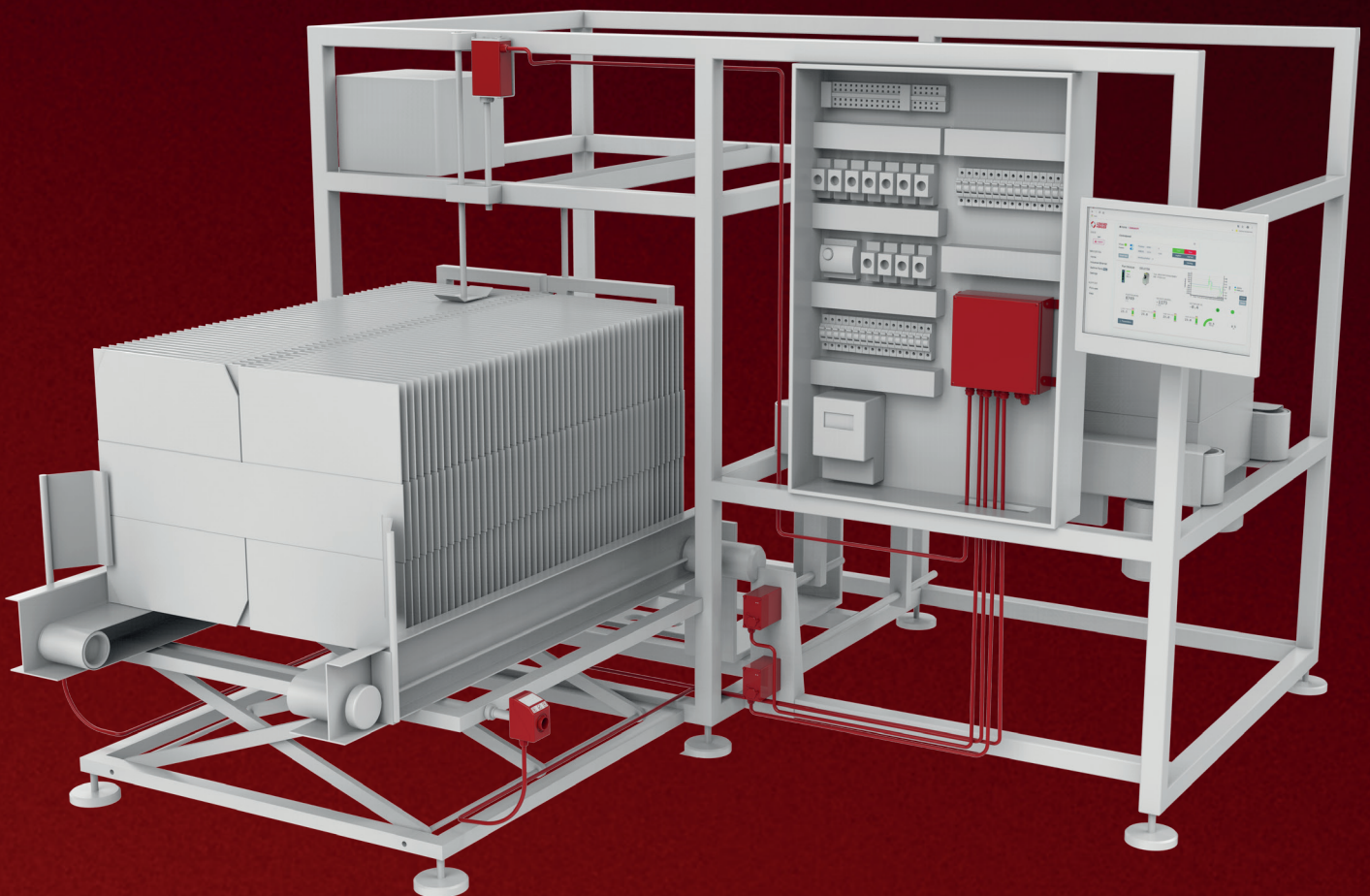


# The key to greater system efficiency

WHITEPAPER: semi- and fully automated format adjustment





Dear Readers,

Automation and system productivity have reached such a high level in many industries that the time required for format change and subsequent restart represents a significant loss of added value. This long-time neglected issue has become an important factor: the duration of the format change is now regarded as a key tool for increasing productivity.

