Erhardt+Leimer

EL.MOTION

BLDC motors

Continuous acquisition and control
of position, speed and torque

Contents

FOCUS ON CUSTOMER SATISFACTION

INTELLIGENT TECHNOLOGY · SMART PRODUCTS

INTERNATIONAL LOCATIONS · WORLDWIDE AVAILABILITY

CUTTING-EDGE TECHNOLOGY
AT HOME ALL OVER THE WORLD

Erhardt+Leimer
Global solutions for production of the future

Intelligent technologies and products in the highest quality designed to optimize the production processes of our customers all around the world. This is our claim as the internationally expanding Erhardt+Leimer group of companies.

With our global presence – from development to production and on to service – we are always close to the customer. We develop customer-specific solutions and provide our customers with excellent products either in digital or intelligent versions depending on their preference. Not only this, but we also set new standards for the production of tomorrow. In the process, it is not just our products that are increasingly becoming smart – our entire company is currently undergoing a digital transformation. One visible indication of this is the E+L online shop, which enables our customers to order products and spare parts quickly and easily from our website.

With more than 1,600 employees at sites across Europe, Asia, and America we deliver cutting-edge technology on-time to any location in the world.

In everything we do, we aim to use all company resources responsibly to protect the environment and demonstrate our commitment to increased sustainability.

We drive innovation

Individual by default

Clear technical challenges are currently emerging in the machinery and mechanical engineering sector: modernization, simplification, and standardization. At the same time, there is also a demand for extreme flexibility and agile processes, i.e. fast implementation combined with great ability to adapt to ever changing requirements. These opposing demands are often faced by engineering departments that tend to be overworked, frequently resulting in conflicting goals during implementation. The drive technology is an essential driving force in all production setups, so when it comes to reconciling the technical conditions with the day-to-day reality of the production environment, it plays a central role. This means that it is also high time to find answers and solutions to allow drive units to be adapted quickly, easily, and reliably.

Erhardt+Leimer is facing up to this challenge with its state-of-the-art drive concept EL.MOTION, which sets new standards for Industry 4.0.

Brushless drive technology

Our brushless drive technology is a tried-and-tested and highly successful product that has been developed by Erhardt+Leimer based on the company's own know-how and many years of practical experience. It is now used in a wide range of systems at our customers. Through careful selection of components, highest quality standards, and international certifications we can ensure that this series of drives is perfect for automation solutions requiring fast reactions, precise control, and the utmost reliability. All servo motors are by design highly dynamic and incredibly stable, making them ideal for many different potential applications. They are particularly suited e.g. to positioning tasks in industrial robotics, in machine tools, actuators, and machine automation.

Direct drive solutions

Erhardt+Leimer offers linear and rotary direct drive solutions that are suitable for a wide range of different tasks thanks to their backlash-free design, and they stand out with exceptional stall torque and high acceleration capability. By removing all mechanical power transmission components, we enable our customers to make considerable time and cost savings during machine servicing and ensure easy integration in the machine layout. The drives consist of a housing made of extruded aluminum and a rotor with an iron core that offers a high power density.

Thanks to the resulting complete elimination of the type of backlash associated with conventional drive systems and the mechanical elasticity of the drive, the EL.MOTION motors are perfect for applications that demand extremely quiet and smooth running coupled with very precise positioning accuracy.

Application areas				
Ceramics & Glass	Food Industry	Freight Transport Industry	Paper Industry	Printing Industry
Rubber Industry	Textile Industry	Wood Industry	Mechanical & Electronic Industry	Flexo Printing Press
Packaging Industry	Automatic Industrial Gates	Converting Industry	Hygiene Industry	Medical Sector
Plastics Industry	Web Positioning	Process Engineering	Industrial Automation	Battery Industry
Replacement for Pneumatic Applications	Mobile Platforms & Elevators	Corrugated Board Industry	Metal Industry	Intralogistics

Industry 4.0 – Production meets digitization

In the modern world of automation, industrial Ethernet protocols play a vital role for connection to the higher-level control system. They enable reliable communication and data exchange in real time, and they improve control and monitoring functions. With the wide range of available fieldbus interfaces and protocols, the EL.MOTION drive units can be easily integrated in any control system – whether PLC, industrial computer, or a proprietary controller.

Technical data

	EtherNet/IP	Profinet
	EtherNet/IP	PROFINET
Hardware	Integrated	Integrated
Status	Active	Active
Application protocol	CIP	Profinet IO
Manufacturer	Rockwell	Siemens
Cycle time	5 ms	8 ms

EtherNet/IP

- Open fieldbus standard based on Ethernet technology and the TCP/IP and UDP/IP stack
- Enables communication in real time with cycle times as low as 5 milliseconds
- Widely used in industrial applications
- Offers seamless integration of equipment

Profinet

- Powerful industrial Ethernet protocol
- Uses UDP/IP and IEEE 802.3 standards and is capable of real-time Ethernet
- Thanks to Conformance Class CC-B a large number of real-time applications can be realized

EtherNet UDP

- Standard Ethernet protocol requiring no special control technology
- Utilizes a request/response method to exchange data with the control computer
- No description files or special development environments required

Simplify your processes with Ethernet

- **Flexibility**
  Thanks to the integrated protocols, you can quickly and easily adapt your motors to a range of different controller types.
- **Easy integration**
  The motors can be seamlessly integrated in existing systems.
- **Programmability**
  Configuration and programming are really straightforward via the development environments of the controller manufacturers.
- **Data availability**
  All relevant data is saved directly on the device and can be downloaded if required.

Rotary drive units

The rotary drive units AD 11, AD 12, and AD 14 are synchronous machines with a high power density. With very compact component dimensions, these motors achieve a torque output in the range from 1 to 4 Nm at speeds between 230 and 1000 rpm, offering a gearbox-free solution for many applications. High axial loads can also be handled without problems thanks to the additional support provided by a two-row slanting ball bearing. As a result, the drive units can be connected directly – without a coupling – to a machine, which makes them very easy to integrate in existing production lines.

Overview of rotary drives		
Rotary drive unit AD 11	You will find detailed descriptions of these products on pages 14 through 19.	
Rotary drive unit AD 11with STO function		
Rotary drive unit AD 12		
Rotary drive unit AD 12 with STO function		
Rotary drive unit AD 14		
Rotary drive unit AD 14 with STO function		

Linear drive units

The linear drive units AG 72, AG 90, AG 91, AG 93, AG 96 and AG 98 are synchronous motors with high positional accuracy and control dynamics. The nominal actuating forces of the relevant motors are in the range from 250 to 10000 N at a speed rate of up to 60 mm/s. The linear drive units are particularly well suited to longterm applications and are used e.g. on moving webs for web control at unwinding and rewinding stations.

Overview of linear drives		
Linear drive unit AG 72	You will find a detailed description of this product on page 26 and a dimension drawing on page 28.	
Linear drive unit AG 90	You will find a detailed description of this product on page 26 and a dimension drawing on page 29.	
Linear drive unit AG 91	You will find a detailed description of this product on page 26 and a dimension drawing on page 30.	
Linear drive unit AG 91with STO function	You will find a detailed description of this product on page 26 and a dimension drawing on page 35.	
Linear drive unit AG 93	You will find a detailed description of this product on page 26 and a dimension drawing on page 31.	
Linear drive unit AG 93 with STO function	You will find a detailed description of this product on page 26 and a dimension drawing on page 36.	
Linear drive unit AG 96	You will find a detailed description of this product on page 26 and a dimension drawing on page 32.	
Linear drive unit AG 96 with STO function	You will find a detailed description of this product on page 26 and a dimension drawing on page 37.	
Linear drive unit AG 98	You will find a detailed description of this product on page 26 and a dimension drawing on page 33.	

Drive technology

Drive structure
- Cascaded control
- Direct drive solution
- Reduced cabling
- Brushless technology

Integration
- Machine network
- Easy diagnostic options
- Internal process monitoring

Setup
- Web-based management
- Automatic System Identification (ASI)
- Visualization of the commissioning process

Networking / communication
- Profinet (GSD)
- EtherNet/IP (EDS)
- EtherNet UDP

EL.MOTION technology

- **High power density**
  The rotor pack in our drives features a very high share of iron. As a result, our drives are extremely powerful and offer very stable positioning. They are designed especially for use in dynamic, high-precision positioning applications.

- **High axial load bearing capacity**
  Thanks to the use of a two-row slanting ball bearing on the drive side of the drive, the rotor shaft is capable of withstanding increased axial loads. As a result, it is not always necessary to use a coupling to reduce axial loads.

- **Integrated electronics**
  Our drives feature integrated power and communication electronics. This offers our customer space and cost savings with regard to integration in their machine concept.

- **Operating range up to 60 °C**
  Our drives are designed to be used all around the world. Noticeable power degradation does not occur until ambient temperatures reach 60 °C or higher.

- **High network compatibility**
  To ensure that they are ready to be deployed in a wide range of industries, a large number of industry-standard fieldbus interface protocols are already integrated in our drives.

- **Multiturn**
  Our drives feature a multiturn encoder for position feedback. This in-house development allows us to permanently store the absolute position value without needing to access a storage medium.

- **Low voltage 24 V**
  Our drive technology has been specially developed for use in low-voltage 24 V DC applications.

- **Servo controller**
  Thanks to their cascaded control structure and closed-loop control functions, our drives provide production system developers with all the functions that would be covered by a commercially available external drive controller.

- **Fieldbus integration**
  Our fieldbus interfaces are certified in accordance with the manufacturers' guidelines and offer full integration in the machine network as well as standards-compliant transmission of data between the individual network nodes.

- **Parameterizable**
  The drives can be parameterized via web-based management. As a result, the process of commissioning and starting to use the drives is simple and intuitive.

50%
standard components allow flexible use of a wide range of different drive variants

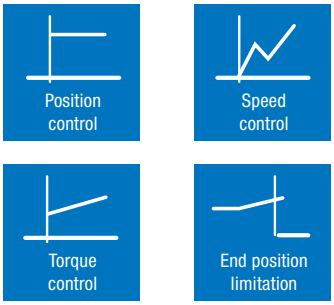
25%
cost savings thanks to the use of decentralized drive concepts

40%
longer service life through intelligent process monitoring

Customer benefits

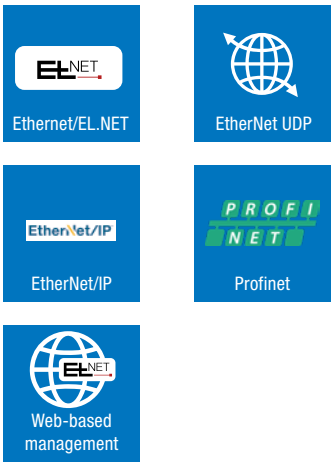
Control

The EL.MOTION product family consists of a range of intelligent drives in which the motor controller is already integrated in the drive. The motors are BLDC (brushless direct current) motors that are operated via the electronic controller as synchronous machines using a vector module. The drives can be used for position control, speed control, or torque control. In addition, the drives offer the option of connecting two external limit switches directly to the drive. The combination of this distributed intelligence with a dedicated interface concept allows a decentralized drive topology to be implemented that greatly reduces wiring and space requirements in the control cabinet.



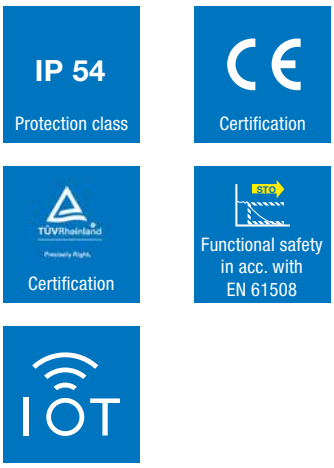
Communication

Erhardt+Leimer makes a wide range of communication standards available for its drives. The AD and AG series come with EL.NET technology, which allows both open and closed-loop control tasks to be implemented without any need whatsoever for an external controller. E+L has a large number of sensors and input/output modules available for this. All the drives come with web-based management on board as standard. This means that when the motor is connected via Ethernet, it can be addressed from the browser of a PC, allowing you to check and adjust settings or query the current status. But that is not all: E+L also places great value on open connectivity and therefore also offers open access via EtherNet UDP or via certified standard protocols such as EtherNet/IP and Profinet. One IP address per drive needs to be reserved in the network for integration of the drives.



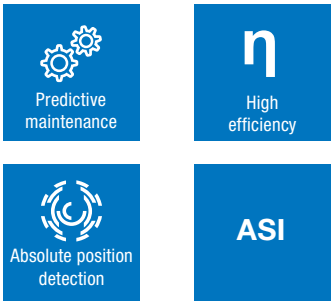
Safety

Both the communication protocols and the optionally available functional safety in accordance with EN 61508 (Safe Torque Off – STO) are all certified by TÜV, Germany's Technical Inspection Association. As standard, the drives are supplied with the protection class IP 54 and can be used up to an ambient temperature of 60°C. The integrated "intelligence" means that the EL.MOTION drives are fully IoT-compatible. They enable predictive maintenance by providing access to performance data and temperature values. The web-based management offers integrated service and analysis tools, such as oscilloscopes and recording functions.



Efficiency

The high-resolution multiturn encoder (4096 pulses per revolution) guarantees high control accuracy and ensures the best efficiency in all operating ranges. Thanks to the high power density, the compact design with simple cabling, and the guided commissioning process with Automatic System Identification (ASI), the drive series AD and AG are highly effective drive solutions.



