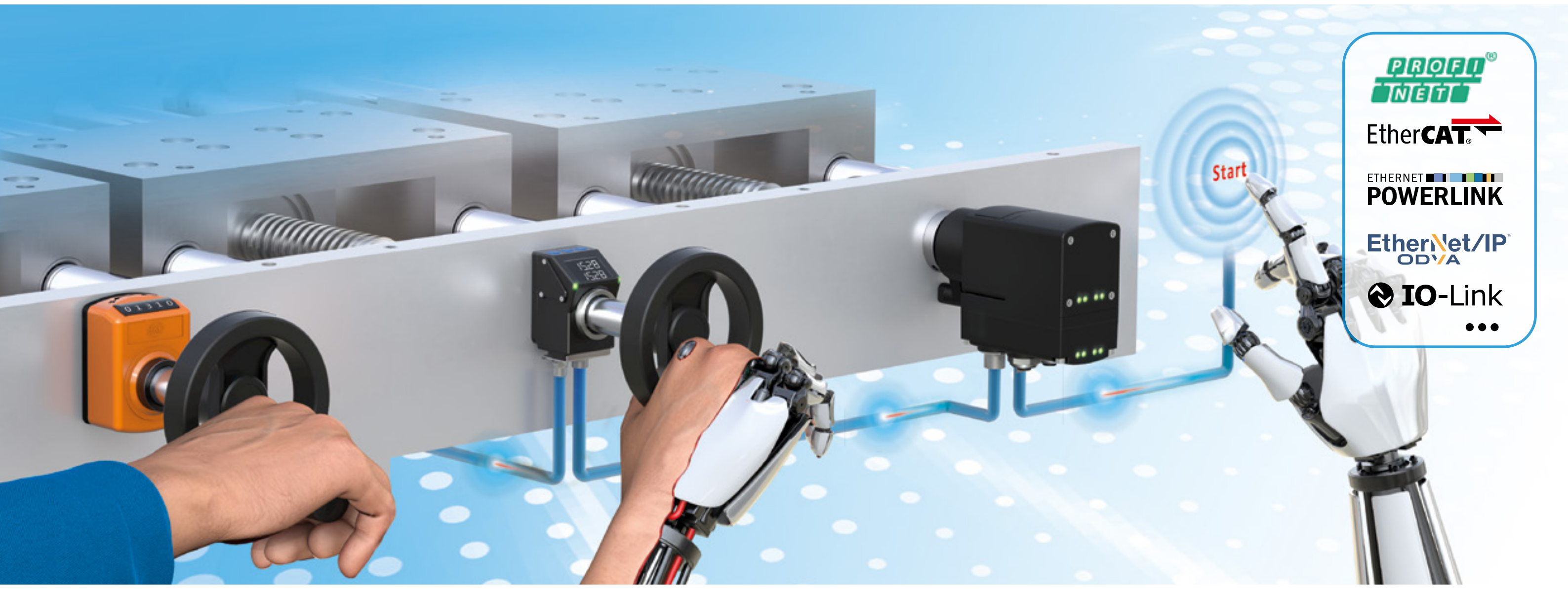
Whitepaper
›Quick Size Changeover‹

SIKO | Size Changeover goes Industry 4.0



A guide for designer engineers, devlopers, machine operators

and technical purchasers

Content

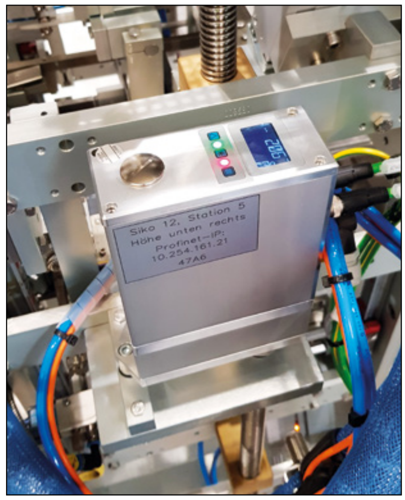
1. Introduction

“That company is successful that can produce the largest possible quantities of a product in a short time! – This assumption about industrial production processes has long since ceased to apply in absolute terms. The market conditions are too diverse, and customer wishes are becoming more and more individual. There is an ever-greater variety of products, which is reflected in decreasing batch sizes in production. The more products need to be individualized, the more short-lived product trends are, the more the demands on the flexibility of production plants increase. It is a question of the optimal system availability and the reduction of downtimes and setup times for the smallest batch sizes down to a number“ “one” of pieces.

Only those who can provide attractive prices even in small and medium quantities remain competitive.

A factor that cannot be underestimated in the improvement of the system availability is the optimization of the changeover times during product changes, i.e., in format adjustment. This does not necessarily require complicated and cost-intensive automation of the entire system.

Instead, all adjustment points should be specifically checked to determine whether they can be optimized and each axis should be equipped with corresponding positioning systems when considered on its own.
The possibilities range from a cost-effective, purely mechanical solution to Industry 4.0-capable, “smart” positioning systems, which are networked and communicate with one another.
In this way, the production processes can be designed efficiently and consequently costs minimized. This white paper shows the possibilities of an intelligent format change, what the requirements are for corresponding monitoring or automating format adjustment, and how the respective implementation takes place.



1.1. What format adjustment means

Although a somewhat bulky term, format adjustment is present everywhere in the industry, in every machine and industry. Regardless of whether packaging or woodworking machine, the term format is used when a new dimension is set on a machine for a new product. Not only due to automation, a change of the axes is required for each machine as soon as the product to be produced or its dimensions are changed to be able to deliver exactly the product that a customer has ordered. Formats can be adjusted either manually via a crank or fully automated. The more individual customer wishes are, the more intelligent, highly efficient format adjustment is required.

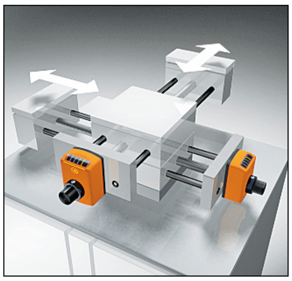
1.2. How format adjustment is implemented

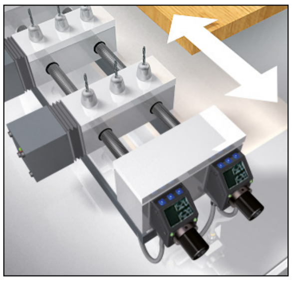
How the format adjustment is technically implemented depends on the design of the machine or the unit. Accordingly, three variants of the format adjustment can be distinguished: spindle adjustment, the adjustment via slides or linear guides, and format part change.

1.2.1. Spindle adjustment

Spindle adjustment is the most common variant of the size changeover, e.g., in packaging, woodworking or even printing machines. The format or the axis of the machine is adjusted by means of the rotary movement of a spindle. This can be done manually via a crank or a hand wheel *(cf. Chapter 2. Manual size changeover)* or fully automated via an actuator *(cf. Chapter 4. Automaticsize changeover)*.

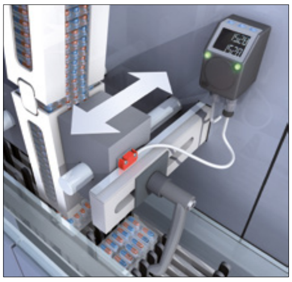
The spindle adjustment provides an extremely fine adjustment possibility, since a few millimeters are covered as a rule only per revolution to readjust the unit. In contrast to this, it is considerably more difficult to fix a value so precisely in the case of a linear guide in which manual displacement takes place.





1.2.2. Adjustment via slides/linear guides

A linear guide is used where no spindle is available for size changeover. In this case, a carriage is pushed over a rod and the new position is set via this mechanical construction. For this purpose, a lot of tact and sensitivity is required during the mechanical adjustment to achieve correct adjustment. A typical application for linear format adjustment is a circular saw, in which the stop for the wood must be pushed to the appropriate size to be able to cut a board of appropriate size. In the case of a linear size changeover, the manual variant is customary in comparison with an automated adjustment, since it is considerably more difficult and complicated to automate a linear movement than a rotary movement. Monitored size changeover using bus-enabled position indicators is recommended to be able to adjust a linear guide as precisely as possible *(see Chapter 3. Monitored size changeover)*.



1.2.3. Format change

When changing the format part, it is no longer a question of a pure adjustment of axes, but format parts, i.e., individual tools or machine parts, are replaced as such. To carry out this manual change correctly, SIKO provides solutions for monitoring *(cf. Chapter 3.3 Monitored setpoint value indicators)*. A format part change could also be carried out automatically; robot technology would be required for this purpose, but this is not the subject of this white paper.

AP10T

1.3. Using optimized size changeover

Changing the settings of a machine always involves certain risks of proceeding incorrectly. With optimized size changeover in terms of monitoring or even automation, this risk can be eliminated and flexible requirements can be reacted to better for the production processes.

1.3.1. Increased accuracy for quality improvement or assurance

A measuring system is first required to set a specific position of an axis, with which it is possible to determine at which position the unit is currently located. If the measuring means are not accurate enough, the position cannot be precisely changed either.