Further potential for efficiency improvements is created by successful integration into the world of „Industrie 4.0“. The following product characteristics are key factors:

- Seamless **integration** into higher-level, digitalised systems.
- **Intelligent** functions which enable added value, such as condition monitoring.
- Straightforward **interaction** with the user, who is guided by the system and given access to key data thanks to smart terminal devices.

This white paper offers an essential overview of the current state of the art when it comes to semi- and fully automated format adjustment. You will also find out more about the specific advantages of Lenord+Bauer products and how the i<sup>3</sup>SAAC product concept meets the requirements of the future. The characteristics embodied by „i<sup>3</sup>“ are **i**ntegrated, **i**ntelligent and **i**nteractive. Real-life examples illustrate how these features can be turned into measurable added value.

Dr. Peter Velling  
Head of Business Unit Machinery

## Guided and documented set-up thanks to semi-automation

### Electronic position displays

In many industries, purely mechanical format adjustment with a counter is no longer sufficient to meet requirements on quality, reproducibility and traceability. One alternative is manual format adjustment with an electronic position display. Generally mounted on the adjustment axis, alphanumeric position displays make manual adjustment processes significantly easier. They are easier and better to read than a mechanical scale or even a vernier and represent a clear improvement as a stand-alone solution. Lenord+Bauer offers them as SeGMo-Assist with a full graphic display.



### Semi-automated format adjustment

These days electronic position displays often offer additional functions that extend beyond simply displaying numbers, particularly if they can communicate with the PLC. These additional functions enable distinguishing features and unique selling points that mechanical engineers can utilise in order to speed up commissioning or shorten set-up times, for instance, or use less qualified personnel – but without any impact on quality or productivity.

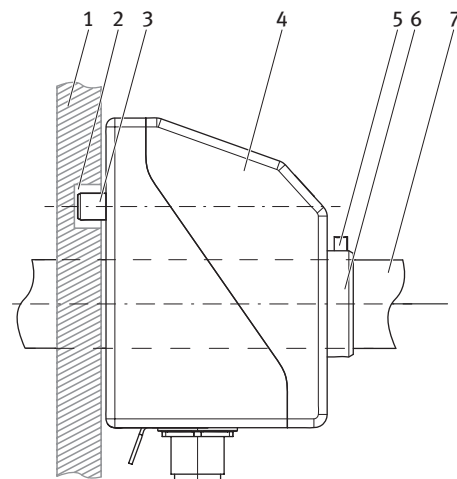
**The PLC connection offers the following advantages:**

- Nominal values can be specified by the control system and displayed on the axis.
- The display feeds the manually set positions of the axes back to the control system.

This allows all adjustment axes connected to the machine control system to be monitored.

- The control system does not release the production order until all requested axes have been set to the new position within a defined tolerance.
- Additional functions, such as instructions for the change of format parts, can be entered directly on the adjustment axis.
- If personnel are available for other activities on the machine anyway, then – depending on the frequency of format adjustment – a fully automated solution can be dispensed with (see also ROI calculator). Manual adjustment and position monitoring using a position display add up to a technically easy and attractively priced solution while at the same time offering a high degree of product quality and process reliability.

### Mechanical construction



- 1 Machine housing
- 2 Bore for mounting the torque support
- 3 Torque support
- 4 Housing
- 5 Setscrew
- 6 Sensor shaft
- 7 Machine shaft

The overwhelming majority of mechanical adjustment axes have a spindle or toothed-belt gearing which converts the rotational movement of the handwheel into a translatory movement – the actual format adjustment. That is also why position



displays are the most widely used for rotational position measurement.