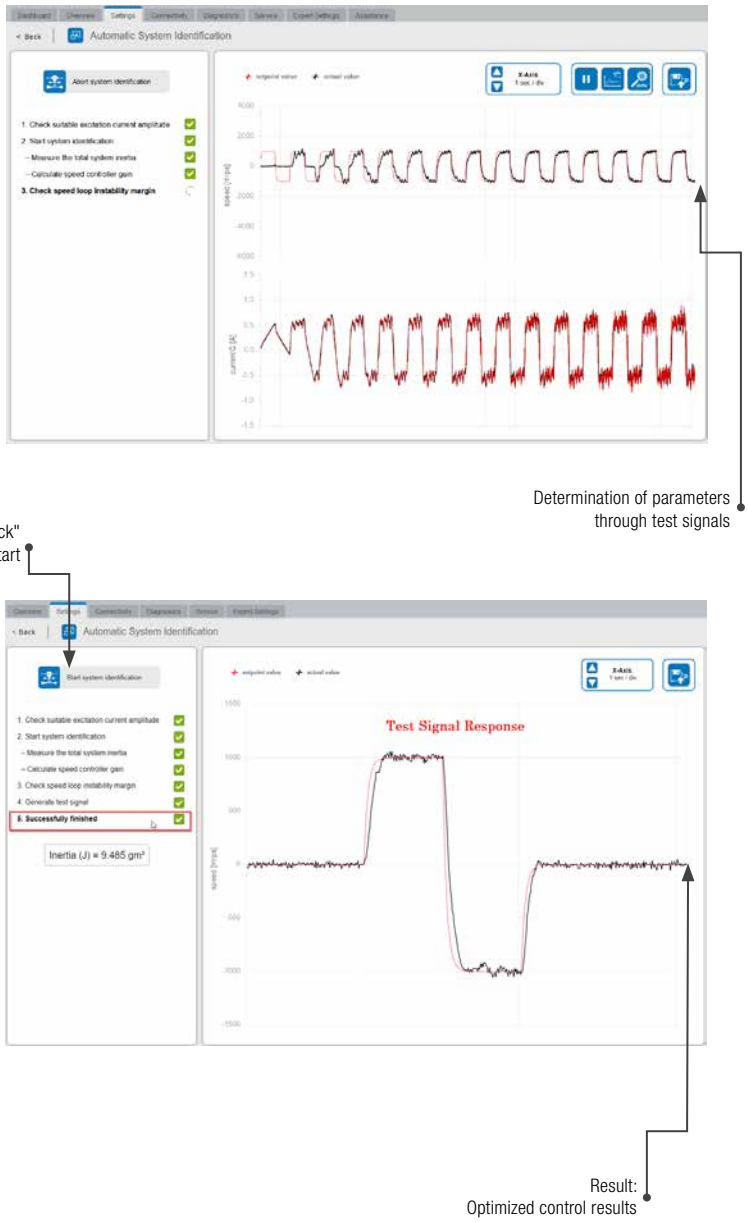
ASI (Automatic System Identification)

Optimize your drives in a matter of seconds

Automatic System Identification (ASI) is a tool for quick and easy commissioning and for optimization of drive applications. In just a few seconds you can automatically and optimally adjust the parameters for the individual drive controllers of both the rotary and linear EL.MOTION drive units. Determination of the controller parameters is part of the guided commissioning process. Here, the parameters for compensation of the mass inertia of the load being moved and for compensation of friction effects are optimally adapted to the relevant customer application.

This means that high costs for servicing and commissioning of the drives are now a thing of the past – as is the need for specialist expertise in control technology on the side of the customer.

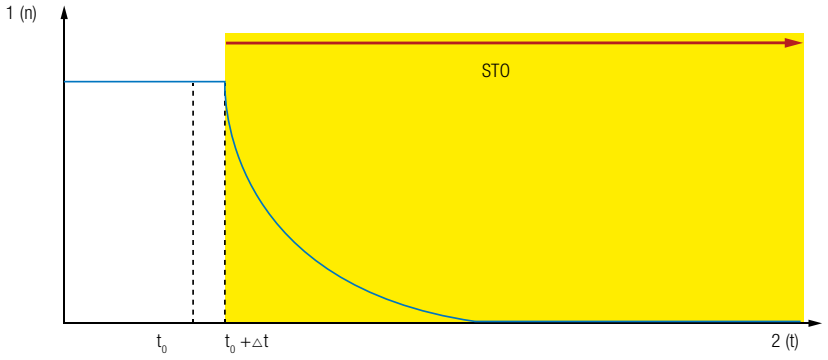
- "One-click" start Automatic System Identification (ASI)
- Customer-friendly guided commissioning and servicing via the integrated web-based management (WBM)
- Shortened commissioning times and reduced costs for our customers
- Optimized coordination of closed-loop control in the drive
- Resonance detection ensure that the control settings are kept at a safe margin to the stability limits
- Can be reapplied to changed moments of inertia at any time
- Higher clock rates for processes
- High stability and quality in motion control
- Optimized productivity for the customer's line



Functional safety

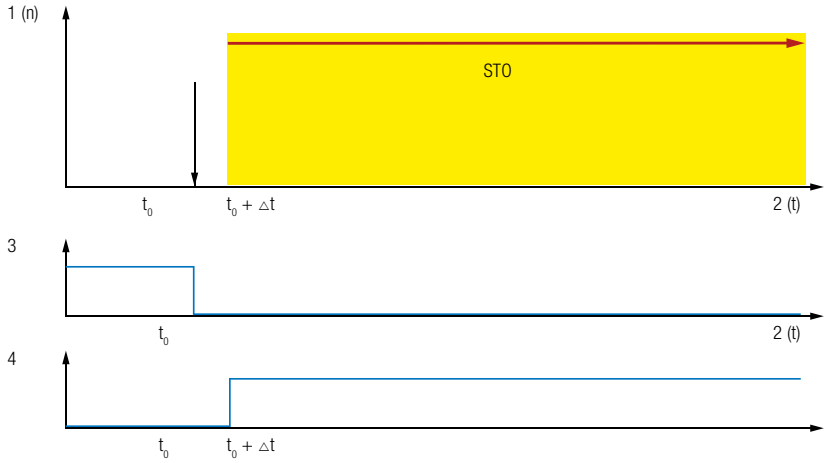
"Safe Torque Off" (STO) function

- The safety function STO (Safe Torque Off) in accordance with EN 61800-5-2 is a safety function that is integrated in the drive; the safety function shuts down the motor torque by interrupting the control signals. The safety function STO can be used wherever the actuating drive comes to a standstill by itself in a sufficiently short time due to the load torque or due to friction, or where "coasting down" of the actuating drive does not have any safety-related consequences. The stoppage position is not monitored.
- The safety function STO corresponds to Stop Category 0 in accordance with EN IEC 60204-1. The figures show the sequence over time for the two basic application examples for use of the STO function. (In the figures, $\triangle t$ identifies the response time of the safety function.)



Prevention of starting through activation of the STO safety function:
1 Speed (n) / 2 Time (t) / 3 Request (STO input) / 4 Status

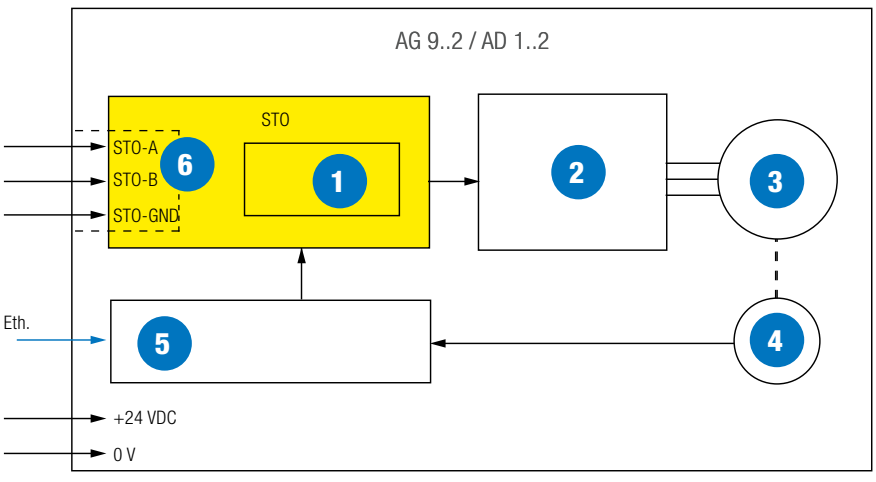
STO activation at standstill



Prevention of starting through activation of the STO safety function:
1 Speed (n) / 2 Time (t) / 3 Request (STO input) / 4 Status

Block diagram (STO)

- The diagram opposite shows the internal layout of the actuating drive as a simplified block diagram. The integrated safety function is marked in yellow. The STO module has a two-channel architecture (channel A and channel B) and therefore achieves Performance Level d, Category 3 as per EN ISO 13849-1.
- The two shutdown channels are supplied by the STO-A and STO-B inputs and act on the safe signal inhibit. If the safety function STO is activated, the control signals to the power stage, and therefore the power supply to the motor, are interrupted by the two-channel safe signal inhibit.



Simplified block diagram of the BLDC drive:
1 Impulse block / 2 Power stage / 3 Motor / 4 Multiturn encoder / 5 Drive control / 6 Electrical isolation

Control structure of the EL.MOTION drives

The EL.MOTION drives use a classic cascaded controller model comprising torque, speed, and position controllers. To ensure the highest possible efficiency, a vector control model with sinusoidal commutation is used. With the aid of an integrated multiturn encoder, the absolute rotor position can be transmitted via the communication data block to the customer's control system.

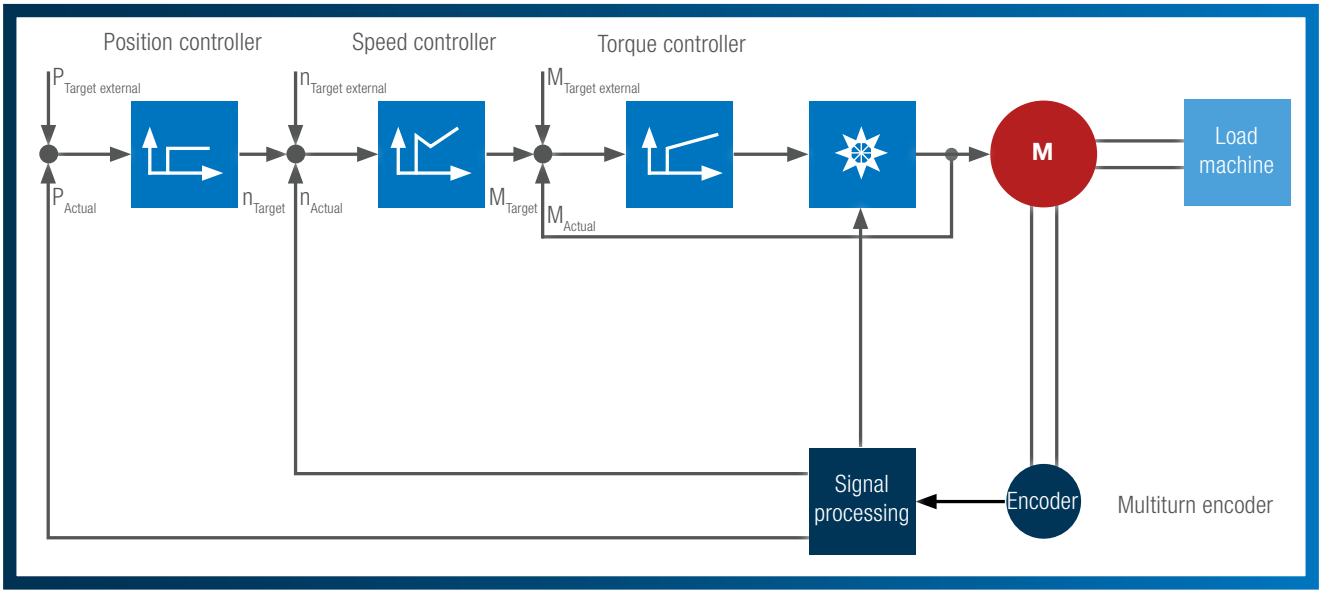


Figure: Cascaded control model

Figure: Control structure within the web-based management

Web-based management

- EL.MOTION components with integrated web server
- Customer-friendly, guided commissioning and servicing via standard web browser
- Using a standard browser on a computer, the following information can be conveniently retrieved from the EL.MOTION network and configured:
  - Network overview
  - Control group overview
  - Parameter view for control components