The error susceptibility of the process increases without a precise positioning system. How good the quality of the respective product is often depends on the experience of the machine operator. In addition, errors can occur during manual adjustment and adversely affect the product result. In the worst case, rejects could be produced until an incorrect machine setting is noticed.

Repeatability is also to be increased with the optimization of the format adjustment. A product should be present again in the same form and quality after a change, even if it is produced again.

Therefore, reproducibility is a decisive factor in format adjustment, so that constant product quality is ensured.

1.3.2. Faster conversion of format adjustment for cost reduction

The effect of cost reduction by optimizing the speed during setup times is most noticeable with monitored and fully automatic format adjustment. If the value to be set is already displayed directly on the axis via the machine control during monitored format adjustment, the search of the values in stored product lists is unnecessary for the machine operator.

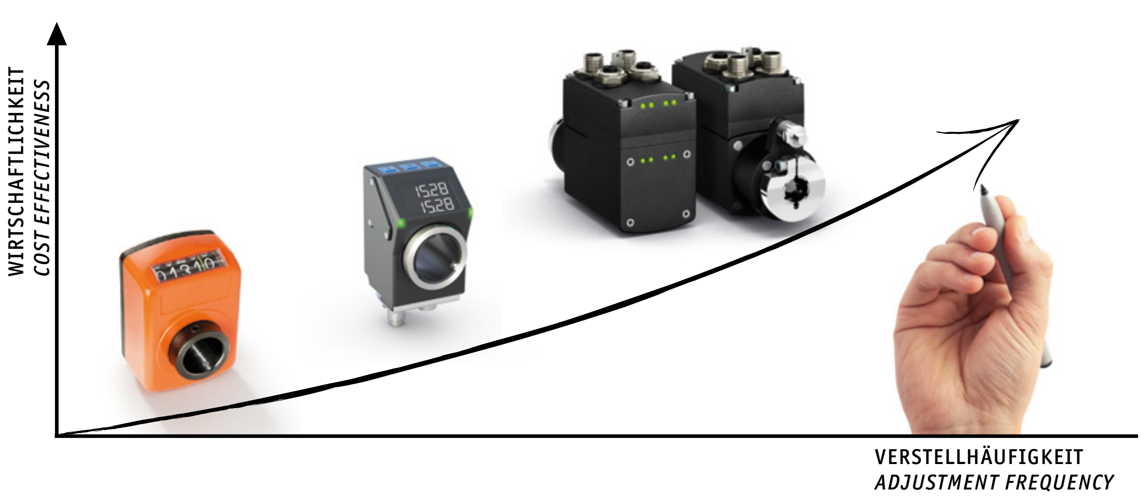
Fully automatic size changeover is even more efficient if no crank has to be operated manually, but instead an actuator takes over the positioning "at the touch of a button".

Technically not very complex converted machines sometimes have only one scale on which the operator has to read a position independently (no longer widely used in Europe). If a mechanical position indicator is used here, it also accelerates the adjustment process through simplified readability as well as reproducibility of the actual values. In general, however, the aspect of cost reduction through accelerated format adjustment refers to the monitored and fully automatic variants.

1.3.3. Increased process reliability by monitoring formats

In addition to reproducibility and cost reduction through speed, an increase in process reliability is another argument for optimizing size changeover. Position status is displayed clearly by LED lights during monitored format adjustment; green means "position correct", and red signals "position incorrect".
This is ergonomic for the operator and, more importantly, readable for superordinate machine control. This makes it possible to program the machine in such a way that it does not resume production until all positions are correctly set after format adjustment. Bus capability of the position indicators is decisive, so that the machine control can read and monitor the position values.

Thanks to bus capability, the machine controller receives the actual values from the position indicator (reading) and can in turn predetermine the setpoint values (writing).



1.4. Outlook of format adjustment requirements

1.4.1. Cost reduction even for sporadic adjustments

At the present time, companies are considering optimizing size changeover, especially when it comes to frequent adjustments, because the investments are profitable. However, it is foreseeable that sporadic adjustments must also be optimized in the medium term with regard to monitoring or even automation. The setup times are too long even for rare adjustments, so that optimization is fundamentally interesting. SIKO GmbH is working on more cost-effective solutions in fully automatic adjustment, so that the expense pays off faster even in the case of rare format changes.

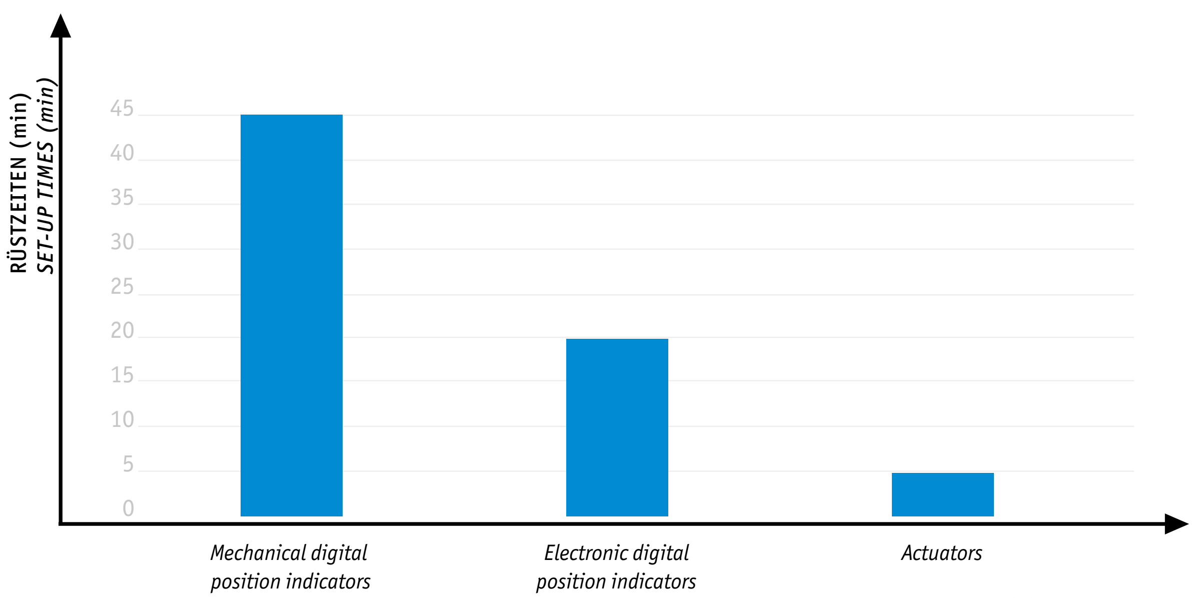
1.4.2. Increased security in critical applications

There are applications, for example in the pharmaceutical sector, in which it must be ensured 100% that the correct position is reached after format adjustment, regardless of whether this takes place once a week or hourly. Monitored format adjustment is indispensable there. For example, in machines, packaging sizes for medicaments are set. The correct administration of the medication must then be monitored, including the weight of the medication or the number of pills in a package. All these aspects are adjusted via a format setting.

Another exemplary application is height adjustment for an inspection camera. The setting of the camera must match different product heights, so that an inspection can function with a degree of safety of 100%.

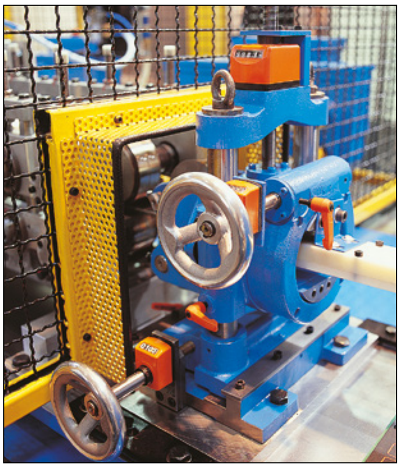
1.4.3. Optimized speed of changeover for one-piece flow

A significant reduction in the changeover times is achieved by automating size changeover in a one-piece flow production. A conventional one-piece flow product is an individual photo book that can be created in different paper formats and sizes and only needs to be produced in very small quantities down to one copy. Such a product would not be affordable and marketable with manual size changeover. Full automation is absolutely necessary with this trend toward such customer-specific products in the smallest number of units.



2. Manual size changeover

Manual size changeover as the simplest and most favorable variant is predestined for basic machines with rare format adjustments. Mechanical-digital or electronic position indicators are used that determine the positioning inexpensively and reliably.


Fa. Dreistern

Digital indicators are responsible for aligning the tools within the "metal forming" process chain.

2.1. Basic requirements for reproducibility in size changeover

The current position of a spindle must first be measured with a suitable measuring system in a defined accuracy. In addition, the actual position must be readable in clear values for reproducibility.

These are also the basic requirements for format adjustment via slides as well as for format part change in principle. The format parts must be clearly marked to ensure that the operator always reinserts the same required ones.

2.2. Basic functions and structure of position indicators

A measuring system is located as a core element in each position indicator, i.e., the position is recorded by a measurement. The measuring system has a high accuracy, typically with a tolerance of approximately ± 0.5 degrees. In addition, a position indicator provides controllable digital display values. Different display values are possible depending on the corresponding spindle pitch. As a rule, the rotational movement of the spindle is converted into a linear movement, which a slide sets. The spindle pitch indicates which path is carried out linearly per revolution. This is always dependent on the design, on the size of the spindle.