Position displays which are pushed onto the end of the gear shaft have become the norm in this segment. The shaft end acts as a fixed bearing, “carrying” the position display. The display is mounted directly and positively on the machine shaft using a clamped connection. A torque support serving as a moving bearing prevents rotation of the position display and also compensates for slight axial and radial movements of the shaft caused by manufacturing tolerances in the shaft and play in the bearing.

The format adjustment with the easiest mechanical construction is a linear guide with lockable carriage. Correct positioning requires a high level of precision, but is made substantially easier with the aid of a position display. For its position display Lenord+Bauer offers a version with a connection for an external sensor for linear position measurement.

## Position acquisition

For rotational position measurement, position displays contain multiturn/rotary encoders that output a rotation angle signal. This is converted into a translatory position in accordance with the corresponding configuration. Incremental rotary encoders are not practicable here because they always need a reference point or reference search routine, which is why absolute multiturn encoders are standard. However, in the de-energised state, e.g. in the event of a power failure or emergency stop, depending on the measuring system, the position signal is lost. In order to keep the position signal and be able to acquire a change of position even in the de-energised state, manufacturers generally use an internal buffer battery. The risk with these displays is that they will send a false position signal if the battery is dead.

For its position displays (SeGMo-Assist) Lenord+Bauer uses a measurement method that dispenses with a buffer battery and is consequently maintenance-free. In the switched off state the drive shaft can be moved by  $\pm 129$  revolutions without loss of the absolute position. Thanks to the battery-less encoder, the device detects its position after power

on and is immediately ready for use. There is thus no need for a reference search routine following a power failure or emergency stop.

## The positioning range

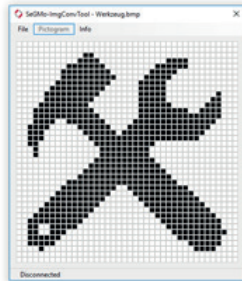
The manual setting of a nominal value is always associated with a certain deviation. That makes it sensible to define a positioning range for each nominal value. An optical signal is the most suitable way of making it easier for the setter or machine operator to reach the target range when adjusting the format. With SeGMo-Assist, a target flag is displayed to this end. Directional arrows are another important tool for minimising the time taken to reach the positioning range.

## The display

The compact dimensions of position displays limit the number of variables displayed. They normally show the actual position, the nominal position, the direction of rotation and operating states. A high resolution is therefore crucial. Not only numbers, but also pictograms and work instructions need to be clearly legible. In addition, status or warning messages that require an intervention by the personnel must be visible from a distance of a few metres. Flashing signals with the greatest possible surface area are ideal for this purpose. This allows the personnel to identify the axes to be adjusted even from a distance. These are important factors in the selection of a position display. Lenord+Bauer meets these requirements with bright OLED (Organic Light-Emitting Diode) displays. Their high luminosity improves the visibility of the flashing signals.

## Format part changes

If the display is of a correspondingly high quality, position displays can take on additional functions. These include work instructions for format part and tool changes, for instance.



Alphanumeric displays are of limited suitability here. Full graphic displays offer the possibility to design pictograms and hence complete sets of instructions for the adjustment axis. The display then becomes a small HMI.

Customised pictograms can be loaded and formatted to suit the display using an easy-to-operate software tool. Up to ten different pictograms can be created per display. During operation they can be called up from the machine control system. Once a step has been confirmed, the machine setter is guided to the next task. This user navigation thus enables intuitive and interactive operation without the need to acquire any special skills.

## Configuring the displays

For configuration, the entire ratio, where appropriate the positioning range, the direction of rotation and the decimals have to be entered. The nominal position, actual position and required direction of rotation can be represented. Configuration can be performed directly on the display via a user menu. If there are several axes in the system, however, it is more convenient to „import“ the entries directly into the displays from the control system by means of a bus interface. The SeGMo-Assist from Lenord+Bauer, for instance, offers this option using a CANopen interface. Other fieldbuses can be realised using the modular SeGMo-Box, which serves as a gateway.

In the future it will also be possible to perform configuration from a mobile terminal device with the aid of a new software version of the SeGMo-Support tool (see the section entitled „Fully automated format adjustment“).