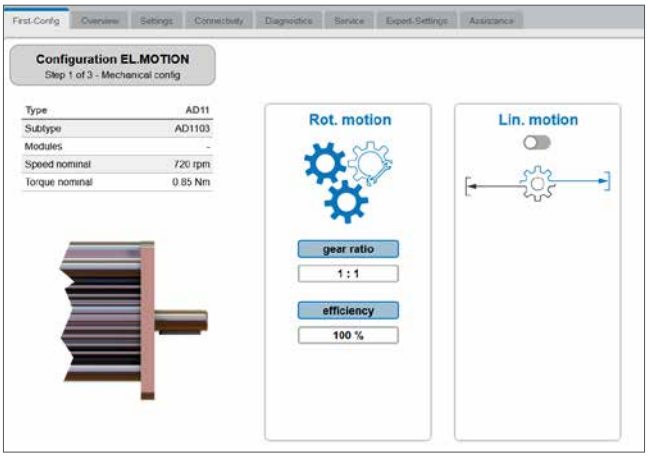


Figure: Guided commissioning

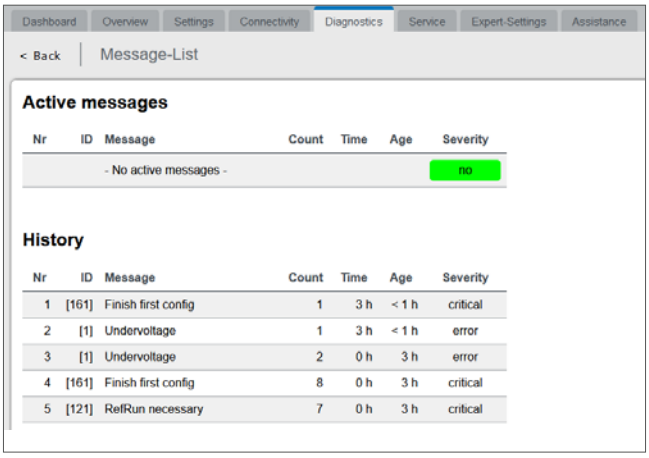


Figure: Active system messages

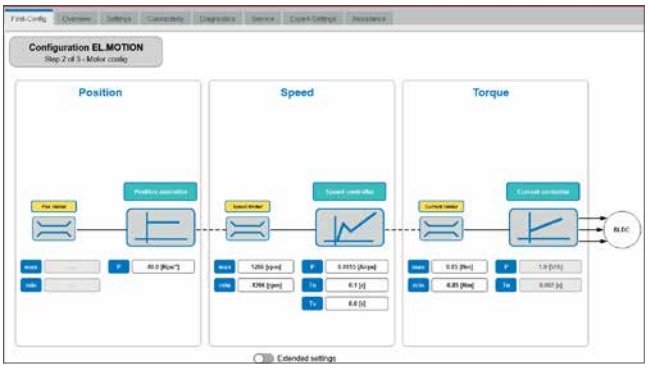


Figure: Parameters for control configuration

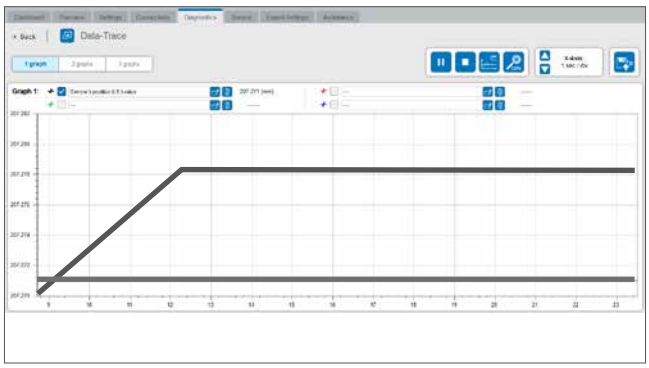


Figure: Data traces

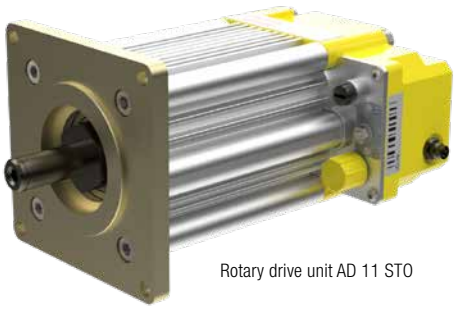
Rotary drive units

- Decentralized drive technology with integrated control electronics, compact and tailor-made for customer-specific solutions
- Permanently excited synchronous machine (BLDC motor), particularly suitable for applications requiring very smooth running and a long service life
- Constant torque across the entire rotational speed range
- High-resolution multiturn encoder for determination of rotor position and absolute position
- Absolute position detection, even after loss of voltage (without buffer battery)
- High power density and overload capability
- Integrated temperature monitoring
- Two-row slanting ball bearing offers protection for high axial loads
- Integrated fieldbus interface with certified standard protocols
- Simple configuration via web-based management with standard web browser
- Can be combined with all E+L gearbox variants and with the safety brake system
- Optionally with integrated logic card for end position limitation
- Optionally with additional STO (Safe Torque Off) function for functional safety in accordance with EN IEC 61508 with SIL 3 and EN ISO 13849-1 with Category 3 Performance Level d

STO (Safe Torque Off)

- Safe Torque Off (STO) in accordance with EN 61800-5-2 integrated in the drive
- Suitable for applications with upstream two-channel safety switching devices (Emergency OFF) and for OSSD safety outputs of PLC controllers
- The two-channel architecture (channel A and channel B) of the STO module achieves Category 3 and Performance Level d in accordance with EN ISO 13849-1
- Two-channel interruption of the control signals to the power stage and therefore of the power supply to the motor as a result of the safe signal inhibit when the STO safety function is activated

Rotary drive unit AD 11



Rotary drive unit AD 11 STO

Rotary drive unit AD 12

Rotary drive unit AD 12 STO

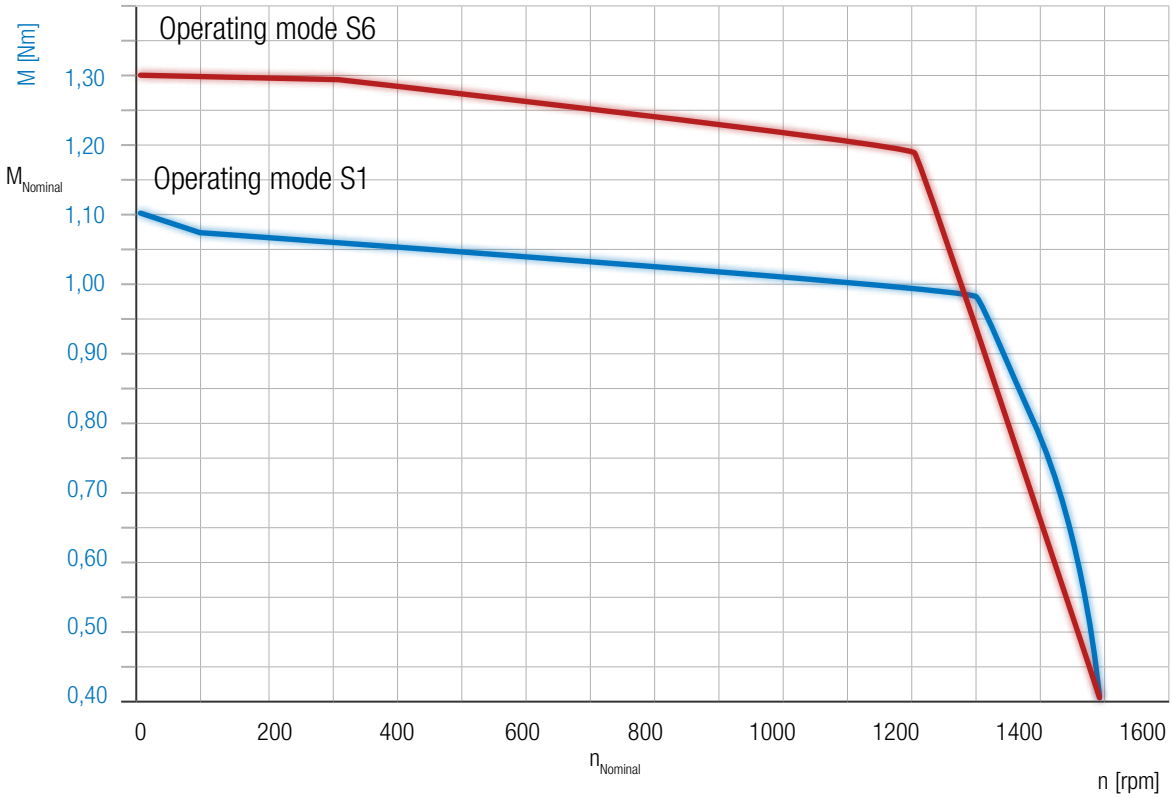
Rotary drive unit AD 14

Rotary drive unit AD 14 STO

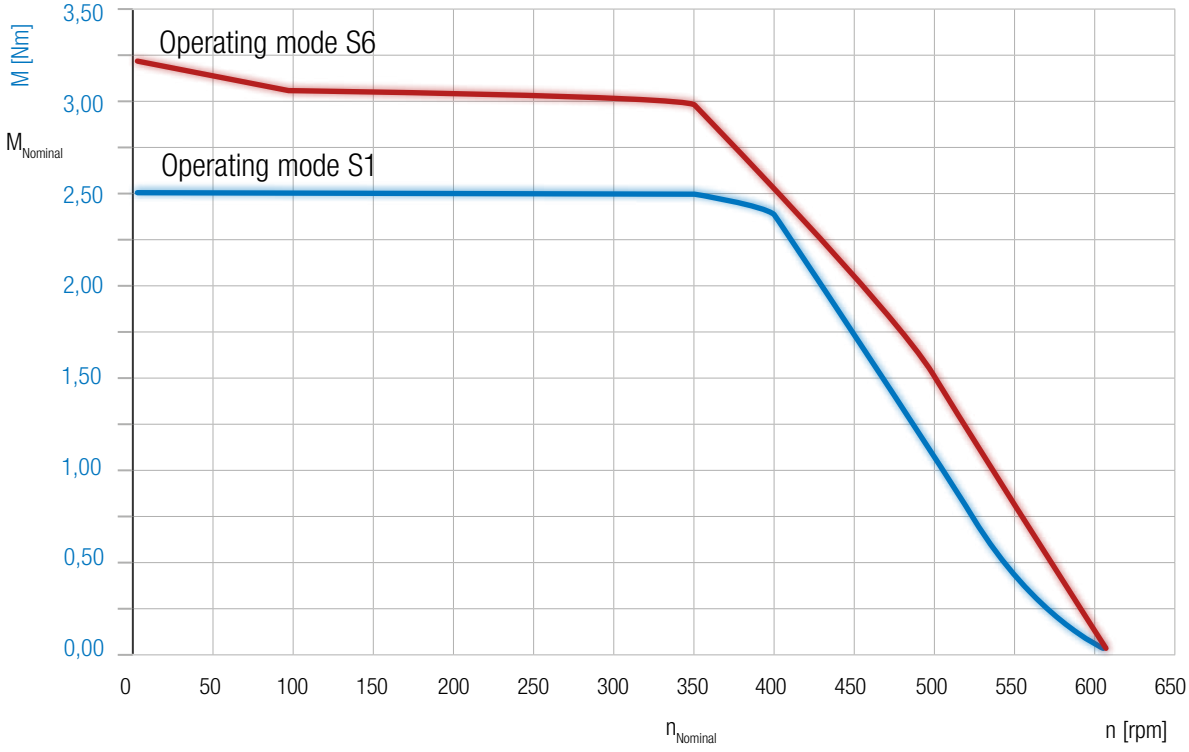
Technical data			
	AD 11	**AD 12**	**AD 14**
Nominal voltage	24 V DC		
Nominal voltage range	20 V DC to 30 V DC		
Nominal current	6.1 A (S1) / 8.0 A (S6)	6.6 A (S1) / 8.6 A (S6)	6.5 A (S1) / 8.4 A (S6)
Nominal torque	1.0 Nm (S1) / 1.2 Nm (S6)	2.4 Nm (S1) / 3.0 Nm (S6)	4.0 Nm (S1) / 4.8 Nm (S6)
Nominal speed	1000 rpm	350 rpm	225 rpm
Maximum torque	1.3 Nm	3.2 Nm	5.0 Nm
Stall torque	1.1 Nm (S1) / 1.3 Nm (S6)	2.5 Nm (S1) / 3.1 Nm (S6)	4.0 Nm (S1) / 5.0 Nm (S6)
Radial force (distance 24 mm)	400 N	800 N	1200 N
Axial force	3000 N		
Constant torque	0.15 Nm/A	0.4 Nm/A	0.6 Nm/A
Rotor moment of inertia	52 kg/mm^2	106 kg/mm^2	177 kg/mm^2
Motor weight	2.5 kg	3.4 kg	4.9 kg
Shaft diameter	14 mm (H7)		
Insulation class	F		
Resolution, multiturn encoder	12 bits per revolution (4096), 701 revolutions for determination of absolute position		
Positioning accuracy	0,09°		
Fieldbus interfaces	EtherNet UDP, EtherNet/IP, Profinet, / M8 D-code, 4-pin		
Operating voltage	M12 L-code, 5-pin		
Limit switch inputs (optional)	4 x digital input / spring terminal		
Installation altitude	3000 m above sea level		
Ambient temperature	10 °C to +50 °C		
Storage temperature	-25 °C to +80 °C		
Relative humidity	15 % to 95% (non-condensing)		
Certifications	CE NRTL certificate CU 72170613 05		
Protection class	IP 54		