A variety of gear ratios are also available for the mechanical position indicators to make it possible to map the specific applications of the customer – whether 1.5 millimeters per revolution or 15 millimeters per revolution when it runs over a gear, for example. Installation via a hollow shaft is decisive for the problem-free and cost-efficient retrofitting of position indicators *(cf. Chapter 2.2.3)*.

In addition, the position indicator is equipped with a sliding bearing with lifetime lubrication, i.e., the indicator is completely maintenance-free. Such a plain bearing is designed for speeds up to 500 revolutions per minute, which represents a fully adequate dimensioning for manual adjustments.

In addition to the measuring system, a position indicator also includes a display. One variant is a mechanical-digital position indicator, the SIKO counters, which represent the values in decimal places in powers of ten in the form of number drums. Therefore, the term "digital" is used, although it is not an electronic display. O the other hand, electronic position indicators have an LCD display.

The AP series is used when it comes to monitored format adjustment, which additionally shows the setpoint value in the second display line.

Variable gear designs, functional overall design with simple slip-on and locking technology make mechanical position indicators a cost-effective classic.

2.2.1. Absolute measurement principle and calibration

The position indicators operate according to an absolute measuring principle, which does not have to be constantly referenced, i.e., the indicator receives an absolute reference, and this position value is then permanently stored. In the case of the electronic position indicators of the DE and AP series, this is done via a battery, i.e., these operate according to an absolute measuring system that is battery-buffered and only needs to be referenced once.

In the case of mechanical position indicators, it is also possible to speak of an absolute measuring system, which is already justified in assembly.

If the display with the hollow shaft is plugged onto the spindle at a certain position and fixed with a thread-twist, an absolute reference is obtained at this point, from which the counting begins. If the indicator were released and fixed again at another location of the spindle, this would be the new absolute reference point.

Consequently, both electronic and mechanical position indicators function according to the absolute measuring principle and also require only one-time calibration. This works by pressing a button in the electronic system and by clamping the hollow shaft already during assembly in the mechanical indicators.

2.2.2. Resolution and accuracy

The resolution indicates the smallest readable measurement step that the indicator provides; for example, 720 increments per revolution in the electronic display AP05, i.e., it concerns measurement steps of 0.5 degrees on the shaft, which represents high accuracy.

The fact that the position indicators provide a clear representation of the measured value already increases the accuracy in this type of size changeover. Sometimes there are very simple ways of setting the format, e.g., using a measuring scale on the machine over which a pointer moves, with which a position on the spindle can then be set.

In this method, however, the interpretation of the measured value depends on the viewer; it depends on whether he looks more from the left or right at the pointer. This inaccuracy in reading the value does not occur with the mechanical, digital and electronic position indicators.

Another aspect in terms of precision is the high system accuracy of the position indicators. This corresponds to ±0.5 degrees with the AP series. An example of the high measurement accuracy: With a spindle pitch of two millimeters, i.e., the setting changes by two millimeters at each handwheel revolution, a deviation of only ± 3 µm results at ± 0.5 degrees.

However, the actual adjustment accuracy of the adjustment position also depends to a great extent on the quality of the mechanical components and guides as well as the spindle quality. The mechanical tolerances must be taken into account in this context. However, the spindle play can be compensated using the AP series via the loop positioning *(cf. Chapter 3.2.3 Functions for ergonomics and user friendliness)*

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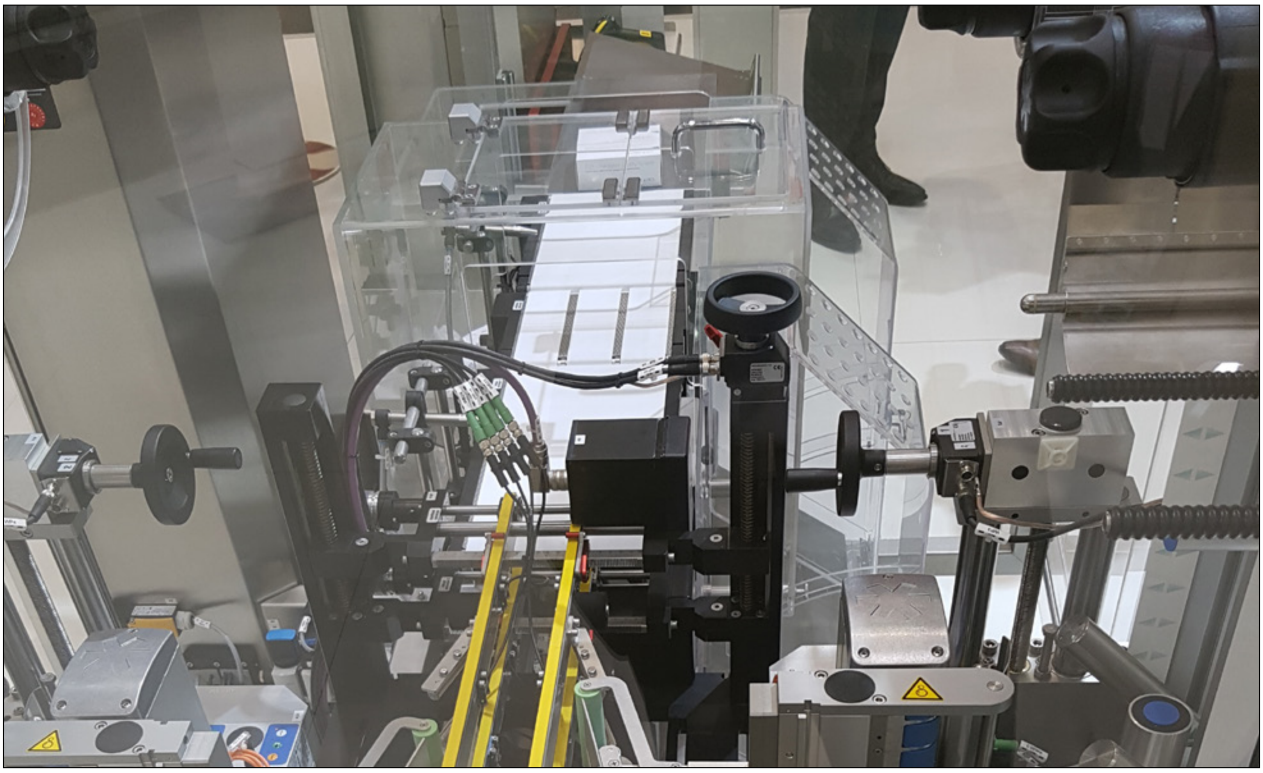


2.2.3. Assembly of position indicators with hollow shaft

Mounting via hollow shaft is easy to do: As a rule, a solid shaft for mounting a crank or a hand wheel is always located on the adjusting spindles. Thanks to the hollow shaft, the position indicators can then be easily plugged and mounted between the machine and this operating element.

2.3. Mechanical-digital position indicators (especially DA series)

The mechanical-digital position indicators are known as original SIKO counters and are market leaders. The position values can be recorded with high precision and are displayed in a clearly legible manner. Thanks to various designs, the position indicators of the DA series adapt to different application requirements in a variety of ways. Very compact variants are available for cramped space, whereas larger displays with many display locations are suitable for long adjustment paths. The display value per revolution is appropriately designed via an integrated gear for the respectively required spindle pitch. The problem-free and cost-effective retrofit capability of the displays is also to be highlighted. Thanks to the lifetime lubrication already mentioned at the beginning, they are also maintenance-free and are distinguished by a long service life.

The special feature of the mechanical position indicators is their respective exclusive suitability for a specific application, i.e., a specific device variant is configured for an application with a specific spindle pitch in a desired resolution. Finally, there is not ONE mechanical position display, but instead a machine often has many different display variants. Due to the design, a display is only suitable for a specific application. The application must be specified in advance, and the designer must define the requirements for the display in detail before a device can be delivered, in contrast to electronic position indicators that can be programmed correspondingly for different applications.

DA02

DA04

DA05/1

DA08

DA09S

DA10

DA10R/1

2.4. Electronic position indicators (DE series)

The decisive advantage of the electronic position indicators of the DE series compared to mechanical-digital ones is free programmability for flexible use. A variety of parameters can be configured freely via the position indicator: the spindle pitch, the decimal points, the direction of rotation, the installation position, including the use in angular mode. All these aspects are oriented to a single application in the case of mechanical indicators, as described under 2.3. Electronic displays can be more standardized, which reduces transaction and storage costs. Due to the flexible programmable display values, they can be used particularly well with non-metric spindles, e.g., inching spindles from the US American area, as well as with gear ratios, i.e., adjustments that are not due to spindle pitches in whole numbers. Free programmability is generally helpful in special-purpose machine manufacturing.

Another advantage: the reliable measurement of the electronic position indicators thanks to the magnetic or capacitive measurement method. The axial movement is no longer detected via a transmission, but contactlessly magnetically or capacitively. The magnetic measuring method is particularly robust and insensitive to soiling or vibrations and is also suitable for use in harsh environmental conditions.

The DE series are also absolute indicators with a battery operation for up to eight years, which guarantees long operational life.