Space-saving M12 Y adapters are used to connect the position displays to the plant control system via CANopen. The adapters are used to forward the bus data with an input and an output. An advantage of this solution is that if a display fails, this has no effect on the data transmission of the intact position displays. The CANopen interface also serves to supply the displays with 24 V DC power, providing a very compact solution with little cabling work.

## Monitoring the format adjustments

The bus interface allows not only nominal position values to be specified, but also actual position values to be returned to the control system. This means that all connected manual adjustment axes can be monitored and traced back. Only on the correct feedback does the control system give the start command. Scrap and damage to what is being packed is avoided. That makes the position display with bus interface an attractively priced solution for process monitoring and quality assurance.

## Boosting productivity through fully automated format adjustment



In contract packaging especially, the trend towards fully automated format adjustment is continuing unabated. This is generally the result of smaller batch sizes and short-notice product changes.

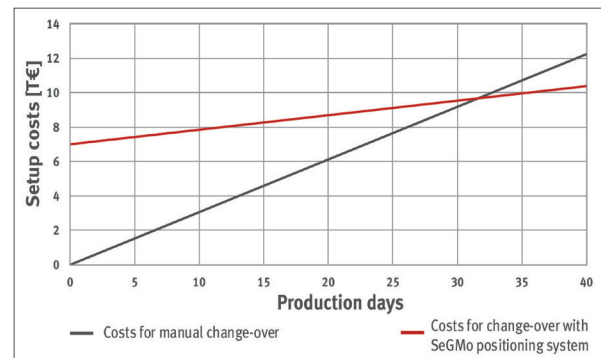
The following examples, however, show that it is not only economic reasons that justify fully automated solutions:

- If there are to be no personnel in the working area of the adjustment axes, the format adjustment must be fully automatic.
- Full automation makes it easier to introduce multi-shift operation. It may also be possible to operate the plant without personnel at night.
- Fully automated format adjustment is of particularly great benefit if the magazines and buffers for the relevant parts spectrum are also fully automated and an order planning system is implemented.

### Return on Investment (ROI) from the automation of format adjustments

With full automation, the saving in set-up times compared with manual adjustment can be converted into production unit quantities. Lenord+Bauer offers an ROI calculator that enables the return on investment in fully automated format adjustment to be evaluated. Once a few items of data have been entered, it makes the daily set-up costs transparent.

The point of intersection in the graph indicates the number of days after which break-even is reached. The straight black line shows the running costs for the format change without automation of the adjustment axes. As there are no costs for the conversion, the line starts at the origin. The costs increase linearly with only one format change per production day. The red line reflects the set-up costs with the positioning system. In this example the purchase of the Lenord+Bauer system is put at EUR 7,000. Due to the reduced set-up times, the curve for the costs per format change is significantly flatter than compared with manual adjustment. In the example graph, the curves intersect after 32 days. At this point in time the costs for the manual format change exceed the total costs for the positioning system. In other words, the investment has paid off. Often the positioning system pays for itself within the first twelve months. This does not even



take account of additional effects such as a permanent improvement in quality due to the precise positioning of the axes and reduced adjustment errors. The feedback from the settings that have been made and monitoring via the PLC allow the plant to get back to 100% as quickly as possible after a change of format.

## Criteria for selecting positioning drives

Positioning drives are now available as highly integrated, decentral drive systems. Their USPs are often found not just in the drives themselves, but especially in the efficient integration of the drive technology into the existing control system architecture of the relevant machines. The selection of a positioning drive is therefore critically dependent not only on the actual drives, but on the available software, interface and service package as well.

The concept for fully automated adjustment from Lenord+Bauer is described below. It allows a ranking of these drives within the competitive environment.

The SeGMo-System is used for the efficient integration of Lenord+Bauer products for semi- and fully automated format adjustment into a machine or plant and consists of the following elements, which can be flexibly combined with each other to suit requirements:

### ■ SeGMo-Drive

The fully automated positioning drives reduce set-up times and costs during every format change.