Speed/torque curve

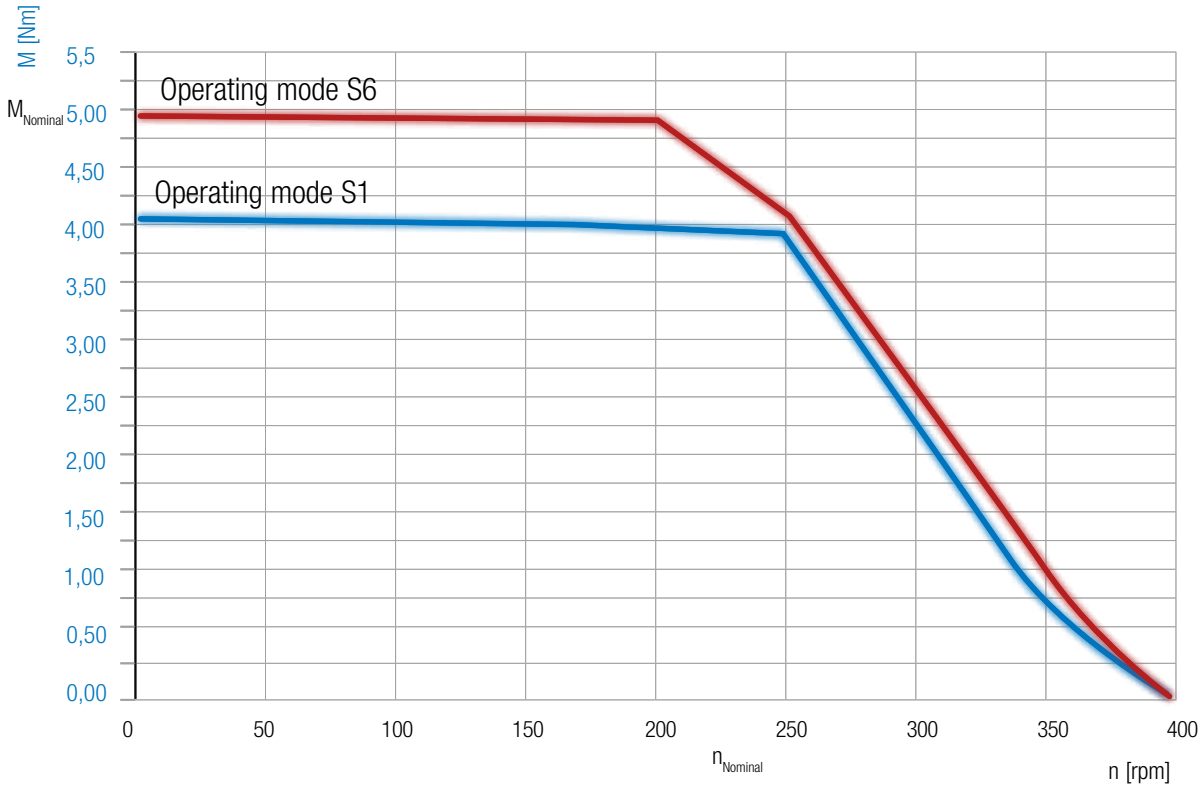
Speed/torque curve AD 11



Speed/torque curve AD 12



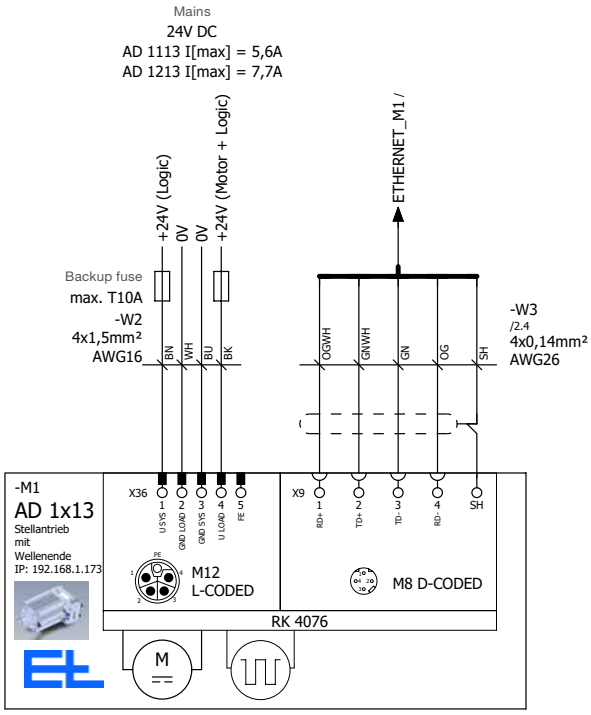
Speed/torque curve AD 14



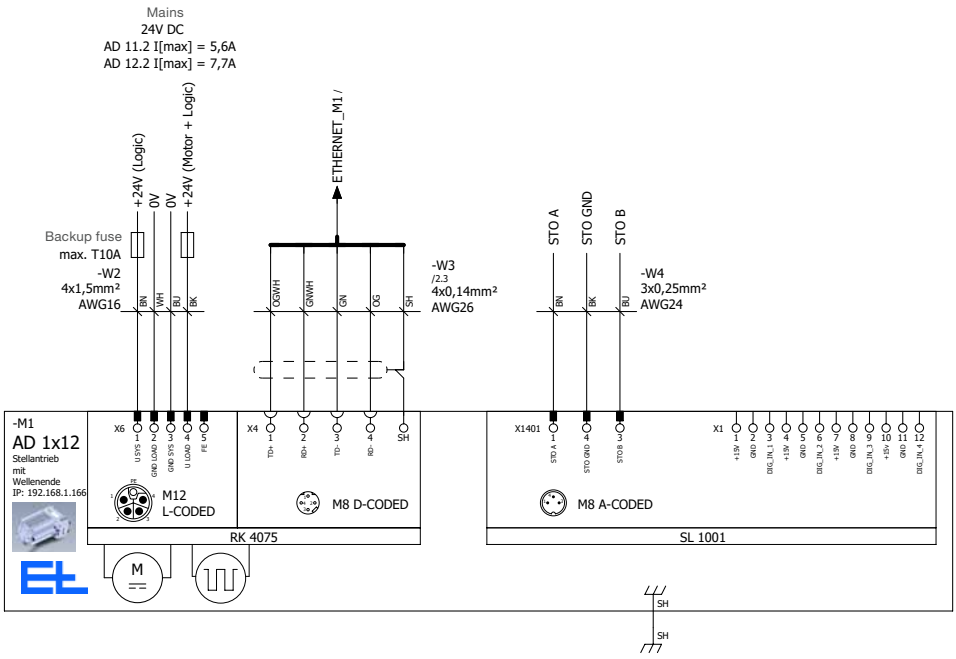
Next-generation E+L motors

Intelligent drives for various industries

Connection diagram AD 1103 | AD 1203 | AD 1403

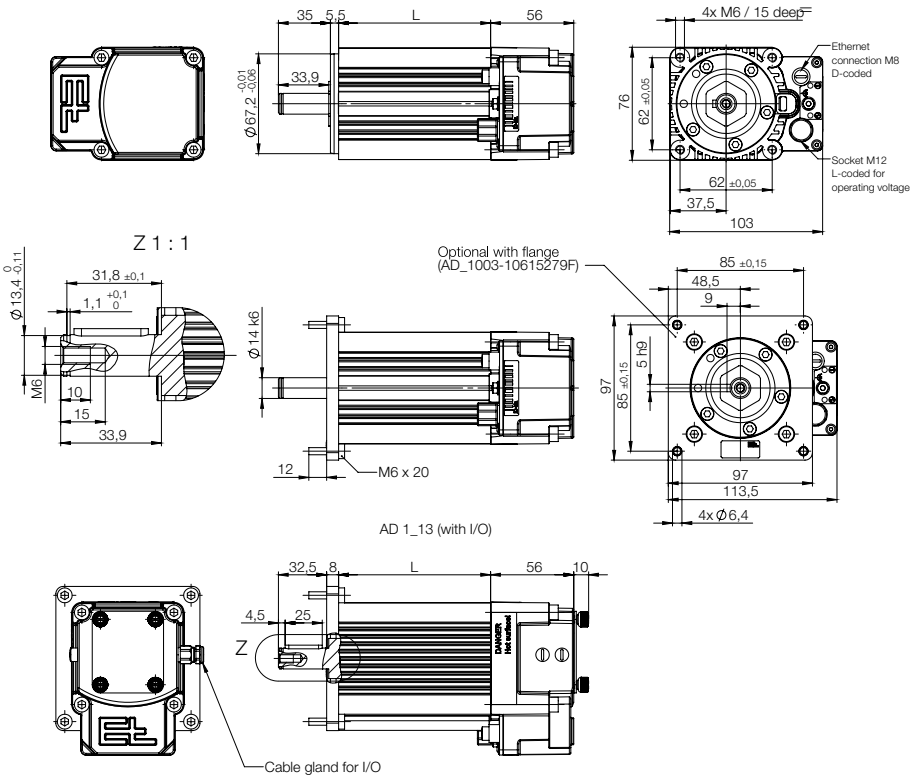


Connection diagram AD 1102 | AD 1202 | AD 1402 (STO)



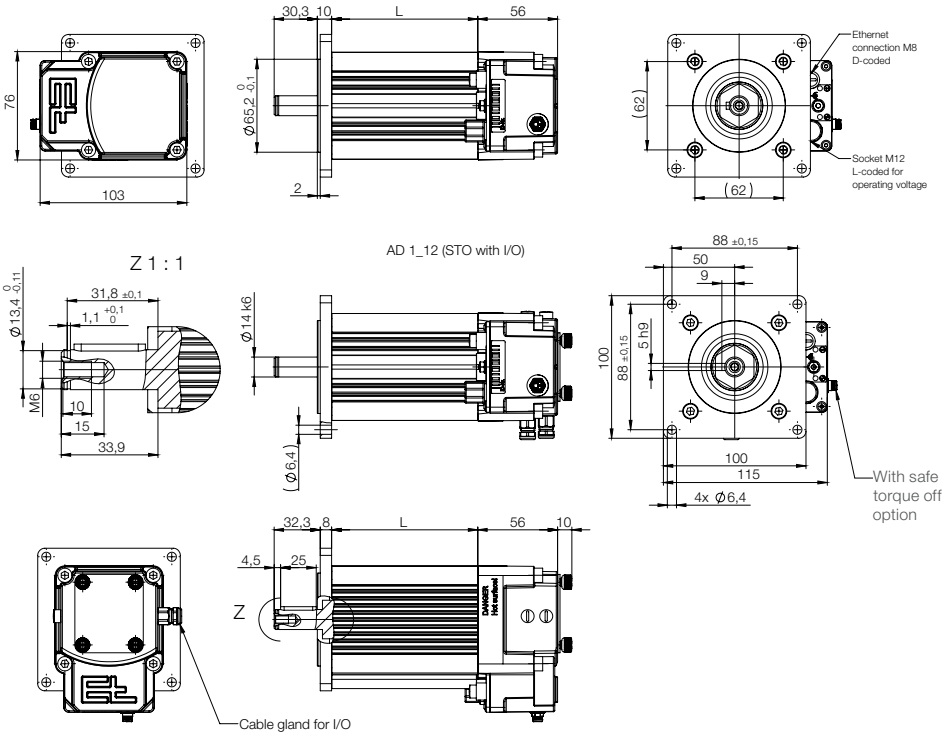
Dimension drawing 158972 for AD 11_3 | AD 12_3 | AD 14_3

Selection table			
Type	AD 11_3	AD 12_3	AD 14_3
Length L (mm)	72.3	102.3	162.8
Nominal torque (Nm)	1	2.4	4
Nominal speed (rpm)	1000	350	225



Dimension drawing 158974 for AD 11_2 | AD 12_2 | AD 14_2 (STO)

Selection table			
Type	AD 11_2	AD 12_2	AD 14_2
Length L (mm)	72.3	102.3	162.8
Nominal torque (Nm)	1	2.4	4
Nominal speed (rpm)	1000	350	225

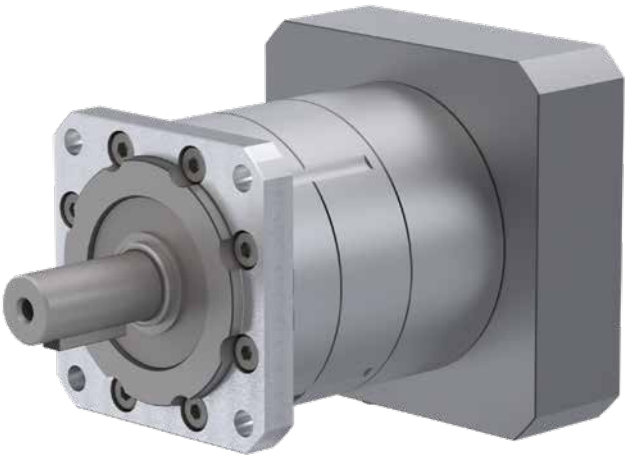


Planetary gearboxes

Thanks to the high precision of the helical gearing and the optimized tooth meshing conditions, this design achieves very quiet running, minimal backlash, and high efficiency. We can produce individual, customized motor flanges to maximize flexibility in terms of attachment of the motor to the customer's machine. Thanks to the wide range of planetary gearboxes we have in our portfolio, we can offer our customer the perfect planetary gearbox to best suit their particular application.

Technical data

- High power density and efficiency
- Quiet operation thanks to case-hardened helical gearing
- Minimal backlash ≤ 2.3 arcmin
- Excellent sealing and lubrication system
- Perfect layout of bearing points
- Large selection of sizes and transmission ratios

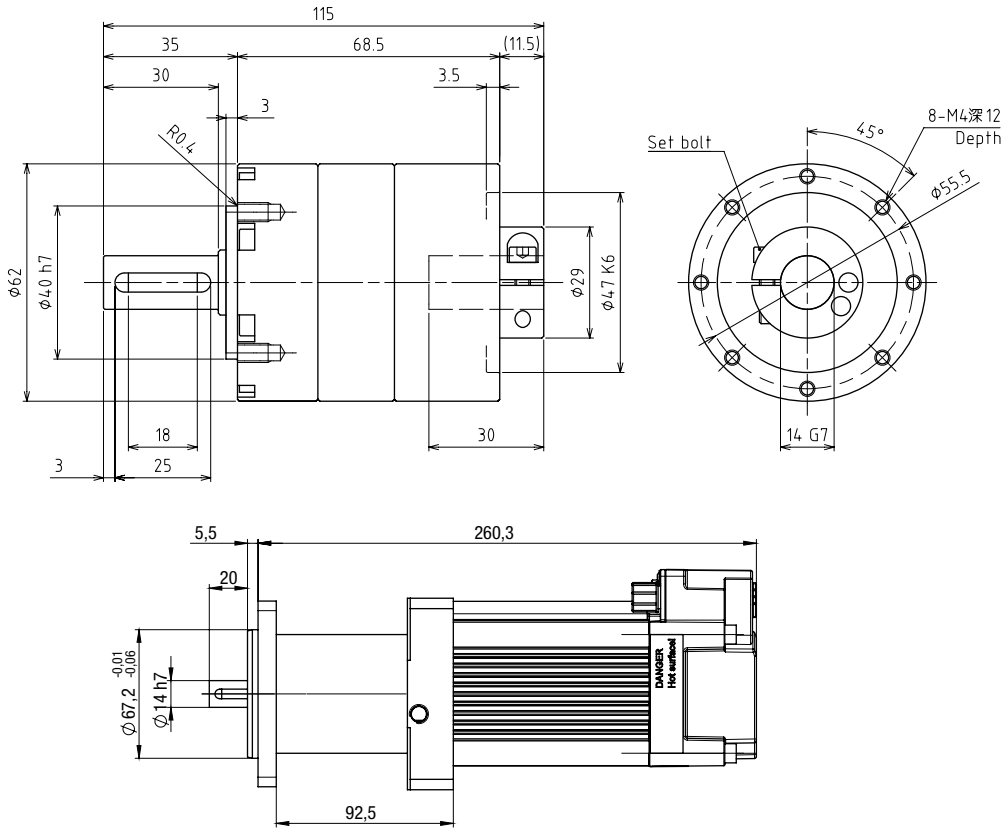


Planetary gearboxes

Technical data

									Bore size on the drive side		
Size	Transmission ratio	Nominal torque (drive side)	Max. drive torque	Emergency stop torque	Nominal speed (drive side)	Max. drive speed	Permissible radial force	Permissible axial force	Weight (≤ ø 14)	Moment of inertia (≤ ø 14)	Torsional rigidity
062	3	35 Nm	55 Nm	80 Nm	3000 rpm	6000 rpm	420 N	520 N	1.0 kg	0.21 kgcm²	2.3 Nm/arcmin
	4	46 Nm	79 Nm	90 Nm	3000 rpm	6000 rpm	420 N	520 N		0.17 kgcm²	2.3 Nm/arcmin
	5	46 Nm	79 Nm	90 Nm	3000 rpm	6000 rpm	420 N	520 N		0.16 kgcm²	2.3 Nm/arcmin
	8	46 Nm	76 Nm	90 Nm	3000 rpm	6000 rpm	420 N	520 N		0.14 kgcm²	2.3 Nm/arcmin
	9	35 Nm	55 Nm	80 Nm	3000 rpm	6000 rpm	420 N	520 N		0.14 kgcm²	2.3 Nm/arcmin
	10	35 Nm	55 Nm	80 Nm	3000 rpm	6000 rpm	420 N	520 N		0.14 kgcm²	2.3 Nm/arcmin
	12	35 Nm	46 Nm	80 Nm	3000 rpm	6000 rpm	420 N	520 N	1.6 kg	0.16 kgcm²	2.3 Nm/arcmin
	15	35 Nm	46 Nm	80 Nm	3000 rpm	6000 rpm	420 N	520 N		0.15 kgcm²	2.3 Nm/arcmin
	16	46 Nm	66 Nm	90 Nm	3000 rpm	6000 rpm	420 N	520 N		0.16 kgcm²	2.3 Nm/arcmin
	20	46 Nm	66 Nm	90 Nm	3000 rpm	6000 rpm	420 N	520 N		0.15 kgcm²	2.3 Nm/arcmin
	25	46 Nm	66 Nm	90 Nm	3000 rpm	6000 rpm	420 N	520 N		0.15 kgcm²	2.3 Nm/arcmin
	32	46 Nm	66 Nm	90 Nm	3000 rpm	6000 rpm	420 N	520 N		0.16 kgcm²	2.3 Nm/arcmin
	40	46 Nm	66 Nm	90 Nm	3000 rpm	6000 rpm	420 N	520 N		0.14 kgcm²	2.3 Nm/arcmin
	50	46 Nm	66 Nm	90 Nm	3000 rpm	6000 rpm	420 N	520 N		0.14 kgcm²	2.3 Nm/arcmin
	80	46 Nm	66 Nm	90 Nm	3000 rpm	6000 rpm	420 N	520 N		0.14 kgcm²	2.3 Nm/arcmin
	100	35 Nm	46 Nm	80 Nm	3000 rpm	6000 rpm	420 N	520 N		0.14 kgcm²	2.3 Nm/arcmin

Dimension drawing AD drive with planetary gearbox



Rotary drive unit AD
with planetary gearbox

Angular gearboxes

Angular gearboxes offer our customers unique advantages in terms of mechanical integration and positioning accuracy and are therefore suitable for use in almost all machine applications. Our single-stage angular gearbox is available with a range of different transmission ratios, so it can be individually matched to the specific requirements of the application.