Compared to the mechanical-digital position indicators, very high resolutions can be achieved with the electronic indicators.

The gear ratio is limited in the mechanical case, normally to approximately 150 counting steps per revolution.
By contrast, up to 3,600 counting steps per revolution can be realized with electronic displays. Consequently, a division into tenths of a degree is readily possible, which the mechanical variant could not fulfill at all.

Positive in the balancing between mechanical or electronic position indicators is the enhancement compatibility between the two, so a conversion or extension is unproblematic. This can already be read in part in the size designations; DA04 and DE04 are suitable for adding components, for example.

3. Monitored size changeover APxx, APxxS

Electronic position indicators of the AP series for monitored size changeover are another step smarter than electronic position indicators for manual format adjustment. They additionally have a bus interface. In bus-controlled operation, setpoint values and actual values can be exchanged between the individual absolute position indicators and an upstream control unit.

3.1. Basic requirements for reproducibility in size changeover

While manual size changeover focuses on the requirement of reproducibility, monitored format adjustment is primarily concerned with process reliability. The required process reliability is achieved centrally via the machine control thanks to the bus integration of the position indicators. It is the leading element that sends setpoint values to the position indicators and reads the measured actual values.

Based on the transmitted position status, it only releases the entire system after correct feedback of all manually set spindle positions, so that rejects or damage to machine modules due to incorrectly set adjustment axes no longer occurs. Machine and economic efficiency of the production facilities also increase significantly thanks to monitored size changeover with bus-enabled electronic position indicators.

DE04

DE10

DE10P

AP05

AP10

AP10S

AP10T

AP20

AP20S

3.2. Monitored network-integrated position indicators

The electronic position indicators receive their basic parameterization from the machine control via fieldbus and the respective setpoint position to be currently set. The setpoint values are stored in formula management within the machine control, i.e., a formula with all necessary setpoint values such as length, height, width of a package to be packed on a machine is located in formula management for each product to be manufactured. For this, various adjustment positions are necessary. Via the monitored, bus-enabled position indicators, the machine control can write the setpoint values and display them on the display as well as read the actual position measured by the position indicator in parallel. The position indicator immediately makes an internal adjustment between setpoint and actual value and finally outputs a position status showing whether the required position has been reached or not.

The position status is clearly displayed for the system operator via two LED lights with red or green. In addition, the position status can be read at any time from the machine control via the fieldbus interface. The integration of the position indicators into the network of the machine takes place via various integrated interfaces: RS485, CAN bus, IO link, Profinet, EtherNet/IP, EtherCAT or Powerlink. When an integrated RS485 is used, additional interfaces can also be implemented using a protocol converter, e.g., Profibus, Profinet, EtherNet/IP, EtherCAT, CC-Link, Device-Net or ControlNet. Functional modules, which facilitate the configuration of the electronic displays in the programming environment of your superordinate control are available for selected interfaces and controllers.

The high accuracy offered by the AP series needs to be emphasized again; the AP05 display has a resolution of 720 increments per revolution. This applies not only to the monitored spindle adjustment, but also in the area of linear slide adjustments. The AP10S provides a precise display with an external magnetic sensor (MS500H), which achieves very high accuracy with a typical resolution of 0.01 mm and a system accuracy of ± 35 µm.

3.2.1. Actual value display by magnetic contactless measuring method

The bus-capable electronic indicators also operate according to the magnetic measuring principle to detect the actual value precisely. As a contactless process, it is completely wear-free and robust against dirt and harsh environmental conditions. Shocks and vibrations in typical industrial applications of mechanical engineering cannot affect the sensors. In addition, it is an absolute measuring system that is battery-buffered. Consequently, referencing is not required.

3.2.2. Setpoint value display and display of the position status for spindle adjustments and linear guides

The machine control specifies the setpoint values, which are also displayed on the position indicator in the second line. The special feature of the monitored format adjustment is also the two LED lights, which clearly indicate the position status with green for “position correct” and red for “position incorrect”. Consequently, they provide the operator with orientation as to which adjustment points if any need to be corrected. Not always are all adjustment positions changed during a product change, but often remain when all setpoint values have been transferred anew and LEDs in the machine remain green on the position status and only individual ones switch to red. The operator sees directly which adjustment positions he must change. This information is missing in a mechanical position display, which only indicates the position on which it is located. As a result, the operator must adjust the setpoint and actual values in his manual formula list and make any changes. This increases the susceptibility to error of the format change. The process reliability is significantly improved in the monitored variant by status LEDs.

3.2.3. Functions for ergonomics and user friendliness

In addition to process reliability, the LED function and an integrated arrow direction indicator are also a plus point in terms of ergonomics and user friendliness. Thanks to the arrow direction display, it is clear to the operator in which direction the adjustment has to take place. The arrows point to the left or right or also clockwise or counter-clockwise. The LED displays also work in the same way. There are two LEDs in each device on the left and right, and it must be adjusted accordingly in the direction corresponding to which of the two LEDs lights red. Therefore, the operator need not interpret numerical values as to whether a specific setpoint value has been reached; the display with the position value could also be covered or switched off. Only the LEDs are required to find the setpoint position. The LED switches to green as soon as the operator reaches the desired setpoint position. Even if it has been rotated beyond the setpoint value, the LED immediately switches to red again and the operator can then reset.

Refer to loop positioning at this point. Mechanical play can occur during spindle adjustment, but which can be compensated for using loop positioning. The programmer of the machine can specify that the movement to the setpoint value always takes place only from the same direction, whereby the start-up direction and loop length can be specified. The following figure illustrates the function with an example: The direction in which each setpoint position is to be moved to is positive. Chart 1: The new position is greater than the actual position; then the setpoint position is moved to directly. Chart 2: The new position is smaller than the actual position. The direction arrows of the position display or the LEDs then indicate that the loop length must be moved beyond the setpoint position. Subsequently, the setpoint value is moved in a positive direction.

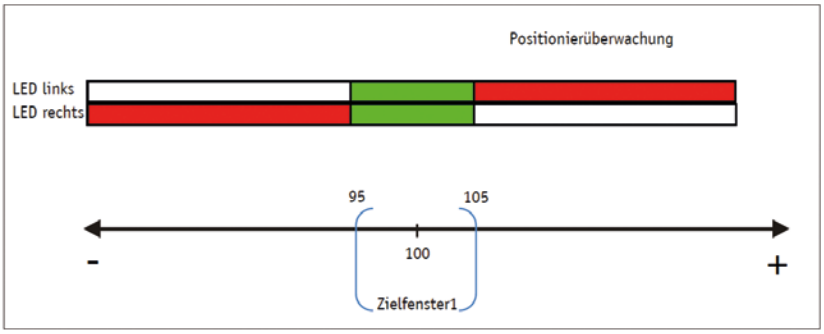


Chart 1

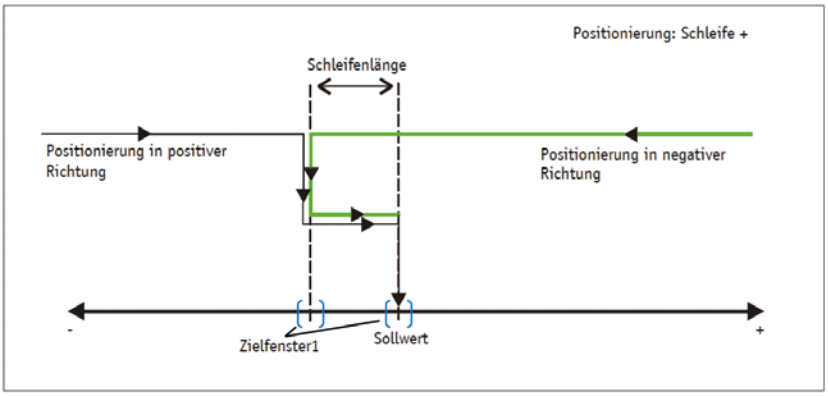
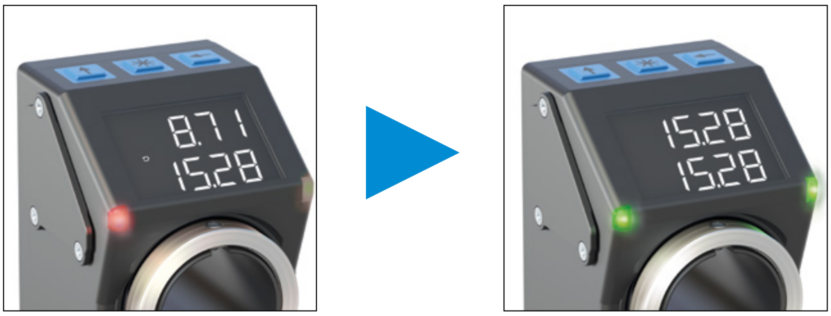