### ■ SeGMo-Assist

The position displays make manual adjustment processes easier by indicating nominal and actual positions. Variants are available for rotary and linear applications. A further version without measuring system assists the operator, e.g. when changing the format part or tool.

### ■ SeGMo-Connect

The pre-assembled hybrid cables (one-cable solution) minimise the amount of cabling required.

### ■ SeGMo-Box

The decentral control unit for up to five adjustment axes reduces the number of bus participants and – thanks to SeGMo-Connect – the cabling effort as well.

### ■ Modular SeGMo-Box

The decentral control unit manages up to 17 adjustment axes via the plug-in PORT modules and can be optimally

configured for the end application.

### ■ SeGMo-Lib

The function block library provided by Lenord+Bauer simplifies integration of the drives into the PLC program.

### ■ SeGMo-SupportTool

Software makes it easy to configure and test the positioning system even without a running PLC.

### ■ SeGMo-Web

The software solution for intelligent condition monitoring monitors the connected positioning drives at the modular SeGMo-Box in real time.

### ■ SeGMo-ImgConv-Tool

This is a simple tool for converting image files into pictograms for SeGMo-Assist (see the section entitled „Semi-automation“).

## High-precision hollow shaft encoders for a broad spectrum of applications

Drives for adjustment axes are frequently equipped with a hollow shaft. The hollow shaft is pushed directly onto the journal of a spindle, for instance, and secured with a clamping ring to form the fixed bearing. A torque support prevents the drive from rotating. This moving bearing compensates for any axial or radial play in the shaft. The positioning drive „rides“ on the shaft and executes a minimal pendular motion. The torque support can be easily adapted to the installation space available.

The SeGMo positioning drives from Lenord+Bauer are complete mechatronic systems and come equipped with a BLDC servomotor, a gear with lifetime lubrication, a battery-less multiturn absolute rotary encoder, bus interfaces and integrated power and control electronics. With nominal torques of up to 15 Nm, they cover the capacity range typical for secondary axes.

Positioning drives are supplied with the appropriate degree of protection and in stainless steel versions for sensitive applications such as those in the food and pharmaceuticals industries.



Due to the complexity of the manufacturing process, there are few suppliers. Lenord+Bauer offers positioning drives with up to IP 67 degree of protection in stainless steel or aluminium. The control units are available for installation in the switch cabinet in IP 20 degree of protection and for decentral mounting on the machine in IP 69K.

The reproducibility of the adjustment is critical for the precision with which a drive approaches its target. With standard servo axes, the encoder system is practically always located on the non-drive side of the motor, behind the gear. The torsional backlash and stiffness are then included into the feedback signal. Where there are high requirements on precision, Lenord+Bauer offers positioning drives of the GEL 61XX series in which the absolute rotary encoder is fitted directly on the gear shaft. As a result, the drive delivers accuracy down to 50 micrometres.

## Easy integration of the positioning drives into the plant control system



The decentral control units for mounting in the switch cabinet or in the plant are a central component of the i³SAAC product concept and enable easy, end-to-end system integration. They ensure communication with the machine control system and control the positioning drives. They are available in the following versions:

- Compact SeGMo-Box for up to five positioning drives. Control unit which serves as star distributor and takes over the power distribution for the connected drives.

