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Exact positioning based on Sercos III and the Axioline I/O system

The controls built into complex drive systems must fulfill the highest synchronization requirements. Thanks to the combination of Sercos III and the Axioline I/O system from Phoenix Contact, events can be detected precisely coordinated with respect to time, and movements can be executed in a correspondingly synchronous fashion.

The term "synchronicity" can be described as the time simplification of two or several of the same processes. Many people feel that simultaneousness is particularly aesthetic. Synchronized divers or swimmers have been named as examples. Considered on their own, such flows of movement may be precise and harmonious. However, if one attempts to detect both actions at the same time, they show themselves as taking place at slightly different times and the movements, which are actually synchronous, then seem completely uncoordinated. So humans have only a limited ability to take in and make sense of several identical flows of movement that take place at slightly different times. Therefore, the synchronization of two processes seems like a simplification of complexity. Movements are brought into chronological order based on the same computation of time.

Transferred to the solution of a technical task involving automation, synchronicity is about placing mechanical movements and electrical events into a logical chronology. Here, signal transmission and processing plays a crucial role. However, the different run times of signals in individual components prove to be a problem. Mechanical devices impact run times differently than electronic products. A comparison of electronic systems reveals that there is a different time impact on the signal run times in this case as well. Here, lag times are referred to that make the coordination of processes complex to varying degrees. If the same tasks, such as the transmission of signals via communication channels, can now be arranged in a uniform fashion, i.e. synchronized, this simplifies the entire automation solution. In turn, such an arrangement with the same chronological order creates opportunities to detect precisely time-coordinated events and to execute movements correspondingly.

Only a few communication systems offer synchronous signal transmission

The highest requirements are in a set of controls used in complex drive systems, as found in packaging and woodprocessing machines or pick-and-place machines, for example. Precise synchronization is always required when spatially distributed processes require identical actions, for example if several servo axes are to implement simultaneously coordinated movements. In today's automation technology environment, only a few communication systems exist that can ensure synchronicity of signal transmission.

With Profinet IRT (Isochronous Real Time), applications with cycle times of less than 31.25 microseconds and a jitter of less than a microsecond can be implemented. This is achieved via a process in which the signal run times are clearly predetermined (deterministic). The Sercos® III protocol works even more precisely. Here, the user can implement cycle times of a minimum of 31.25 microseconds with a synchronization accuracy (jitter) of fewer than 20 nanoseconds. The high accuracy is achieved thanks to a special time slot process. At present, the Ethercat system, which is characterized by cycle times of less than 100 microseconds and a jitter smaller than a microsecond, holds the largest market share among real-time communication systems. The solution is based on the approach of precisely harmonized, distributed clocks implemented into the slaves designed for the synchronization tasks.

Analog input information available deterministically and synchronously in the control

The application of a painting robot clarifies the advantages offered by the synchronization of automation technology. The complexity of a painting robot consists of driving a spray head along a defined trajectory while applying the paint to a car body with determined pressure (figure 1). Such a robot typically consists of four to six individual axes. In order to reach the target position of the spray head as accurately and quickly as possible, the target positions must be sent to all drives simultaneously. For this purpose, Sercos III, which transfers the data to the drives serially, is often used as a drive bus. However, the target positions of the individual drives can be transmitted in synchronization to each other, i.e. on a logically parallel basis.

The second challenge results from the pressure control of the paint liquid. In the example described, an I/O station can be integrated into the Sercos network in which the drives are installed. For the purposes of ascertaining the paint quantity, both the pressure and the through-flow velocity are of interest. Both pieces of information are captured by sensors with analog outputs and transferred to the analog outputs of a Phoenix Contact Axioline I/O station. Since a high control accuracy is achieved only if the analog input information is available deterministically and synchronously in the control, Axioline is particularly suitable for implementing the task.