Chart 2



3.2.4. Flexible Use thanks to Parameterization

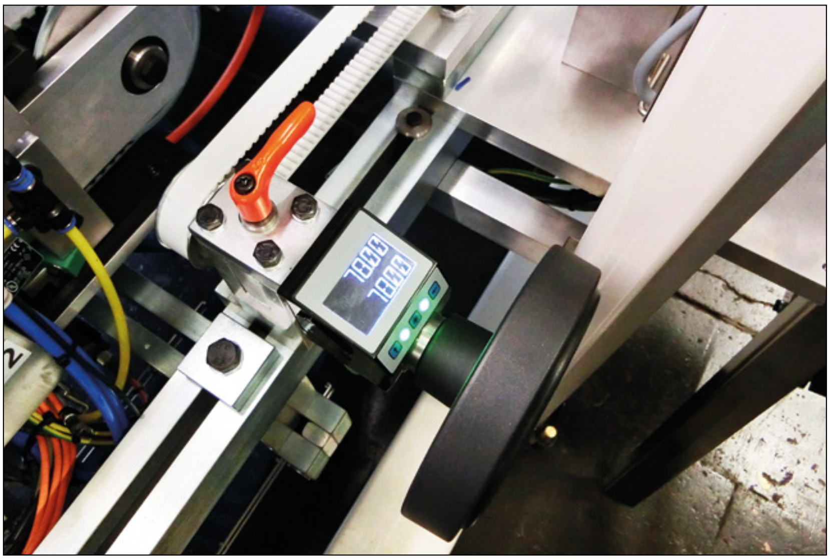
The free parameterization of the AP devices provides flexibility similar to that of the DE series. It is particularly advantageous in this case that the parameterization can and should be carried out via the bus interface. This makes it possible to specify all position displays in plant settings on the machine and connect them to the fieldbus. Then the programmer can transmit the parameterization centrally from the machine control to the individual devices and only has to set the bus address on the devices themselves. The complete programming of the position indicators is possible via operating buttons and a corresponding menu structure, but not recommended.

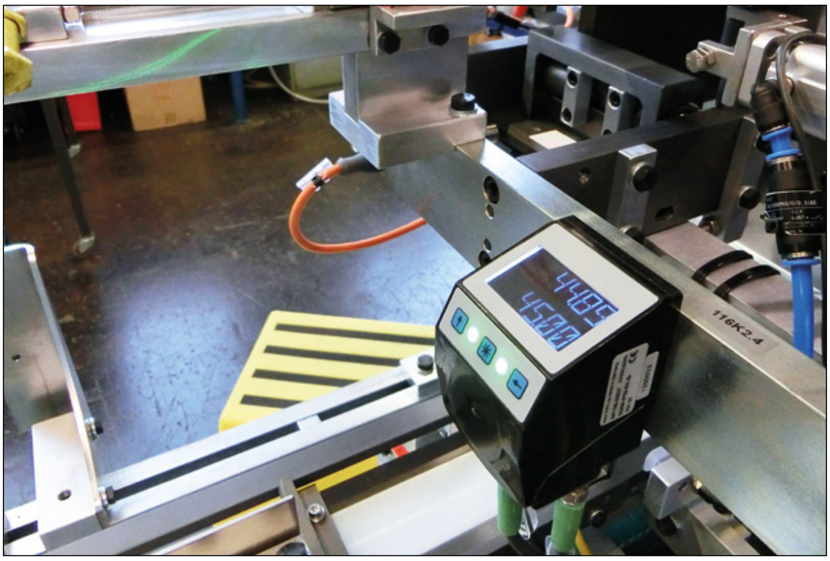
The parameterization is also completely stored in the machine control only via the interface.

If an indicator is damaged and needs to be replaced, it is advantageous if the entire parameterization is stored in the machine control and can be transmitted directly to the new indicator again. As a result, the machine is ready for operation more quickly. Therefore, we recommend managing parameterization centrally.

3.2.5. Applications

Applications for monitored format adjustments are available in various areas of mechanical engineering. Particularly typical are the woodworking machines, printing machines, and in the food and pharmaceutical sectors where increased process reliability is especially required.





3.3. Monitored setpoint value displays

While the acquisition of the measured value constitutes a large part of the functionality in the electronic position indicators for spindle adjustment and linear slides in Chapter 3.2., format part change is exclusively about the display of the pure setpoint value on site.

3.3.1. Display of the position status for format part or tool change

The setpoint value display AP10T is used for guided format part or tool change. A classic example of this comes from woodworking: holes must be made for the shelves for a side board of a shelf.
If different sizes of shelves are manufactured, the drills must be replaced. During this tool change, the correct designation can be displayed in the setpoint value display of the AP10T if the tool or the format part is clearly marked. By pressing the acknowledge button on the device, the operator confirms that the format part has been changed correctly.
However, the process reliability here depends heavily on the respective operator, who must insert and acknowledge the correct format part.

3.3.2. Outlook: Format part detection using RFID

To handle a format part change with more certainty, format part detection using RFID is an option. Instead of or in addition to the marking by a sticker or laser engraving, format parts can then be read electronically by radio using an RFID chip. This enables automated detection. The need for such an automatic control increases for mechanical engineers, especially in places that are particularly process-critical. RFID monitoring in terms of process security would certainly be worthwhile. SIKO is working on integrating an RFID reading head into the position indicator AP10T to design the format part detection as 100 percent process-reliable too.

4. Automatic Size Changeover

The next step beyond the monitoring of the size changeover is the complete automation of the adjustments without manual intervention via compact actuators. There are two reasons for automation: On the one hand, the changeover times are significantly reduced, which is particularly interesting in the case of frequent product changes. On the other hand, there are often axes which are difficult to access and which can be reached only via a ladder or only by removing covering parts, for example.

Automation eliminates the need for this and ultimately means increased efficiency too. Automation with actuators is exclusively about spindle adjustments, since an actuator is a purely rotary system.

AG26
13 Nm

AG25
5 Nm

AG06
13 Nm

AG05
5 Nm

AG24
14 Nm

AG03/1
3.2 Nm

AG02
9 Nm

AG01
4.2 Nm

4.1. Compact positioning drives for easy automation of existing adjustment axes

4.1.1. Basic construction of an actuator

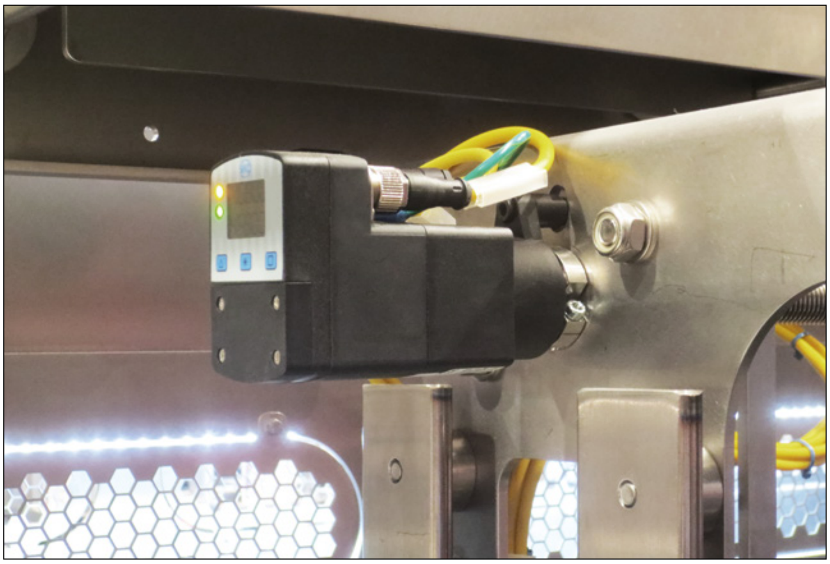
The basic idea of an actuator is its highly integrated design, via which “all” components are present in the device itself: a brushless DC motor (which is wear-free), a low-play and high-performance gear, a position encoder as well as power and control electronics. As a result, the actuator can be connected directly to the controller.

The actuator is also easy to adapt to the existing spindle thanks to the integrated hollow shaft. The customer does not have to adapt the mechanical design that he had provided for manual size changeover for the drive. Simple mounting of the hollow shaft onto the spindle enables automated adjustment. The actuator is particular distinguished by its compact design. Space is often very limited in machine units, so that compact devices are required, but which must include power and extensive functionality despite the small size. The compact actuators of SIKO stand out clearly from other systems.

Various standard interfaces enable direct communication with superordinate machine control (PLC). This functions as a control center, which specifies the setpoint values and also the start command to the drive. However, fully automated positioning is controlled within the drive with respect to setpoint value and speed, among other things. Process data, i.e., position, speed, and direction of rotation, are then provided continuously and can also be read by the controller. This function is important for monitoring and diagnosis options if irregularities or errors occur *(cf. Chapter 4.3.)*.

4.1.2. Actuator and software tools as a complete solution for integration

In addition to the actuator as hardware, SIKO provides various software tools as a complete solution, which can be used for diagnosis or simplified integration. For example, individual software drivers may be loaded into a controller that makes it easy to identify a drive and ultimately integrate it into the existing system.