The units are lubricated for life, meaning that the gearbox is practically maintenance-free under normal operating condi- tions. We can produce individual, customized adaptation solutions to maximize flexibility in terms of integration of the drive unit in the customer's machine.

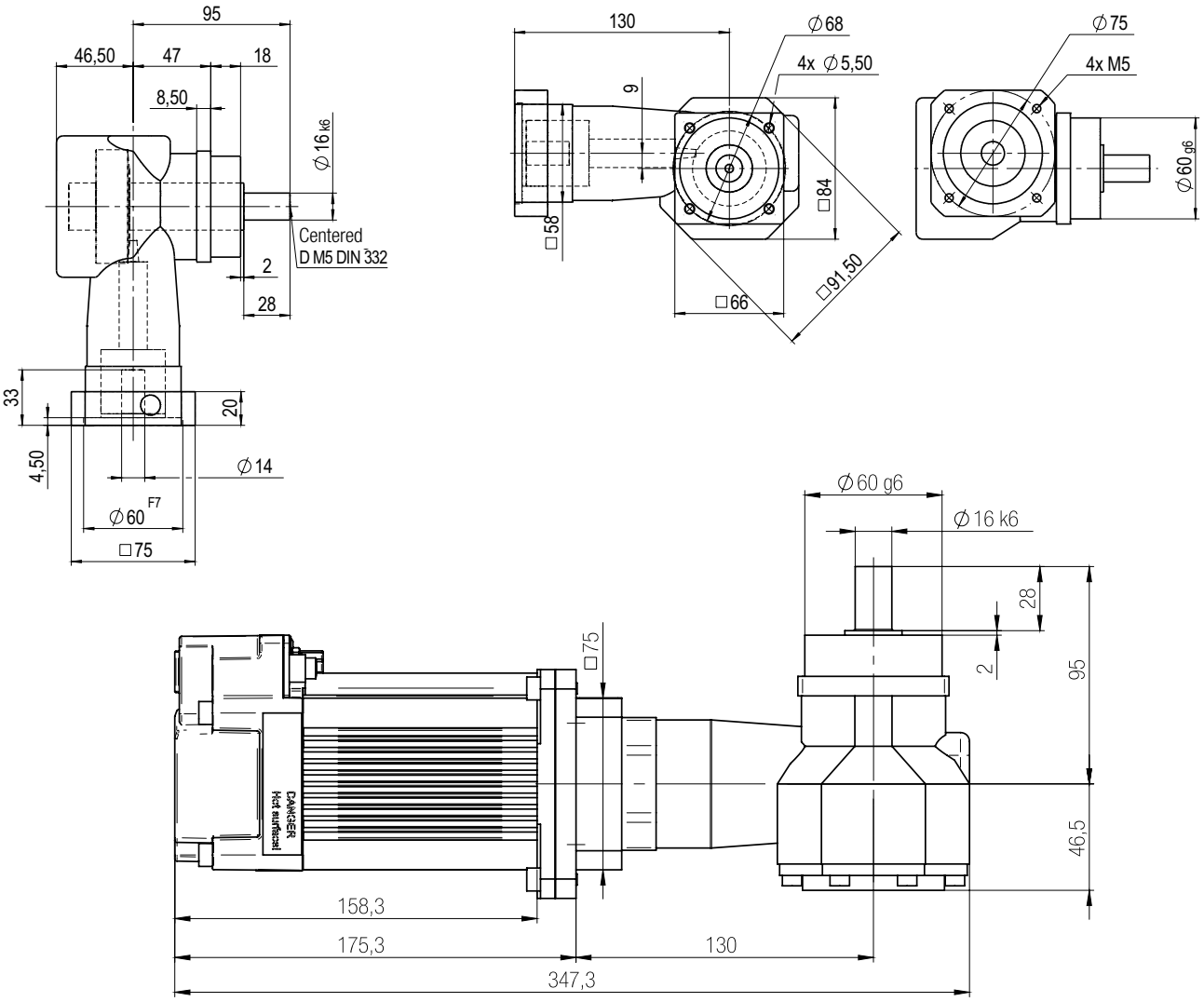
Angular gearboxes

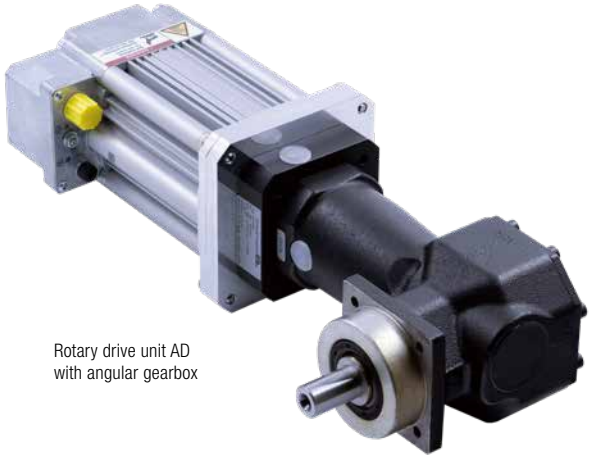
Technical data

- Single-stage angular gearbox with transmission ratios of 5:1, 8:1, 10:1, and 15:1
- Compact, stable design for maximum performance with small dimensions and low weight
- Lubricated for life and therefore maintenance-free
- Energy savings thanks to high efficiency of up to 96%
- Customer-specific flange adaptations are possible
- High torsional rigidity at the output shaft

Technical data	
Size	DE-PL55
Transmission ratio	5/8/10/15
Nominal torque	35 Nm
Acceleration	Max. 53 Nm
Emergency stop torque	70 Nm
Speed at the drive	Max. 6000 rpm
Nominal speed at the drive with i = 5/8	3100 rpm
Nominal speed at the drive with i = 10/15	3800 rpm
Backlash	< 7 arcmin
Torsional rigidity at the output	2.5 Nm/arcmin
Radial force	2200 N
Axial force	1100 N
Efficiency under full load	> 96%
Running noise (n_1 = 3000 rpm)	> 66 dB(A)
Weight	Approx. 2.6 kg
Service life	> 30,000 h S5 load spectrum as the design basis
Lubrication	Lubricated for life, enclosed system
Mounting positions	Any
Operating temperature	-10 °C to +90 °C
Paint finish	Undercoat RAL 9005 – Jet Black
Ex protection	Explosion-proof gearbox available on request
Protection class	IP 64

Dimension drawing AD drive with angular gearbox





Rotary drive unit AD
with angular gearbox

Solid and hollow shaft gearboxes

Solid and hollow shaft gearboxes offer our customers unique advantages in terms of mechanical integration and positioning accuracy and are therefore suitable for use in almost all machine applications. Our single-stage angular gearbox is available with a range of different transmission ratios, so it can be individually matched to the specific requirements of the application.

The units are lubricated for life, meaning that the gearbox is practically maintenance-free under normal operating conditions. We can produce individual, customized adaptation solutions to maximize flexibility in terms of integration of the drive unit in the customer's machine.

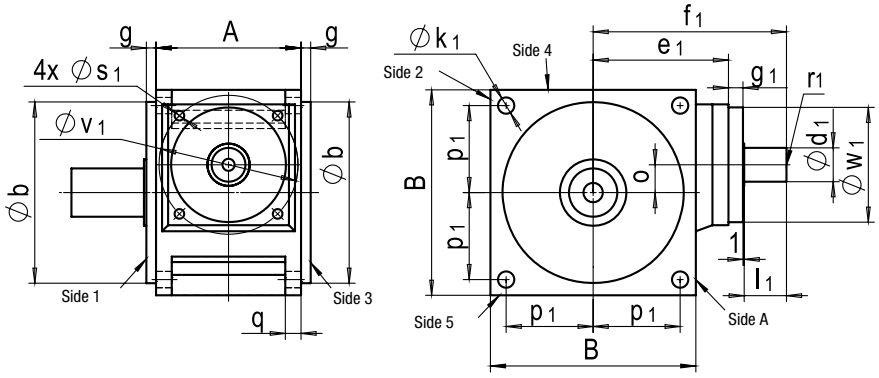
Technical data

- Version available with solid and hollow shaft
- Single-stage angular gearbox with transmission ratios from 3:1 to 15:1
- Compact, stable design for maximum performance with compact dimensions and low weight
- Lubricated for life and therefore maintenance-free
- Energy savings thanks to high efficiency of up to 96 % with high coupling stiffness
- Customer-specific flange adaptations are possible

Solid and hollow shaft gearboxes

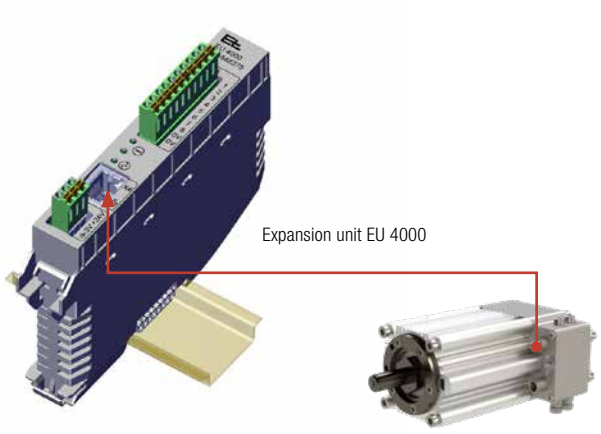
Technical data	
Size	D55
Transmission ratio	3 up to 15
Nominal torque	35 Nm
Acceleration	Max. 53 Nm
Emergency stop torque	70 Nm
Speed at the drive	Max. 8000 rpm
Nominal speed at the drive with i = 3/4/5	2100 rpm
Nominal speed at the drive with i = 6/8/10	3200 rpm
Backlash	< 5 arcmin
Torsional rigidity at the output	2.1 Nm/arcmin
Radial force	3300 N
Axial force	1650 N
Efficiency under full load	> 96 %
Running noise (n_1 = 3000 rpm)	> 66 dB(A)
Weight	Approx. 3.5 kg
Service life	> 30,000 h S5 load spectrum as the design basis
Lubrication	Lubricated for life, enclosed system
Mounting positions	Any
Operating temperature	-10 °C to +90 °C
Paint finish	Undercoat RAL 9005 – Jet Black
Protection class	IP 64

Dimension drawing AD drive with solid and hollow shaft gearbox



Expansion unit for easy machine integration

The expansion unit acts as a connecting link between the hardware on the customer's side and the EL.MOTION drive units. It can be used to transmit commands or values from an external controller, e.g. a PLC, from switch contacts, or from analog signals. Corresponding messages can also be sent out via outputs. Users can freely select the configuration of the inputs and outputs (Multi I/O). The expansion unit can be integrated as a DIN rail module in the control cabinet that houses the customer's control system.