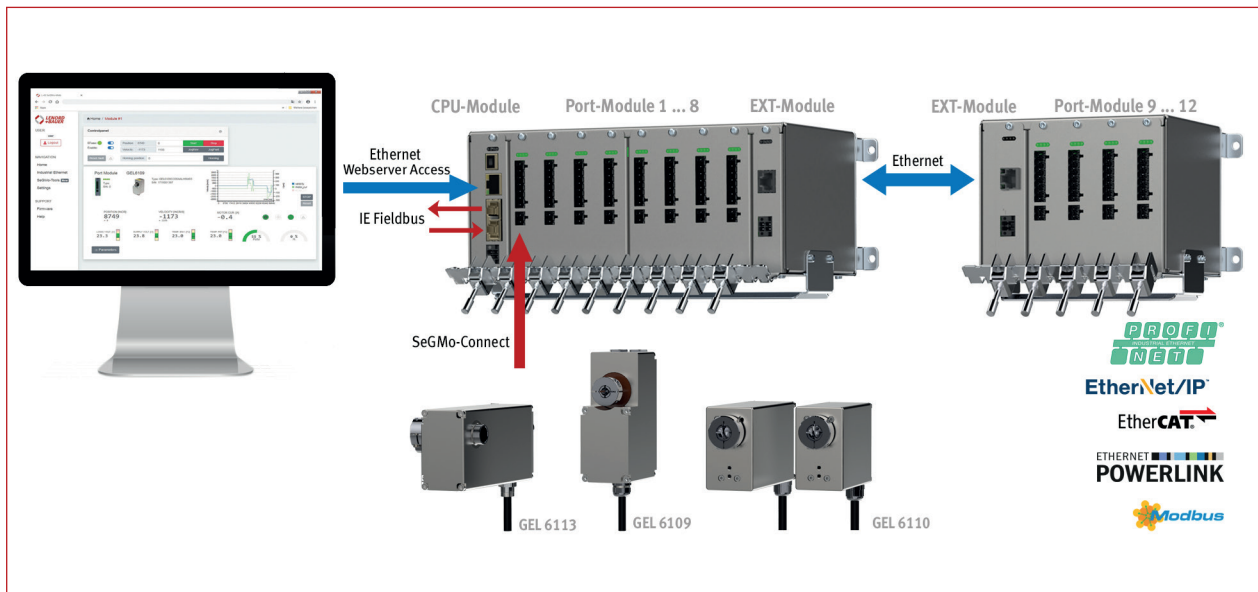
- As a modular SeGMo-Box for up to 17 positioning drives, with two different basic housings offering the option of freely populating four or nine slots. That means the box can be adapted specifically to the end application, giving cost benefits for the customer:



- CPU module: central control module that controls the drives and provides communication with the PLC via all standard interfaces.
- PORT module: connects one positioning drive via the hybrid cable SeGMo-Connect.
- EXT module: for grouping several SeGMo-Boxes as necessary in plants with distributed structures.

With the modular control unit, the power to the motors can be provided separately for each positioning drive. This is a straightforward way of enabling positioning drives in certain parts of the plant to be grouped and safely powered down together. The drives are connected to the relevant SeGMo-Box by hybrid cables that are suitable for drag chains. This one-cable technology enormously simplifies connection.





*The CPU module exchanges all relevant data with the machine control system via Ethernet in real time. Via pre-fabricated fieldbus function blocks the drives can be integrated into the machine control system without the need for extensive in-house programming.*

## Test adjustment axes even without connection to a PLC

For safety reasons, in many companies the assembly personnel do not have free access to the PLC while the system is being installed. This situation makes it more difficult for the service technician to check the relevant drive axis as the plant control system must be programmed for the servo drives in advance. Trouble-free functioning of the created program and appropriate access rights for the operator are essential prerequisites for such work.

In mechanical engineering, timetable pressures often mean that the mechanics, electricians, control system and sensors of a plant have to be installed at the same time. It may, for instance, be the case that drives and axes are already mounted, but the PLC has not yet been fully programmed. This makes it difficult to adjust and finalise individual modules or parts of the plant.

Interactivity that is not dependent on a control system is much in demand. In the i³SAAC concept, it is implemented from the USB connection right through to the web server. In the SeGMo-Support tool, Lenord+Bauer offers a solution that allows the positioning drives to be moved without prior programming of the PLC or without