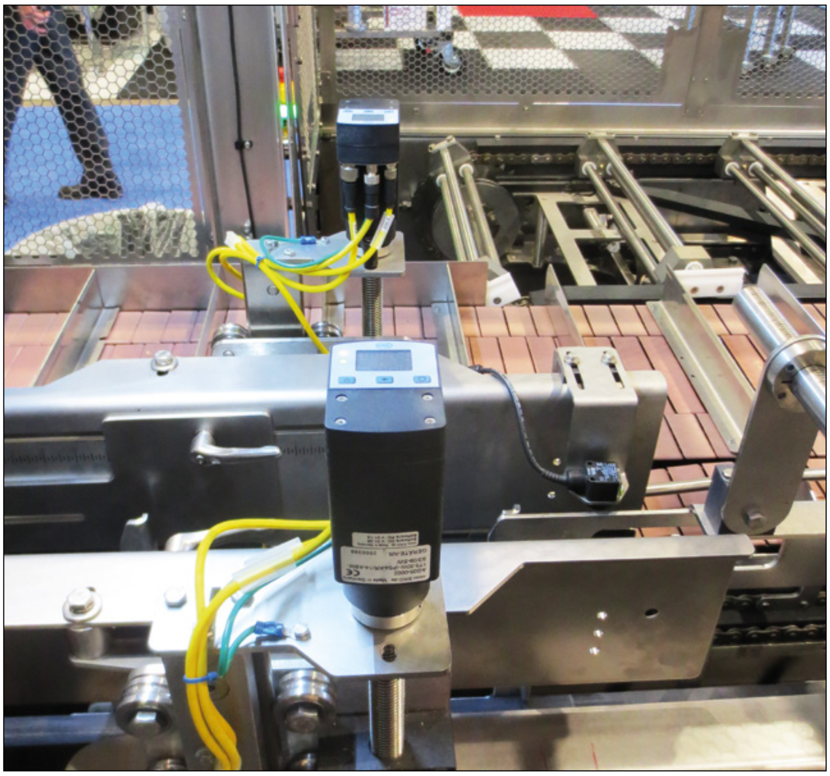


4.1.3. Different power classes for different applications

The bandwidth of size changeovers is relatively large. It begins with a simple fine adjustment, for example, where a fine adjustment is carried out by means of a small rotary knob during manual adjustment in an edge gluing machine in the woodworking area. Since such a machine has especially many adjusting axes, automation is very interesting in the case of frequent product changes. Only low torques are required in this context. Therefore, small drives with a low power requirement can be used. The smallest SIKO actuator AG05 with 50 watts power has more than sufficient power reserves for such applications.

The other extreme is shown in packaging machines, for example, where complete feed systems for cardboard boxes must be adjusted in width depending on the packaging size, i.e., entire machine units must be moved. This requires relatively high torques that can exceed 10 Newton meters. The AG24 is suitable as a larger SIKO drive in this case.

There is a wide range of adjustment requirements in the medium range A classic also in the packaging sector is a cardboard erector, by which the folded cardboard boxes are erected into boxes. Drives from the medium power range between 50 and 70 watts, e.g., AG25, are suitable for this application.



4.2. Function description of actuator

4.2.1. Process data exchange between setpoint value, actual value, and speed

Actuators basically operate in two different modes, which are considered standard operating modes on the market: positioning mode and speed mode. In the positioning mode, the desired value is transmitted from the control to the drive and, if necessary, the actual value is also read from the control in this context. The latter is not absolutely necessary, since the actual value is also monitored directly by the drive. The drive then automatically moves the item to the desired position with the speed previously requested by the control until it arrives there.

The positioning mode is the conventional application, while the speed mode is not quite as common. However, it is particularly suitable, for example, if several axes are to be driven synchronously and there is real-time monitoring to ensure that all drives or all axles have the same height or the same position at a certain point in time. This is also important when the axes are mechanically connected to one another additionally. In the speed mode, the controller only predetermines a speed and direction and then permanently monitors the actual value until the setpoint position is reached.
When the drive comes close to the position, the controller decreases the (rotational) speed.

An important safety function is that the machine does not function again until all axes or drives have found their respective position. When the position is reached, a corresponding bit is set in the message – the communication exchange for control – as confirmation of the position. In addition, the controller could also read back the actual value on the drive and compare it with the setpoint value. If they match, the controller can initiate resumption of production.

4.2.2. Flexible thanks to parameterization

Numerous parameters can be defined via the bus interface to be able to adapt the drive optimally to the respective application. The simplest parameter is the setting of the adjustment in millimeters. For this purpose, the programmer must know how much linear path is moved on the axis per revolution. This parameter can be stored in the drive. Although this is a rotational movement, the drive can be set to a specific number of millimeters.

In addition, acceleration and braking ramps can also be programmed, so that you can specify how quickly the drive accelerates and how quickly or slowly it brakes again. This is important for accurate positioning, so that it does not move beyond the setpoint position.

The maximum current can also be set as a parameter to limit a certain torque. In this way, certain safety precautions can be guaranteed. Further control parameters can also be set to be able to position different masses correctly with different moments of inertia, for example. The loop positioning described in Chapter 3.2.3 is also a possible parameter here to compensate for the spindle play. Limit values can be defined to define a certain positioning range beyond which the drive does not move.

The many possibilities of parameterization provide the machine manufacturer a lot of flexibility and functionality. All can be variously set via the bus interface or configured directly at the actuator via programming tools if access via a bus interface is not possible due to lack of availability of the control.

4.3. Predictive Maintenance – Monitoring diagnostic values current, temperature, voltage

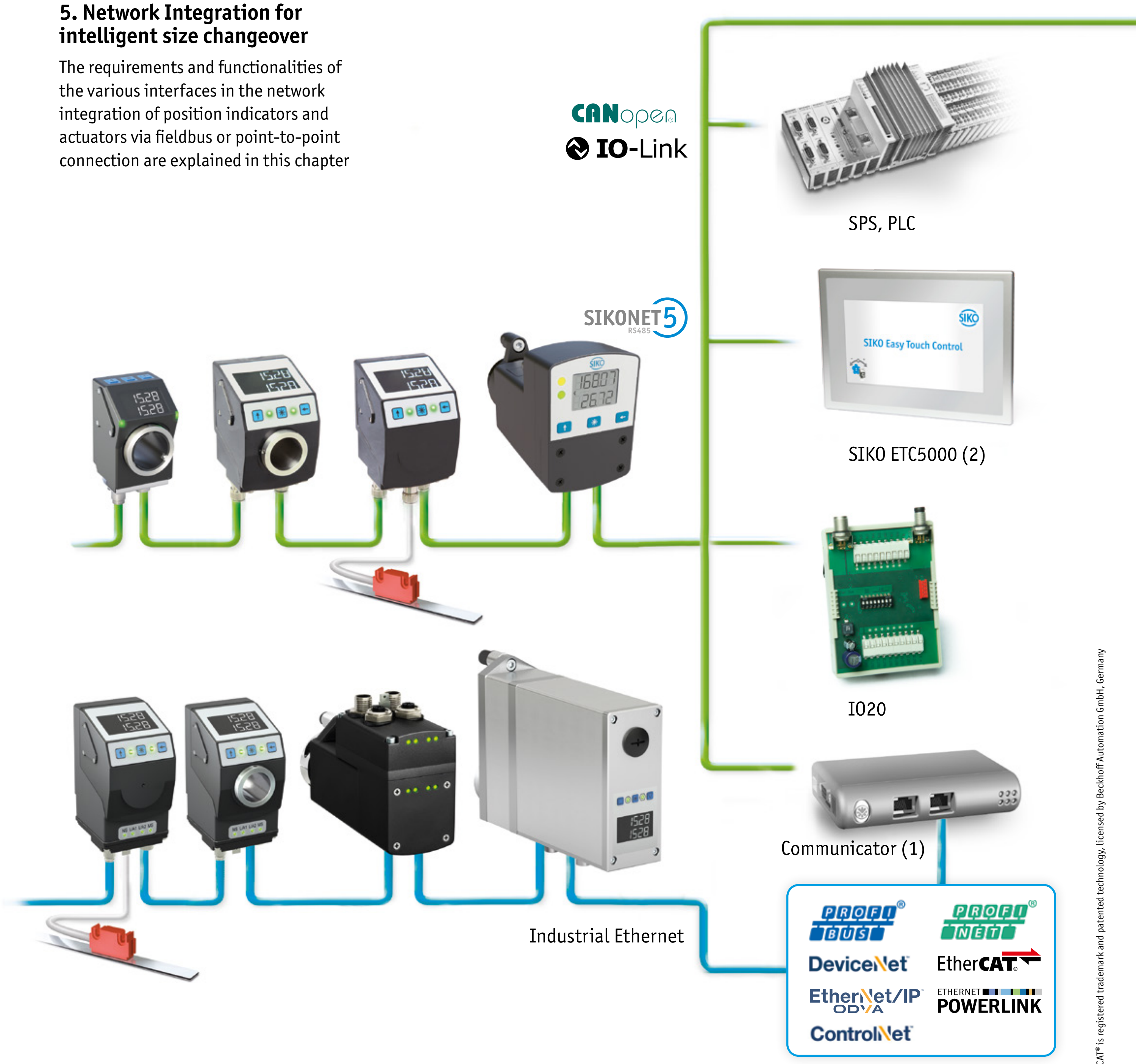
The diagnostic capability that lies in the actuators is hidden behind this aspect. Conclusions can be drawn about the operating state of both the drive and the system itself via various display values and parameters of the drive to detect irregularities or maintenance requirements at an early stage.