Multifunctional I/O module

Digital inputs

- Start, Stop, Block motor
- Speed, 2 levels
- Rotation clockwise/counterclockwise
- Encoder A/B synchronization

Analog inputs

- Analog setpoint value from the customer's side
- Analog speed variables

Digital outputs

- Positions feedback
- End positions
- Speed levels
- Motor status messages
- Status message

Analog output

- Position output values

Technical data	
Operating voltage, nominal value	24 V DC
Operating voltage, nominal range	20 V DC to 30 V DC (ripple included)
Current consumption	50 mA (without PoE) Max. 350 mA (with PoE)
Ethernet interface	RJ 45 socket, 100 Mbit/s, potential-free
Ethernet PoE port (IEEE 802.3af)	RJ45 PSE, 100 Mbit/s, class 2 (7 W)
Ambient temperature	+10 °C to +50 °C
Storage temperature	-25 °C to +80 °C
Relative humidity	15 % to 95 % (non-condensing)
Installation altitude	0 mm to 2000 mm above sea level
Protection class	IP 20
Certificate	UL 61010-1 CAN/CSA -C22.2 61010-1-12
Fastening	DIN rail: DIN EN 60715:2018-07
Weight	Approx. 80 g
Dimensions (L x W x H)	121 x 23 x 94 mm

Functions

Terminal X5	Input				Output			
	Digital	Analog	Counter	Interrupt	Digital		Analog	Counter
					Power	Fast		
1	x	x	Encoder A	-	x	-	-	-
2	x	x	Encoder B	-	x	-	-	-
3	x	x	-	x	x	x	-	Compare
4	x	x	-	x	x	x	-	Compare
5	x	x	Capture	-	x	x	-	Compare
6	x	x	Capture	-	x	x	-	Compare
7	x	x	-	x	x	-	-	-
8	x		-	x	x	-	x	-
9	GND							
10	GND							

Linear drive units

- Linear actuating drive with permanently excited synchronous machine (BLDC motor), particularly suitable for applications requiring very smooth running and a long service life
- Integrated digital controller with position, speed, and current controller for highest quality of positioning control
- High-resolution multiturn encoder for determination of rotor position and absolute position
- Absolute position detection, even after loss of voltage (without buffer battery)
- Space-saving design thanks to integrated control electronics
- Integrated fieldbus interfaces Ethernet UDP, EtherNet/IP, Profinet
- High power density and overload capability
- Integrated temperature monitoring
- Maintenance-free thanks to the use of high-grade mechanical components
- Customer-friendly guided commissioning and servicing functions via web-based management
- Optionally with functional safety in accordance with EN IEC 61508 with SIL3 and EN ISO 13849-1 in Performance Level d, category 3 (not possible with AG 72)

Technical data

	AG 72	AG 90	AG 91	AG 93	AG 96	AG 98
Nominal actuating travel	See selection tables (pages 28 to 33)					
Nominal actuating speed	60 mm/s	30 mm/s	60 mm/s	30 mm/s	15 mm/s	10 mm/s
Nominal actuating force	250 N	800 N	1000 N	3000 N	5500 N	10000 N
Resolution, multiturn encoder	12 bits per revolution (4096 increments)					
Positioning accuracy	±25 µm					
Ambient temperature	+10 °C to +60 °C					
Storage temperature	-20 °C to +80 °C					
Relative humidity	15 % to 95 % (non-condensing)					
Operating voltage	24 V DC M12 L-code, 5-pin					
Current consumption	2.5 A DC	1.9 A DC	5.6 A DC	7.7 A DC	7.85 A DC	8.8 A DC
Fieldbus interfaces	EtherNet UDP; EtherNet/IP; Profinet; M8 D-code, 4-pin					
Certifications	Declaration of incorporation in accordance with Machinery Directive 2006/42/EC NRTL certificate CU					
Protection class	IP 54					

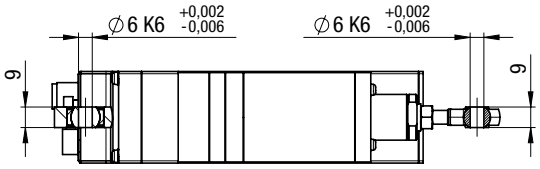
Overview of linear drives		
Linear drive unit AG 72	You will find a dimension drawing of this product on page 28.	
Linear drive unit AG 90	You will find a dimension drawing of this product on page 29.	
Linear drive unit AG 91	You will find a dimension drawing of this product on page 30.	
Linear drive unit AG 93	You will find a dimension drawing of this product on page 31.	
Linear drive unit AG 96	You will find a dimension drawing of this product on page 32.	
Linear drive unit AG 98	You will find a dimension drawing of this product on page 33.	

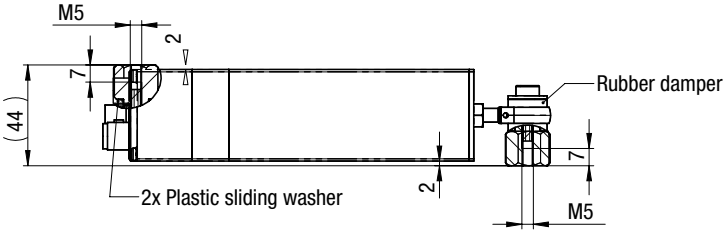
Dimension drawing linear drive unit AG 72

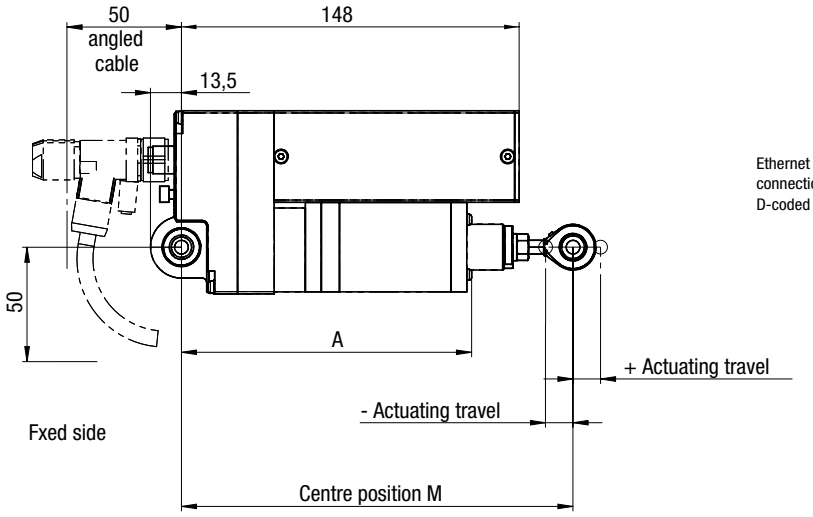
Selection table

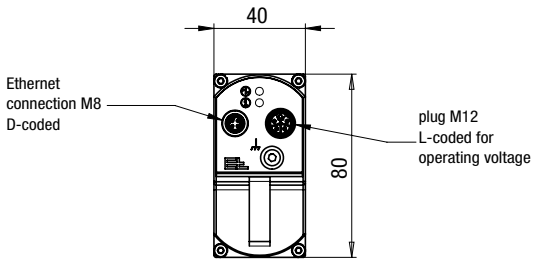
Type	Nominal actuating travel	Nominal actuating force	Centre position	Drive unit length
AG 7213	±6 mm	250 N	153 mm	115 mm
AG 7223	±12 mm	250 N	171 mm	127 mm
AG 7233	±15 mm	250 N	180 mm	133 mm
AG 7243	±25 mm	250 N	210 mm	153 mm
AG 7263	±50 mm	250 N	285 mm	203 mm

Linear drive unit AG 72





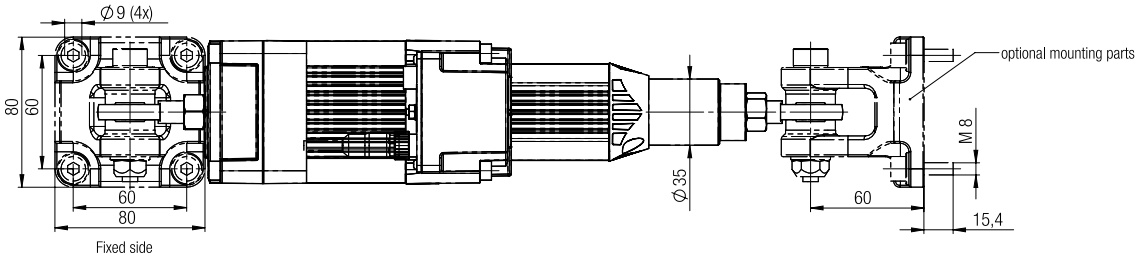


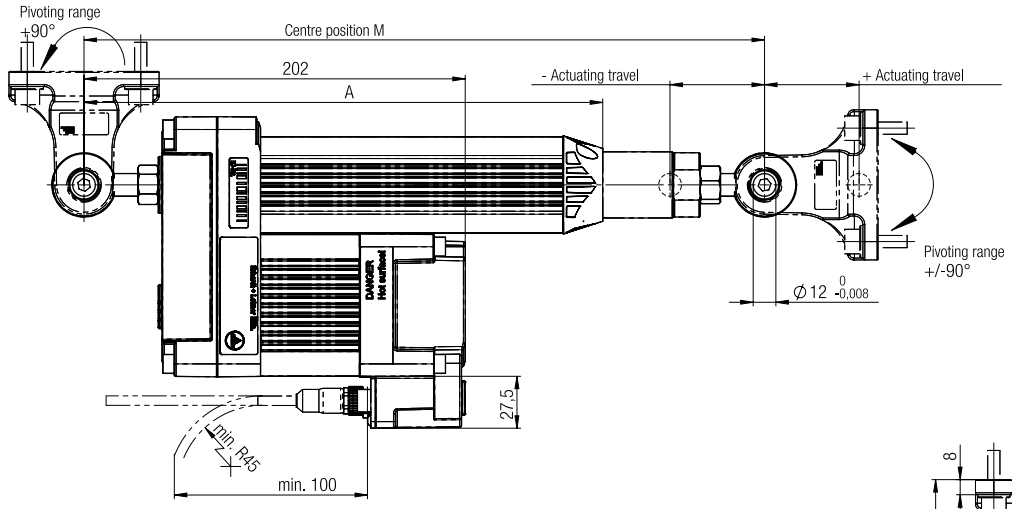


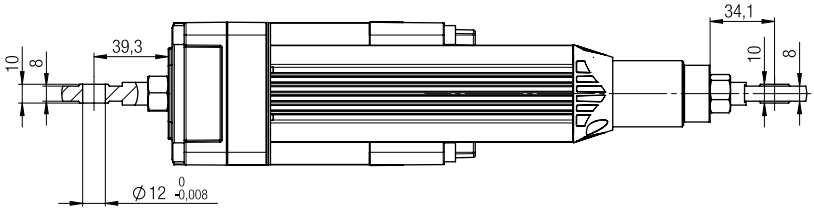
Dimension drawing linear drive unit AG 90

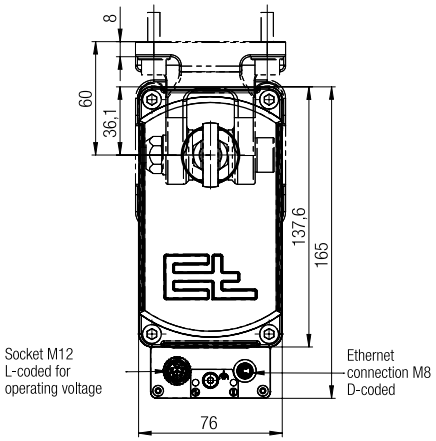
Selection table				
Type	Nominal actuating travel	Nominal actuating force	Centre position	Drive unit length
AG 9003	±25 mm	800 N	285 mm	225 mm
AG 9013	±50 mm	800 N	360 mm	275 mm
AG 9023	±75 mm	800 N	435 mm	325 mm
AG 9033	±100 mm	800 N	510 mm	375 mm

Linear drive unit AG 90





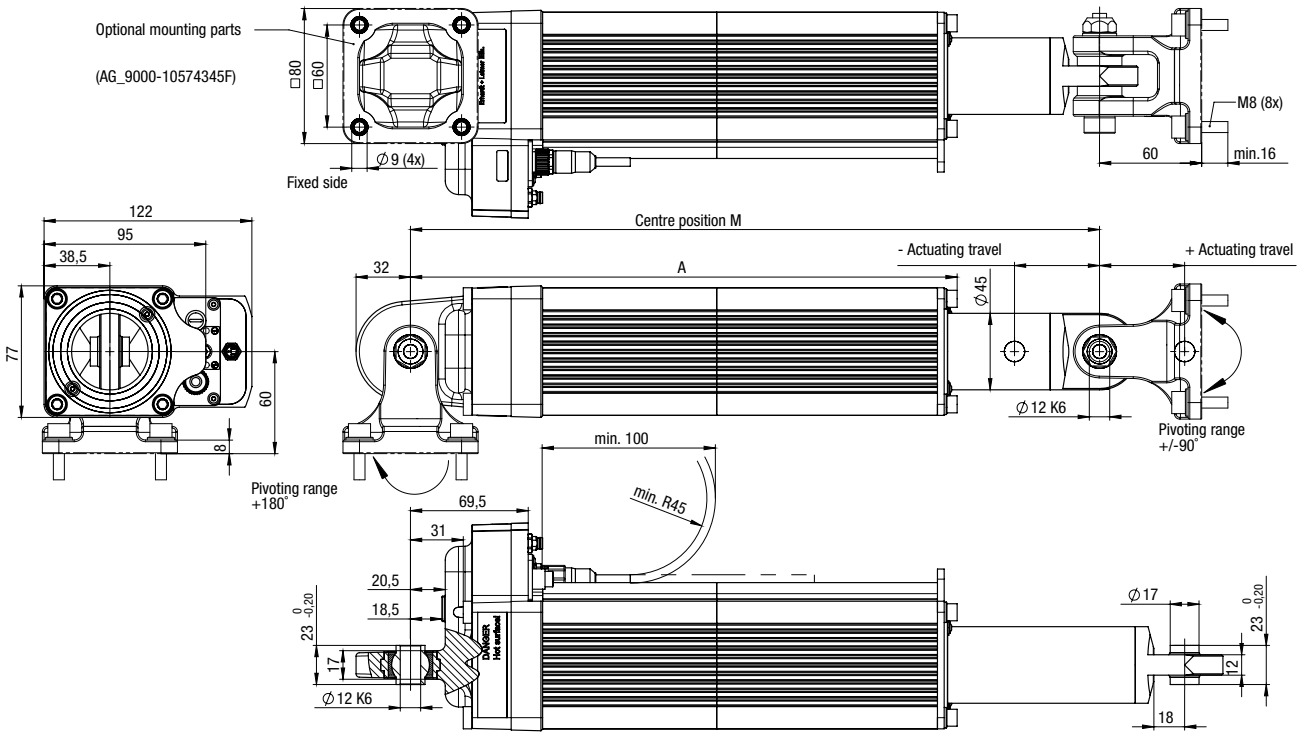




Dimension drawing linear drive unit AG 91

Selection table				
Type	Nominal actuating travel	Nominal actuating force	Centre position	Drive unit length
AG 9103	±25 mm	1000 N	285 mm	227 mm
AG 9113	±50 mm	1000 N	360 mm	277 mm
AG 9123	±75 mm	1000 N	435 mm	327 mm
AG 9133	±100 mm	1000 N	510 mm	377 mm