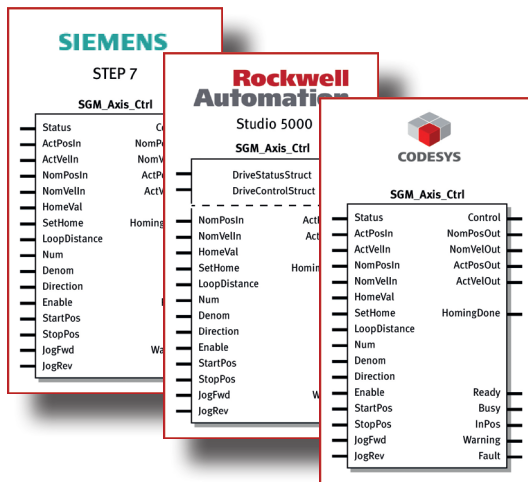
a bus connection. All that is needed is a USB connection from a terminal device to the SeGMo-Box. The SeGMo-Support Tool enables direct access to the connected drives. Moving the axis from the terminal device in jog mode and homing facilitates performance of all the steps required for setting up and testing the axis. Along with testing the mechanical installation and setting up the spindles or lifting units, it is now possible to check ratings such as motor current or load-dependent heating from a very early stage.

Even more conveniently, the SeGMo-Support Tool can be accessed via an optional web server (SeGMo-Web). In both cases all drives can be configured comfortably. The transmitted data can be used for diagnosis in subsequent operation.

## Freedom of choice in the interface

Many manufacturers of positioning drives have decided on particular interfaces. The support given to the machine manufacturer when it comes to connecting lower-level control systems to its machine control system can differ widely from one positioning drive provider to another. Only the device files are in standard format – a MUST for the particular interface. Lenord+Bauer supports all standard fieldbuses with its products.

## Quick commissioning without programming



The initial commissioning of a servo drive is often when the wheat is separated from the chaff. Here the easy integration and convenient interaction are the keys to efficient, trouble-free engineering – and i<sup>3</sup>SAAC supplies the central components.

Lenord+Bauer configures the entire drive system with the aid of the SeGMo-Support Tool: In addition to the required device files, executable function blocks are available for all standard automation platforms:

- TIA-Portal, Step 7, SCOUT
- Studio 5000 / RSLogix
- Automation Studio
- TwinCAT
- CODESYS 3.x/SoMachine V4

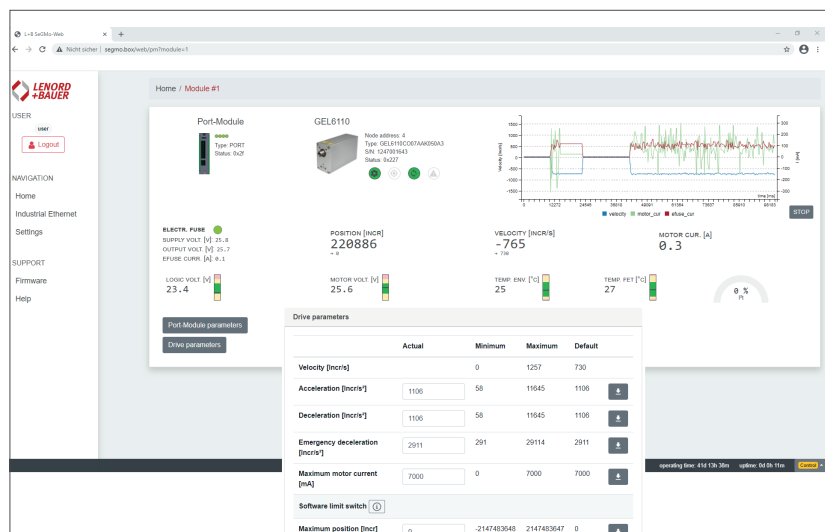
Once the function blocks have been integrated

into the user's PLC program, the drives can be immediately addressed via the machine control system. Lenord+Bauer has also designed the function blocks so that they look as similar as possible in every control system platform, which means that the technician won't have any problems quickly finding their way round another control system environment when they embark on a new project.

## Data for condition monitoring and predictive maintenance

i<sup>3</sup>SAAC provides a number of intelligent functions that point the way to Industrie 4.0. With SeGMo-Web, the actual speed, position, motor current and temperature values of the drives can be monitored in real time via the modular SeGMo-Box. That makes the data available for condition monitoring, predictive maintenance and quality assurance. SeGMo-Web is the interactive, adaptable interface for visualising the motor data.