Fast I/O system renders expensive control units superfluous

In the application example, the bus coupler synchronizes with the local bus on the Sercos cycle (figure 2). In addition, the bus coupler knows the information relating to the update time of the analog input. This is 250 microseconds with the standard analog inputs. In the painting robot application, the Axioline local bus cycle amounts to only 3 microseconds. This data proves to be important for the synchronization of the Sercos devices so that a universal synchronization time can be determined in the master. »

Figure 1: Exact spray head positioning and pressure control by means of synchronous communication

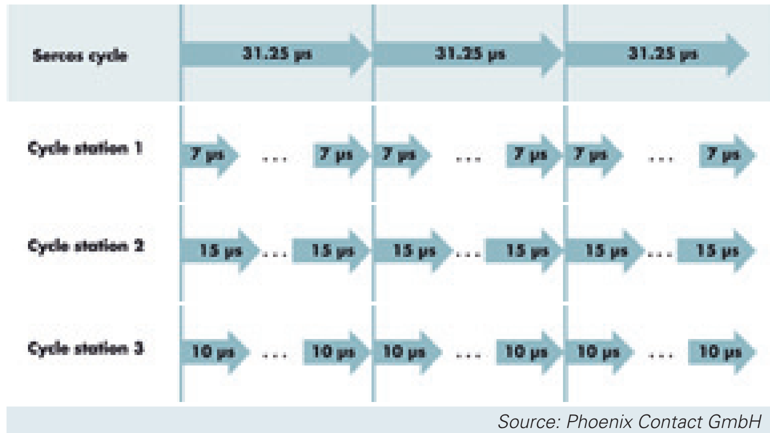

Figure 2: The Axioline local bus synchronizes to the superimposed network

Figure 3: Synchronous position detection for moving machine elements

Consequently, the analog input starts the measurement 253 microseconds before synchronization time so that the analog data can be transferred to the Sercos cycle as accurately as possible. This process allows absolutely deterministic and synchronous communication, even if the analog modules are found in two different I/O stations, since the delays of various length cables are also compensated for. Thus, the use of the synchronous Axioline I/O system eradicates the need for expensive control units.

Wherever drives have to perform a positioning task, there is a use for synchronous I/O systems. Another example is the electric vertical drive shaft for moving movable machine parts (figure 3). Here, several spatially separated SSI absolute encoders can detect the position of the element to be moved, although in most cases each encoder is assigned to a drive. Thanks to simultaneous reading of the SSI encoders, individual target/actual deviations compared to other drives are determined in real-time, in addition to the current position. This is especially important in cases where mechanical elements are not to tilt. Therefore, several small drives can move machine elements simultaneously easily and cost-effectively using the synchronous position detection.

Conclusion

Whether the Sercos system or other transmission protocols are used with the synchronization function, the Axiobus implements the synchronicity precisely right into the application via the network. In the process, not the Axiobus but the superimposed network alone determines the performance of the synchronization. Moreover, the user does not have to install any special modules, since the function is integrated into the Axiobus as standard. Thus, the Axioline I/O system from Phoenix Contact contributes to the simplification of solutions for increasingly complex automation tasks. In this way, the user saves time planning and implementing the application.

Reliable data transmission and processing even with short Sercos cycle time

The Sercos III Bus Coupler for Axioline constitutes the link between the real-time I/O system and a third-generation Sercos network. Up to 63 Axioline modules can be connected to the bus coupler, with the cycle time of the local buses increasing by only a microsecond per module (figure 4). In the event of an additional local bus offset of 2 microseconds, the local bus cycle time of a typical Axioline station amounts to only 10 microseconds. Due to the special design of the Axioline bus coupler with development technology, no delay results in the transfer of the local bus data to the superimposed Axioline system. For the Sercos protocol, this means that the current data is transmitted and processed even in the event of a Sercos cycle of 31.25 microseconds. The synchronous output of several digital standard outputs takes place with an accuracy to each other of less than a microsecond.

Source: Phoenix Contact GmbH

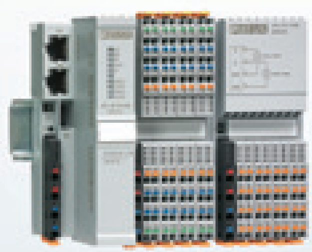

Figure 4: Axioline with Sercos III Bus Coupler simplifies complex tasks