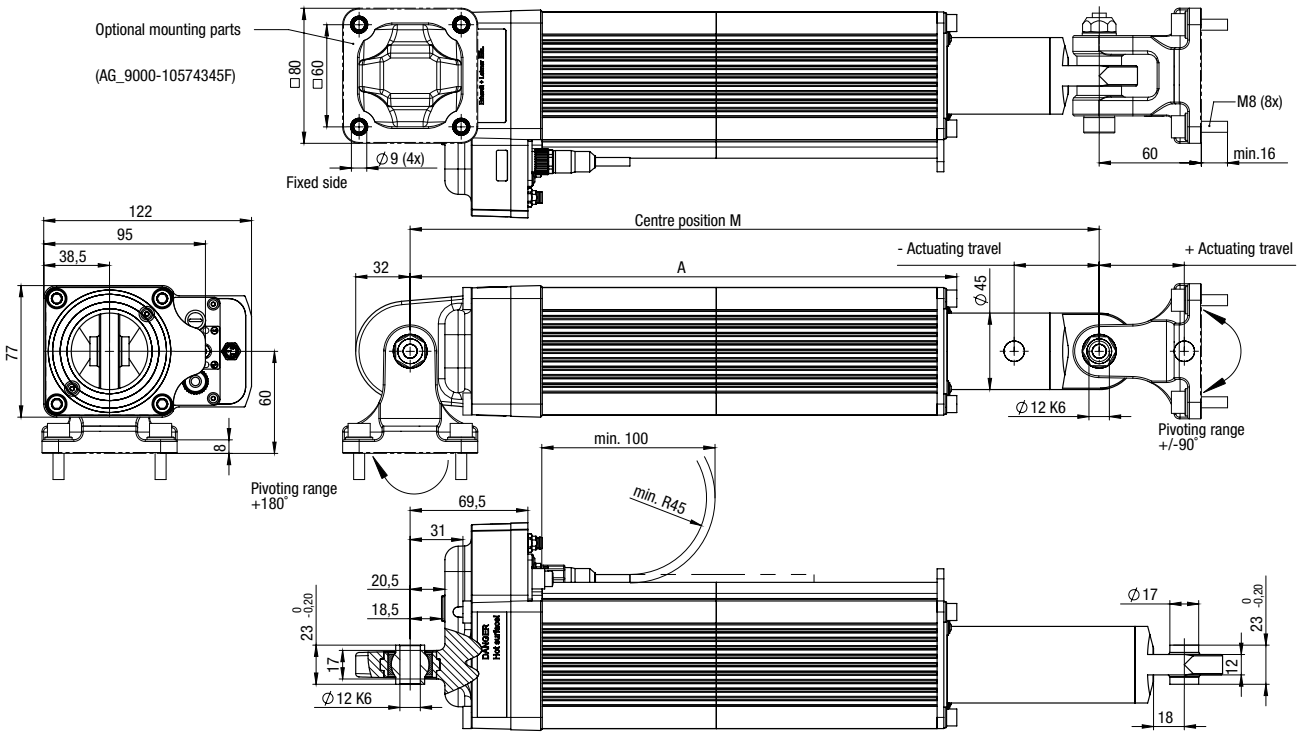
Linear drive unit AG 91



Dimension drawing linear drive unit AG 93

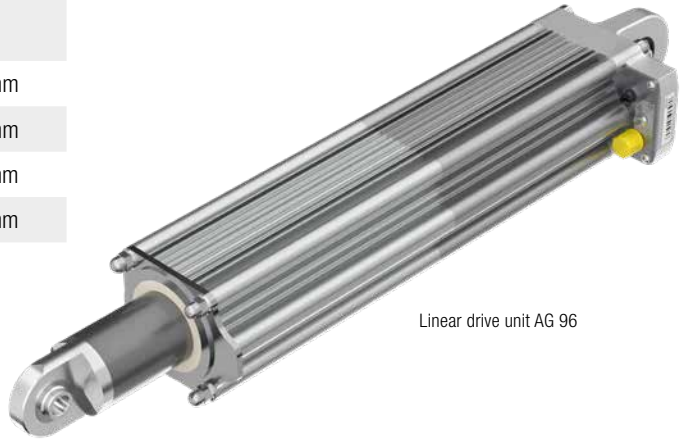
Selection table				
Type	Nominal actuating travel	Nominal actuating force	Centre position	Drive unit length
AG 9313	±50 mm	3000 N	390 mm	307 mm
AG 9333	±100 mm	3000 N	540 mm	407 mm
AG 9343	±150 mm	3000 N	745 mm	568 mm
AG 9353	±200 mm	3000 N	895 mm	668 mm

Linear drive unit AG 93

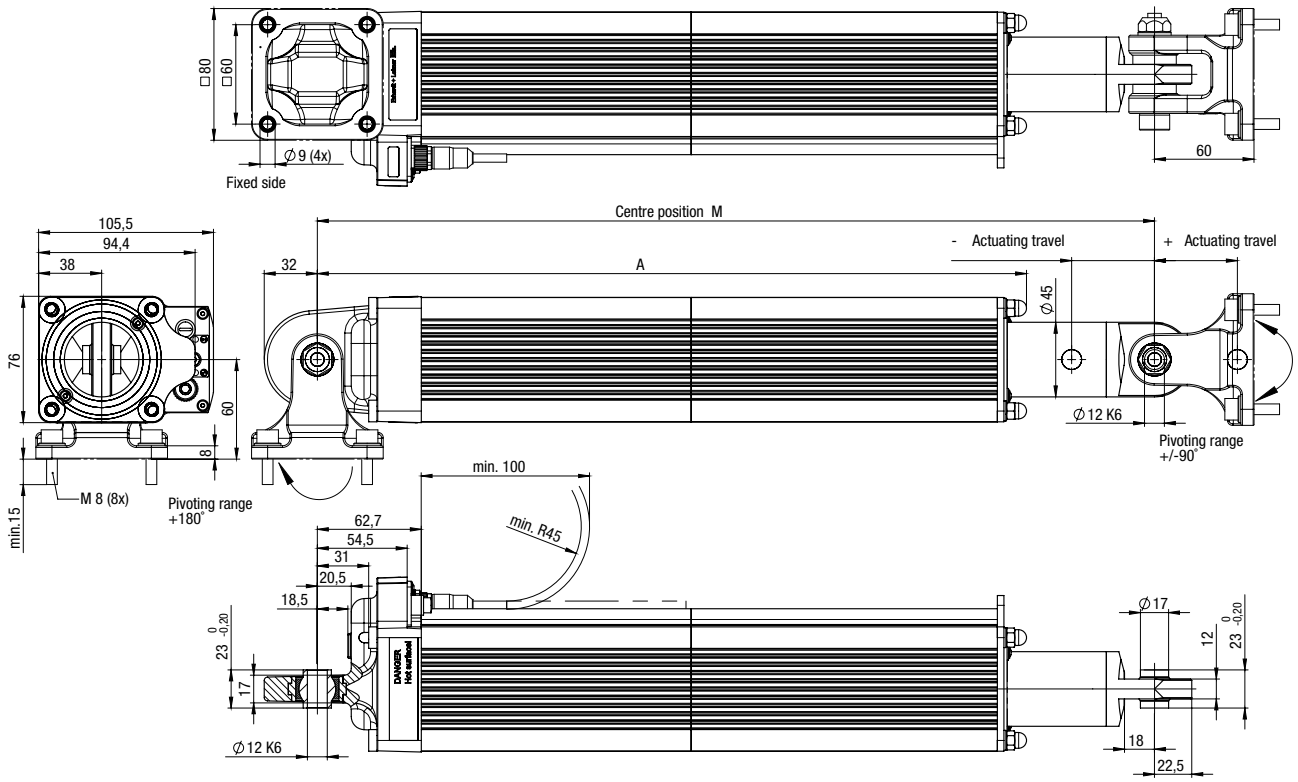


Dimension drawing linear drive unit AG 96

Selection table				
Type	Nominal actuating travel	Nominal actuating force	Centre position	Drive unit length
AG 9613	±50 mm	5500 N	505 mm	428 mm
AG 9633	±100 mm	5500 N	655 mm	528 mm
AG 9643	±150 mm	5500 N	805 mm	628 mm
AG 9653	±200 mm	5500 N	955 mm	728 mm



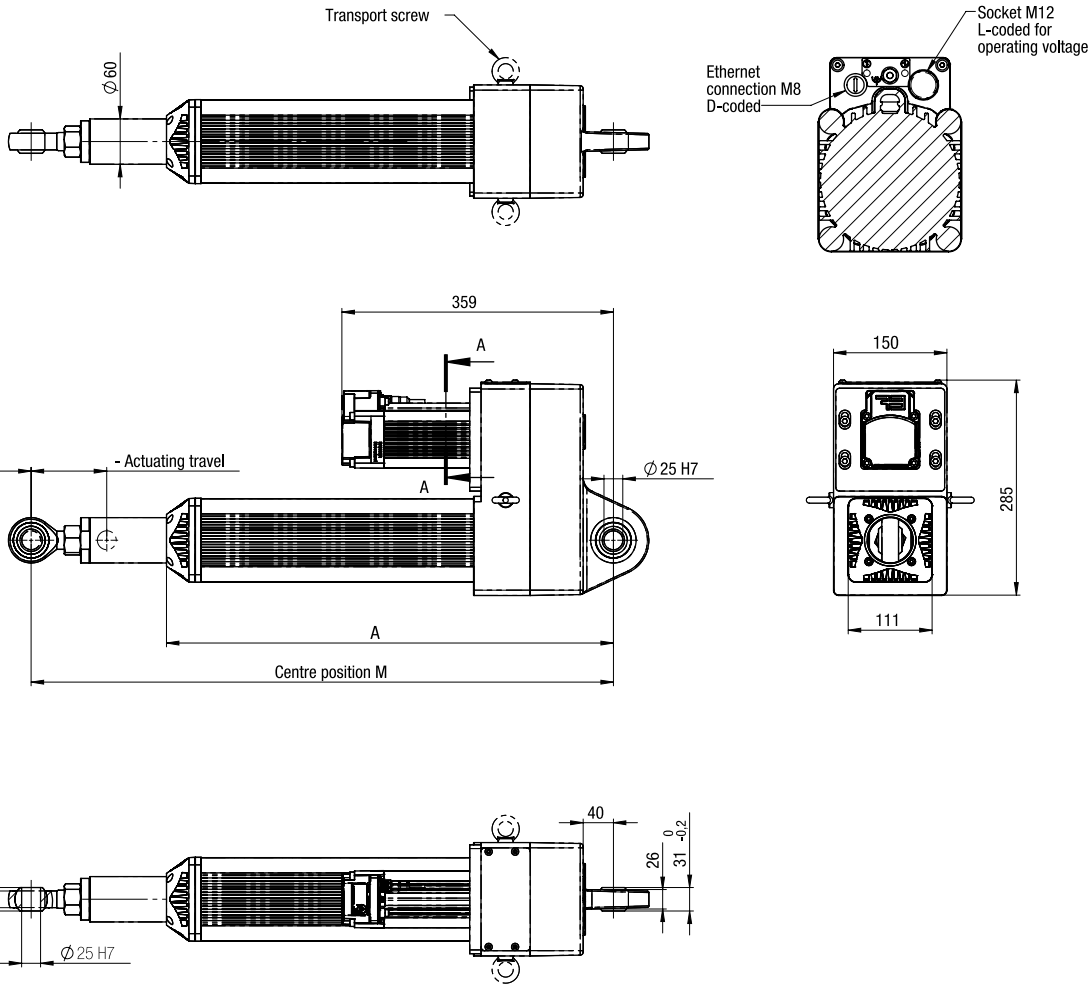
Linear drive unit AG 96



Dimension drawing linear drive unit AG 98

Selection table				
Type	Nominal actuating travel	Nominal actuating force	Centre position	Drive unit length
AG 9813	±50 mm	10000 N	620 mm	491 mm
AG 9823	±75 mm	10000 N	695 mm	541 mm
AG 9833	±100 mm	10000 N	770 mm	591 mm
AG 9843	±150 mm	10000 N	920 mm	691 mm
AG 9853	±200 mm	10000 N	1070 mm	891 mm
AG 9863	±300 mm	10000 N	1370 mm	991 mm

Linear drive unit AG 98



Linear drive units with STO function

SAFETY APPROVED

STO (Safe Torque Off)

- Safe Torque Off (STO) in accordance with EN 61800-5-2 integrated in the drive
- Suitable for applications with upstream two-channel safety switching devices (Emergency OFF) and for OSSD safety outputs of PLC controllers
- The two-channel architecture (channel A and channel B) of the STO module achieves Category 3 and Performance Level d in accordance with EN ISO 13849-1
- Two-channel interruption of the control signals to the power stage and therefore of the power supply to the motor as a result of the safe signal inhibit when the STO safety function is activated

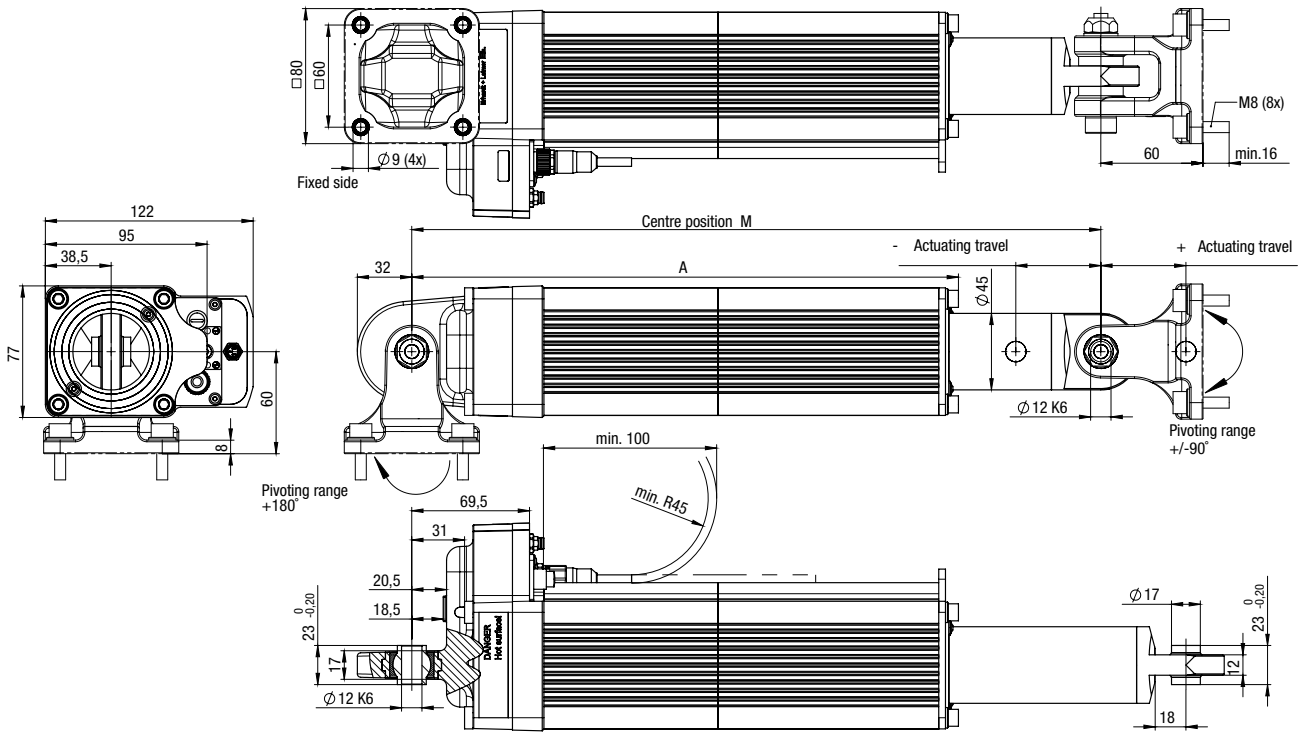
Standards	Category	Description
IEC 61508-1: 2010 IEC 61508-2: 2010	SIL 3	Functional safety of electrical/electronic/programmable electronic safety-related systems Part 1: General requirements Teil 2: Requirements for electrical/electronic/programmable electronic safety-related systems
IEC 61508-5-2: 2016	SIL 3	Adjustable speed electrical power drive systemsPart 5-2: Safety requirements - Functional
IEC 62061: 2021	SIL 3	Safety of machinery - Functional safety of safety-related control systems
ISO 13849-1: 2015 ISO 13849-2: 2012	PL d	Safety of machinery - Safety-related parts of control systems Part 1: General principles for design Part 2: Validation

Overview of linear drives with STO function		
Linear drive unit AG 91 with STO function	You will find a dimension drawing of this product on page 35.	
Linear drive unit AG 93 with STO function	You will find a dimension drawing of this product on page 36.	
Linear drive unit AG 96 with STO function	You will find a dimension drawing of this product on page 37.	

