technology is designed to



(Photo: Sigmatek)

With the S-Dias module series, SIGMATEK has made classic industrial automation systems suitable for mobile system components, including the necessary drive technology. On the Right, the servo motor output stage and the stepper motor output stage - both with integrated safety functions.

enable the signals to safely travel over any communication path via Black Channel – even via WLAN. This enables developers to design sections of machines and production facilities – such as AGVs or wireless handheld operation devices with emergency stop buttons like the HGW 1033 from SIGMATEK – regardless of location.

New Servo Output Stage with STO

A broad selection of I/O modules with various functions allows interaction with all types of sensors and actuators. There are special modules for counters, distance measuring systems and thermoelements, for axis positioning, current control and measurement technology. For motion control, the appropriate modules are also available, which are ideally suited for use in location-independent units due to their compact design and high functional density. The servo motor output stage with 'Safe Torque Off' function, the DC 061 with a resolver and DC 062 with an incremental encoder input are predestined for AGV motors. Newly added for the SPS IPC Drives, a stepper motor module for controlling 2-phase stepper motors (ST 151). This has an incremental encoder input for position feedback, as well as STO. The SR 022 module is also equipped with an incremental encoder to regulate DC motors. Regarding the compatibility of the automation solution for semiautomatic system components with the surrounding facility, the software is already in development: With the SIGMATEK solution, the entire process, motion and Safety technology, as well as visualization are developed with the object-oriented engineering environment LASAL. Which in particular, supports a modular mechatronic machine design. Furthermore, there are extensive libraries in LASAL with tested technology modules with which programming and testing can be considerably reduced. Last but not least, options such as OPC UA, VNC repeaters or integrated web servers are available for connecting external systems or remote maintenance mechanisms via the Internet. gh

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