For example, current consumption in the motor can be monitored continuously. If it becomes clear that the current rises continuously over a certain period of time, although the load on the axis is always the same, the system must be checked. Possible causes might include that the spindle must be cleaned or even lubricated. As a result, the parameters help to detect necessary maintenance in advance. The current can also be monitored in conjunction with the temperature, which can be read directly in the device. When the temperature rises, this means that the load on the drive is higher than usual. It can be concluded from this that perhaps the ambient temperature or the ambient conditions have changed directly at the drive. Of course, the data are also reported back to the superordinate controller, so that the temperature can be continuously monitored and appropriate measures can be planned if the temperature exceeds a certain value, for example. There are also safety measures in the drive, which remove the drive from the mains if current or temperature exceed limit values to avoid damage. However, it is no longer “predictive maintenance”, but instead “immediate maintenance” in this case.

In addition, the voltage values can be monitored on the control and load circuit. If voltage losses occur when the drive no longer has 24 volts on the load circuit or on the control circuit, this can be an indication that the power supply no longer provides the required quality. The reasons for this can be the external power supply, but also the internal power supply of the machine or even defective wiring, so that transition resistances are to be recorded that require a voltage drop.

5. Network Integration for intelligent size changeover

The requirements and functionalities of the various interfaces in the network integration of position indicators and actuators via fieldbus or point-to-point connection are explained in this chapter



5.1. Integration in machine controls (PLC)

5.1.1. Requirements and available interfaces

Two levels must be observed in the requirements for network integration on the possible interfaces: on the one hand, the requirements with regard to the application, e.g., the reaction speed in communication. On the other hand, there are requirements in terms of integration into the machine. This includes network topology.

The first concerns real-time communication, which is necessary in some cases. This is less the case with manual format adjustment as described in Chapter 3, because a new setting is made manually, and the control reads the position status. These are relatively static data; no real-time communication is necessary for this purpose, but information speeds of a few milliseconds to one second are usually sufficient. With automation, however, increased real-time requirements for the reaction speeds always apply, because regulation or even synchronized movements are required. Consequently, if a bus-enabled electronic position indicator is used as feedback sensor for automation, there is a real-time requirement here. On the other hand, although the SIKO actuators are automated, they have internal control; they provide a closed loop. Monitoring precise to milliseconds is not necessary thanks to this internal setpoint/actual value comparison and the positioning mode. Lower information speed is also sufficient in this context.

The other requirement level concerns the simplicity and operational reliability of the network topology to integrate the devices optimally into the machine. The network topology can be ring, star or chain-shaped with respective advantages and disadvantages *(more on this in the comments on the specific interfaces under 5.1.1.1. to 5.1.1.3.)*.

In addition, a certain compatibility is required if a certain machine control is already used in the machine. In a Siemens control system, for example, it is simplest to integrate a device with a Profibus or Profinet interface.
These are conditions that are already established in the machine. In addition, the previous knowledge of the programmers must be considered. Machine manufacturers want to use the programming skills of their employees and correspondingly known interfaces.

5.1.1.1. RS485 and CAN interfaces

RS485 and CAN have long been established, cost-effective serial interfaces. Numerous field devices can be networked over large distances at a relatively high speed using them. It is a robust, older tried and tested technology, which is more simply designed than current standards. Nevertheless, it is still very widespread in order to connect many network subscribers inexpensively. The network is always constructed as a daisy chain topology, i.e., as a chain which is terminated on both sides. The communication protocol is set up on the two physical interfaces RS485 and CAN. At SIKO, this is the SIKONET5 protocol with RS485, which is used both for monitored position indicators and actuators. It provides an easily understandable structure and consequently a quick start with a large range of functions. On the other hand, the CAN interface uses a CANopen protocol, which is widely used in automation technology, especially in Europe.

Due to the fact that the protocol of this communication can already be implemented on the existing processor in the device at both interfaces, i.e., without additional hardware, relatively small and compact devices can be manufactured. This facilitates installation in limited space.

Both serial interfaces provide quite good immunity against interference. Due to the daisy chain topology, however, there is no two-way accessibility of the network participants. Unlike in the case of a ring, a subscriber cannot be reached from both sides, but only from one direction in the case of a hardware fault. As a result, the diagnostic capability can be lost and entire bus lines fail. In the simplest case, a hardware fault can be a cable break.

RS485 and CAN only have a medium speed range in communication. Therefore, there are often no RS485 and CAN direct interfaces on widely used modern controllers these days. These must then be connected via an interface converter in many cases. Modern interfaces would also normally be used in field devices if a modern control is used. However, these represent a higher cost factor, which is reflected in the device price as well as in the cabling in part.

5.1.1.2. IO-Link interface

IO-Link is a serial, bidirectional point-to-point connection for signal transmission and power supply in any network or fieldbus. IO-Link complies with the international standard IEC 61131-9 and is therefore a non-proprietary interface that has already been widely used in recent years, especially in European machine construction. IO-Link masters required to integrate field devices into the machine's network are available from a variety of different manufacturers and for all common fieldbus systems. Several, usually up to eight, IO-Link field devices are then connected star-shaped to each IO-Link master. As a result, the wiring of the field devices can be modular in machines that consist of several parts, so that complexity is reduced.

Against the background that the electrical installation can take place with unshielded cables with a length up to max. 20 m and with standard M8 or M12 plugs, the integration costs for IO-Link are low overall.

Commissioning is very simplified by the point-to-point connection, since IO-Link devices do not have to be addressed. In addition, if there is a fault, it can be quickly located and has no effect on other field devices.

5.1.1.3. Industrial Ethernet Interfaces

These modern interfaces have a very high reaction rate. Any desired topology can be used, and a ring structure is also possible. This increases operational safety, because all subscribers can be reached on both sides, which is particularly decisive in the event of an interruption of the connection.

The Internet is connected with the individual field devices with industrial Ethernet interfaces, e.g., access to the device data can be made possible via an integrated web server by means of a simple browser.

However, higher hardware costs and a larger installation space result, since significantly more and more complex hardware must be integrated. The costs/benefit ratio must be considered. In the case of a normal proximity switch, for example, an Ethernet interface would never be used, because procurement is out of proportion in relation to dedicated communication hardware.

There are various interface standards in the market, which were essentially initiated by the control manufacturers. SIKO offers Profinet, Ethernet/IP, EtherCAT and Powerlink. Ethernet/IP is widely used as a standard, especially in the North American market, distributed by the market-leading control manufacturer Rockwell, while Siemens Profinet is preferred as a standard variant in Europe. SIKO basically has very high coverage of the controls used in mechanical engineering with the four interfaces offered.

With the industrial Ethernet interfaces, commissioning and parameterization of the position indicators and actuators are very simple and user-friendly. There are various ways to configure communication parameters, e.g., including via a web server or a partially automated communication recording via a DHCP server.

5.1.1.4. Exchange of process and diagnostic data

Diverse process and diagnostic data exchange are possible via the industrial Ethernet interfaces, which also supports measures for "predictive maintenance". The Ethernet protocol can be enhanced in such a way that these data can be exchanged with other systems such as a cloud or even an ERP system in addition to the control. This opens up new dimensions in the handling of data and how access to such data can be designed. This is where development is heading in the direction of Industry 4.0.

5.1.2. Alternative integration via protocol converter and RS485

SIKO position indicators for monitored size changeover were only offered with serial interfaces previously. This meant an inexpensive device and a compact device dimension. Nevertheless, the demand for connection to a modern interface increased. This requirement can be solved via a protocol converter.

Using it, up to 31 SIKO devices with an RS485 interface can be included in an industrial Ethernet. SIKO offers a complete solution including all system components up to the cable and bus termination plug, a software support package and the configuration of these protocol converters. In addition, the programming skills of the employees can be used; in other words, these do not have to deal with CANopen or the proprietary SIKONET5 protocols, but can use the already known programming options in the Ethernet protocols. Nevertheless, it is possible to connect a plurality of field devices, e.g., AP10 position indicators, via a cost-effective RS485 interface.
A disadvantage or a restriction is the still significantly weaker communication speed compared to direct Ethernet communication. Currently, SIKO generally offers modern Ethernet interfaces both for the control drives and the position indicators. For cost reasons, however, the described solution via protocol converters can still be a desired variant.

5.2. Pre-programmed HMI control as retrofit solution

There is also a very simple solution to be put into operation for retrofitting such an intelligent format adjustment in existing machines. In older machines, there is partly no machine control or they only have a control with completely outdated cutting points. If the system is to be optimized, the operator is usually looking for a solution that promises simple electrical installation and commissioning and requires only slight programming knowledge. For these cases, SIKO offers the HMI control ETC5000 (Easy Touch Control) as a complete solution including cables and accessories, adapters and bus termination plugs. The advantage: everything is pre-programmed with the ETC5000 as a plug-and-play solution.

5.2.1. Retrofit for optimizing existing systems

Frequent adjustments to older production systems without machine control can be easily optimized using the HMI control ETC5000 as a retrofit solution, i.e., both as monitored format adjustment and fully automated. There is no need for cost-intensive conversion to a PLC, but instead the ETC5000 enables rapid commissioning thanks to an operational user interface. All SIKO devices in the area of intelligent format adjustment can be parameterized via a pre-installed program via touch operation on the indicator. During ongoing operation, a large number of formulas can be specified for different products with that, which are stored in formula management. The operator can select them via the display.