Dimension drawing linear drive unit AG 91 with STO function

Selection table				
Type	Nominal actuating travel	Nominal actuating force	Centre position	Drive unit length
AG 9102	±25 mm	1000 N	300 mm	242 mm
AG 9112	±50 mm	1000 N	375 mm	292 mm
AG 9122	±75 mm	1000 N	450 mm	342 mm
AG 9132	±100 mm	1000 N	525 mm	392 mm

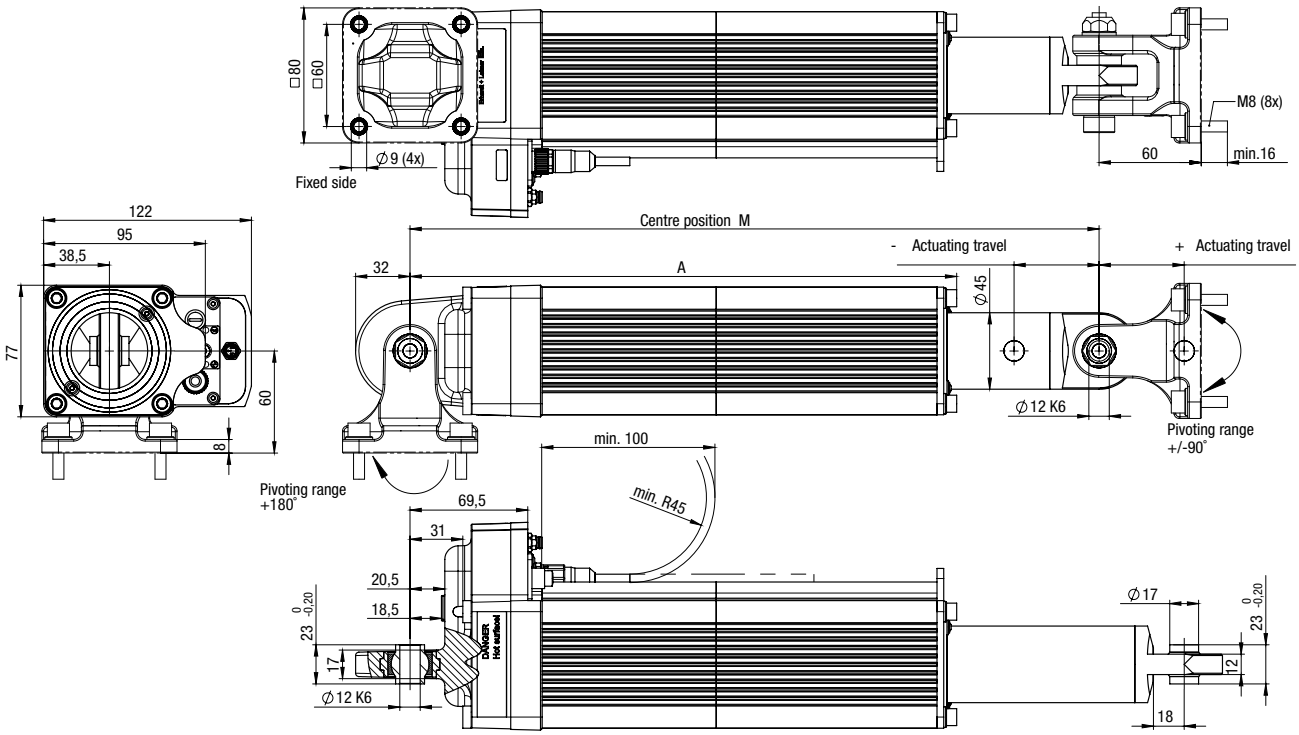
Linear drive unit AG 91 with STO function



Dimension drawing linear drive unit AG 93 with STO function

Selection table				
Type	Nominal actuating travel	Nominal actuating force	Centre position	Drive unit length
AG 9312	±50 mm	3000 N	405 mm	322 mm
AG 9332	±100 mm	3000 N	555 mm	422 mm
AG 9342	±150 mm	3000 N	760 mm	583 mm
AG 9352	±200 mm	3000 N	910 mm	683 mm

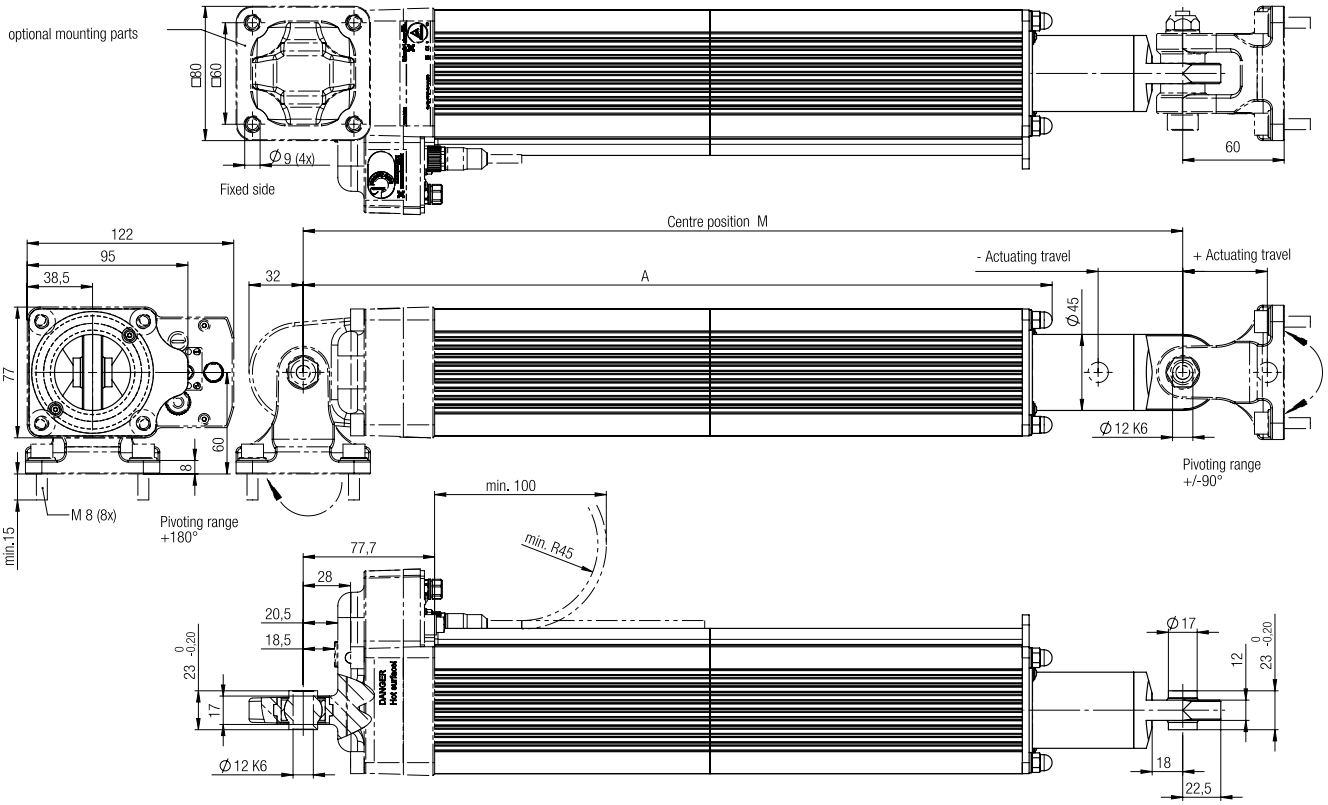
Linear drive unit AG 93 with STO function



Dimension drawing linear drive unit AG 96 with STO function

Selection table				
Type	Nominal actuating travel	Nominal actuating force	Centre position	Drive unit length
AG 9612	±50 mm	5500 N	520 mm	443 mm
AG 9632	±100 mm	5500 N	670 mm	543 mm
AG 9642	±150 mm	5500 N	820 mm	643 mm
AG 9652	±200 mm	5500 N	970 mm	743 mm

Linear drive unit AG 96 with STO function



Formulas used for the drive calculations

	Translation	Rotation
Speed	$v = \frac{s}{t}$	$v = \omega \cdot r$; $\omega = 2\pi \cdot \frac{n}{60}$
Distance	$s = v \cdot t$	$\rho = \omega \cdot t = 2\pi \cdot \frac{n}{60} \cdot t$
Acceleration	$a = \frac{v}{t_a}$	$\alpha = \frac{\omega}{t_a}$
Torque		$M = F \cdot r$
Power	$P = F \cdot v$	$P = M \cdot \omega = M \cdot 2\pi \cdot \frac{n}{60} \sim \frac{M \cdot n}{9.55}$
Force	$F = m \cdot a$	$F = J_R \cdot \alpha$
Work	$W = F \cdot s = \frac{m \cdot v^2}{2}$	$W = M \cdot \rho = \frac{J_a \cdot \omega^2}{2}$
Moment of inertia	$J_T = m_T \cdot r^2$	Cylinder: $J_R = m_R \cdot r^2$ Full cylinder: $J_R = \frac{1}{2} \cdot m_R \cdot r^2$ Hollow shaft: $J_R = \frac{1}{2} \cdot m_R \cdot (r_1^2 + r_2^2)$
Centrifugal force	$Z = \frac{m \cdot v^2}{r}$	$Z = m \cdot \omega^2 \cdot r$

Drive type	Speed
Spindle drive	$n_{Machine} = \frac{v \cdot 60}{h}$
Rack/lifting drive	$n_{Machine} = \frac{v \cdot 60}{\pi \cdot d_{tR}}$

Drive type	Load torque
Spindle drive	$M_{Load} = h \cdot \frac{m_{LinMov} \cdot \mu g + F_f}{2 \cdot \eta}$
Rack drive	$M_{Load} = r \cdot m_{LinMov} \cdot \mu g + \frac{F_f}{\eta}$
Lifting drive	$M_{Load} = \frac{m_{LinMov} \cdot gr}{\eta}$

Drive type	Moment of inertia
Spindle drive	$J_T = m_{LinMov} \cdot (\frac{h}{2\pi})^2$
Rack/lifting drive	$J_T = m_{LinMov} \cdot r^2$

Moment of inertia	
Total of the machine	$J_{Mach} = J_T + J_R$
In relation to gearbox	$J_{GearMot} = J_M \cdot i^2 + J_{Gearbox}$
Total on gear shaft	$J_{Tot} = J_{Mach} + J_{GearMot}$

Acceleration	
Total torque/time on gear shaft	$M_\alpha = \frac{n_2 \cdot J_{Tot}}{9.55 \cdot t_a}$; $t_a = \frac{n_2 \cdot J_{Tot}}{9.55 \cdot M_\alpha}$

Symbol	Meaning	Unit
a	Acceleration	[m/s²]
F	Force	[N]
F_f	Feed force	[N]
g	9.81	[m/s²]
h	Spindle pitch	[m]
i	Gear reduction	
$J_{GearMot}$	Moment of inertia of geared motor	[kgm²]
J_M	Moment of inertia of mass on load side	[kgm²]
J_{Mach}	Total moment of inertia of machine	[kgm²]
J_R	Rotational moment of inertia	[kgm²]
J_T	Translational moment of inertia	[kgm²]
M	Torque	[Nm]
M_{Load}	Load torque	[Nm]
m_{LinMov}	Mass of linearly moved parts	[kg]
m_R	Rotating mass	[kg]
M_α	Acceleration torque	[Nm]
n	Speed	[rpm]
$n_{Machine}$	Machine speed	[rpm]
P	Power	[W]
r	Radius	[m]
s	Distance	[m]
t	Time	[s]
t_a	Acceleration or braking time	[s]
v	Speed	[m/s]
W	Work	[Nm]
Z	Centrifugal force	[N]
α	Angular acceleration	[1/s²]
η	Efficiency	
μ	Coefficient of friction	
ρ	Turning angle	
ω	Angular velocity	[1/s]
	$9.55 \sim \frac{60}{2\pi}$	

Questionnaire

General data			
Customer			
Street			
Zip code		City/town	
Country		Internet	
Contact person			
Phone		E-mail	
Project			

Technical data			
Type of machine			
Make			
Position on the machine			
Task			
Function	❑ Torque control	❑ Speed control	❑ Position control
Required torque	_____ Nm		
Required speed	_____ rpm		
Moment of inertia	_____ kg/m²		
Ambient temperature	_____ °C		
Ambient conditions	❑ Dry	❑ Dusty	❑ Wet ❑ _____
Operating voltage	❑ 24 V DC	❑ _____V	❑ _____Hz

Drive specification		
Flange plate	❑ With mounting flange	❑ Without mounting flange
End position limitation	❑ With end position limitation	❑ Without end position limitation
Functional safety	❑ With functional safety (STO)	❑ Without functional safety

Comments

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