They provide information about contamination on the driven spindle or the guide, for instance, allowing the failure of the machine to be prevented by intervening in good time. Another function is that maintenance assignments can now be realised as and when required, e.g. as a function of operating hours, rather than after fixed intervals as before. Again, during operation this data is permanently „logged“ by the modular SeGMo-Box. This eliminates unnecessary maintenance work and prevents guides being overgreased while at the same time saving running costs.

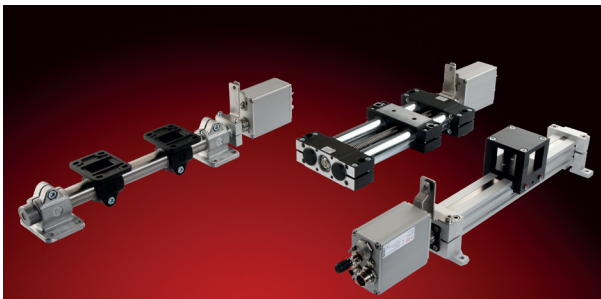


## Reduced cabling work

Given the large number of electrical components in the machines, such as sensors, limit switches, safety technology and the entire electrical drive technology, considerable cabling is required. The desire to reduce this to a minimum has led to the development of one-cable solutions in servo technology.

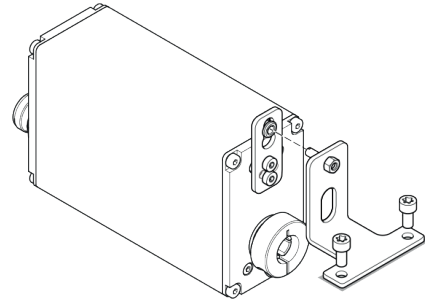
Lenord+Bauer offers the same concept here too, with a one-cable solution for its positioning drives (SeGMo-Connect). Instead of two cables for bus communication and a third cable to supply power to the positioning drives, only one hybrid cable suitable for use in drag chains is connected. In the maximum set-up version with five positioning drives connected to the SeGMo-Box, the number of cables is reduced from fifteen to five. Not only does the pre-assembled hybrid cable minimise the cabling effort, it also reduces the space required in cable ducts and drag chains. It is configured for moving use in drag chains and is supplied in food-safe and halogen-free variants and as a cULus Recognized Component.

## Plug-&-play adjustment axes



It is no great technical challenge to synchronise positioning drives and linear axes with each other. However, it takes a certain amount of time to design the adapter between the positioning drive and the linear axis and to configure and go through the approval process for the complete adjustment axis. To save its customers this effort, RK Rose+Krieger and Lenord+Bauer have entered into a cooperation agreement to provide complete adjustment axes. Lenord+Bauer offers

the matching torque support for Rose+Krieger linear axes to enable the mounting of SeGMo drives. Working in close collaboration, the two companies equip complex machines with several linear units and decentral control units including operator terminal.



## i³SAAC: Ready for Industrie 4.0

The technology drivers of Industrie 4.0 are digitalisation and the intelligent evaluation of data. Both are realised as a part of i³SAAC, allowing applications of the future – such as condition monitoring and system monitoring – to be developed. This was highlighted in this article based on the following features:

- The intelligent preparation of data enables the condition of an axis to be monitored, thereby preventing unplanned system failures.
- Fast integration is achieved because automation libraries, commissioning tools and decentral control units are provided.
- The freely configurable user interface, the USB connection and the web server are designed for easy interaction with the system.

The system will provide increasing support through active condition monitoring. As well as data on the status of the components, for instance, changes in the starting torque will also be indicated, allowing contamination and wear on the axis to be identified.

Why not tell us what your requirements are? Together we can develop future solutions for your application!

## Benefit from massive potential savings!

Your advantages thanks to SeGMo:

- Shorter set-up times
- Exact reproducibility
- High flexibility in your production plant
- Simple installation
- Intelligent condition monitoring
- Fast return on investment

We are the right partner not only in new projects, but also in the event of modernisation. Let us advise you on the optimum use of the SeGMo-System!

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