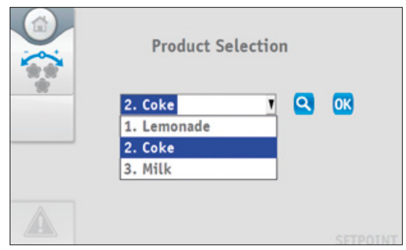
Setpoint values are then automatically sent to all axes or linear adjustment positions, to which the actuator can move automatically or even manually adjusted and monitored with an electronic position indicator. The degree of automation of the machine must be determined individually. In the case of axes which have to be adjusted very frequently, the automated variant is recommended using an actuator. Adjustment points on the other hand, which need to be changed less often, can be monitored with an electronic position indicator

5.2.2. Hardware components for retrofitting

SIKO provides comprehensive system components from a single source to enable retrofitting with the ETC5000 and the positioning devices without any problems. As a result, the ready-to-install, complete cabling rounds out the system solution. Even from the mechanical side, there are hardly any obstacles in the retrofit solution, since the essential dimensions of mechanical and monitored position indicators as well as the actuators are identical.

5.2.3. 5.2.3. Setting up and programming individual solutions

The fact that this is a plug-and-play solution with pre-programmed user interface does not mean that there is no room for setting up and programming individual solutions. Required parameters can be easily configured by the operator of the production plant via the HMI control, and the formulas to be stored for each individual product can be managed very clearly. The process engineers can individually define the target values and settings with which the system runs most efficiently.



1. Select product

2. Position axes

3. Finished!

6. Outlook: More automation, more data

6.1. Relevance of intelligent size changeover for the future

The trend toward individualization of products and the associated need for flexible, intelligent format adjustment will continue or probably continue to increase. The keyword “One Piece Flow” is decisive in this context. The machine must provide such flexibility that it can also produce the quantity “one” without exorbitantly increasing the costs. The demand for individualized products is increasing, customized for the customer regardless of whether in the industrial or consumer sector. More individuality in the products also requires greater flexibility in mechanical engineering.
As a result, the degree of automatization in machines will certainly increase even more than it will decrease.

Ultimately, it is also about enabling a quick adaptation to the market conditions so that, for example, promotional goods can be produced quickly and cost-efficiently, e.g., in the supermarket and in the beverage sector. A bottle could be preferred as container, or 0.5 liters should now be filled instead of 0.33 liters. Consequently, machines must be flexibly adjustable to prevailing market conditions. Faster throughput is also required. The topic of cost reduction is central in production, for example, due to significantly reduced changeover times of entire production lines with ever more frequent product changes.

Another aspect is the reliability in format adjustment, which will become increasingly important. This includes understanding processes to ensure the correctness of the settings. Monitored or automated format adjustment is essential for monitoring and ensuring processes in the future. The susceptibility to errors due to the “human factor” can thereby be reduced further, since the operator no longer has to be responsible for the actual adjustment, but much is done automatically by the machine.
Consequently, the responsibility of operating personnel is reduced.

6.2. More intelligence and connectivity for Industry 4.0

To meet the requirements for smarter and more flexible solutions, SIKO is always active in the further development of peripheral modules such as displays and servomotors. In addition to the actual process data, it is be helpful if the components mentioned collect even more information about the operating state of the system, for example, the ambient temperature. The displays and drives could take independent measures, so that warning messages are sent to reduce the power of a drive if limit ranges are exceeded. The topic of self-diagnosis will certainly become even more important in the future with these peripheral modules. This can extend up to the lifetime monitoring, so that data are also collected internally and the peripheral module develops into a data logger. A visual example in this respect is the wristwatch.

Although the actual process data such as clock time and wake-up function are also relevant, a smartwatch also determines how many steps the user takes, what the body temperature is or how the sleep quality was last night. Peripheral components such as the position indicators will be able to collect more and more data in the future that provide information about the overall application. If more and more data is collected, increased connectivity is also required. The existing Ethernet communication will be expanded further, so that you can also communicate directly with the cloud using the devices. This is then done in combination with the industrial Ethernet protocols and additional protocols such as OPC UA. Solutions already exist in which both run parallel on a cable. On the one hand, this allows communication with the controller and, on the other hand, additionally with ERP systems and cloud technology. There are more possibilities for information distribution and more possibilities for accessing data.

7.User/Press Reviews

“The AG02 drives perform the same task in approx. 1.5 minutes, regardless of whether only one axis is adjusted or all 14. In the last case – 30 minutes compared to 1.5 minutes – we are 20 times faster with automatic format adjustment.”
Mr. Salzani, Mechanical Department Manager at Vimco S.r.l.
Excerpt from the A&D, February 2007

“In addition, automation prevents adjustment errors, the quality of the products increases, and waste is minimized.”
Excerpt from the A&D, February 2007

“Automated actuators reduce setup times by 90%“
Günter Herkommer, editorial office at computer-automation.de Online publication on May 6, 2014

We were able to reduce setup times from 45 minutes to fewer than five minutes. This is an enormous increase in efficiency.”

Herbert Erath, Head of Special Machine Engineering, Fischer (Fischer Dübel)
Excerpt from “konstruktionspraxis”, October 2013”

“Due to the changing workpiece formats, an essential prerequisite for us was that the actuators used provide a high degree of precision and at a low cost.”

Tobias Schreck, Product Manager of Coating Technology, Robert Bürkle Company
Excerpt from “HoB special May 2008”

“Average process acceleration of 300 percent can be assumed. The waste rate could be significantly reduced, because incorrect settings are not possible with system-compliant operation.”

Automation, 1/2018. Retrofit user report “Better than new” based on an interview with Klaus Schmieder from EUROTEC International GmbH. The described application case was the optimization of a used double-sided format and edge sizing machine of type Homag KF20/22/ QA/35


Elektroautomation | Antriebstechnik

Besser statt neu

Das Retrofit-Paket von Siko besteht in der Regel aus dem Easy Touch Control, den Stellantrieben und einem busfähigen Hutschienenmodul nebst Zubehör.

“If a new product is selected, all actuators adjust to the new position and production can be continued immediately. In addition to the drastic reduction in setup times, another significant advantage is the precise reproducibility of the baking results. „

Konstruktion S1-2017, OEM user report “High flexibility in product changes thanks to compact actuators” based on an interview with Mr. Jan Lazis, designer engineer at WP- Kemper (manufacturer of bakery machines). Described machine: Dough divider and molding machine “Soft Star CTi”


Motoren

Hohe Flexibilität bei Produktwechseln durch kompakte Stellantriebe

In Maschinen für industriell gefertigte Backwaren müssen Produktwechsel flexibel, exakt und mit großer Wiederholbarkeit ausgeführt werden. Das erfordert Präzision bei zahlreichen Einstell- und Justierarbeiten. In der neuen Teigteil- und Wirkmaschine Soft Star CTi (Bild 1) sind die kompakten Feldbus-Positionierantriebe von Siko eingesetzt, die Motor, Getriebe, absolutes Messsystem, Steuer- und Leistungselektronik in sich vereinen. Auf diese Weise wird eine hohe Präzision erreicht. Takt- und Umrüstzeit sind gering, die Prozesssicherheit hoch.

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"The benefits are immediately perceptible. Setup work is cut to a minimum; conversation to a new product takes place more quickly, precisely, safely and ergonomically for the operator. In fact, we are abel to halve refitting times with the SIKO position indicators."
Quote from Joerg Philip Zimmermann, Head of Product Sales Packaging at ZAHORANSKY AG, about his experiences with the use of the bus-enabled position indicator AP10S on the Z.PACK brush machines. Excerpt from "Food & Beverage Asia" by the freelance journalist Michaela Wassenberg, 04/2019.

https://bit.ly/2VGSyzI

"Safe reproducibility of the settings is important for us, so that each batch and each product receive the same precise coding and sealing – if required – as the previous ones. This is guaranteed by the AP05." ... "Thanks to the SIKO AP05 position indicator, changeover times are significantly shorter and consequently more efficient with a monitored format change."
Quote by Daniel Anders, Product Manager Track & Trace at WIPTEC-OCS GmbH, about his experience with the bus-enabled position display AP05 on the machine TQS-HC-A. The TQS-HC-A machine enables combining printing, reading, labeling and weighing in one process. Excerpt from the OEM application report "Forgery- and Process-Proof with Track & Trace Pharma" by the freelance journalist Michaela Wassenberg, 02/2019.

8. About SIKO GmbH

SIKO has been at home in measurement technology and has developed and produced pioneering components for format adjustment, among other things, for more than 50 years. The original SIKO counters, which display mechanical-digital spindle positions, are world-famous. The small "indicators in orange" are used across all industries and millions of times in all production environments, because guide elements, material stops or tools can be positioned or aligned precisely and reliably on almost all machines or systems. For higher requirements and frequent format adjustments, SIKO has continuously developed its technologies and has a wide range of intelligent, Industry 4.0-capable positioning systems for automation processes.

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