NORRDIGI EMA

Electromechanical Actuators and Motion Control Systems

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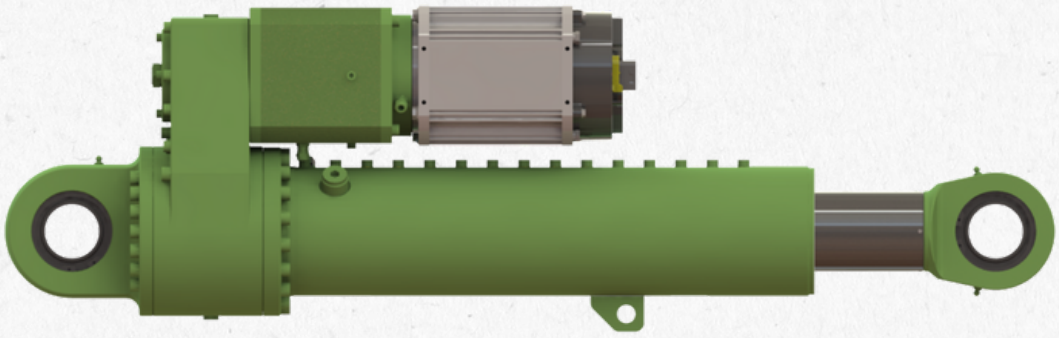
Table Of Contents

Norrhydro is one of the leading Nordic suppliers of linear motion solutions. The NorrDigi® EMA represents innovative technology with high energy efficiency and precise motion control.

We offer electromechanical solutions customised to specific needs in mobile applications, for industrial use and harsh marine environments.

Well-engineered motion control solutions provide a decisive competitive edge throughout the application's lifecycle.



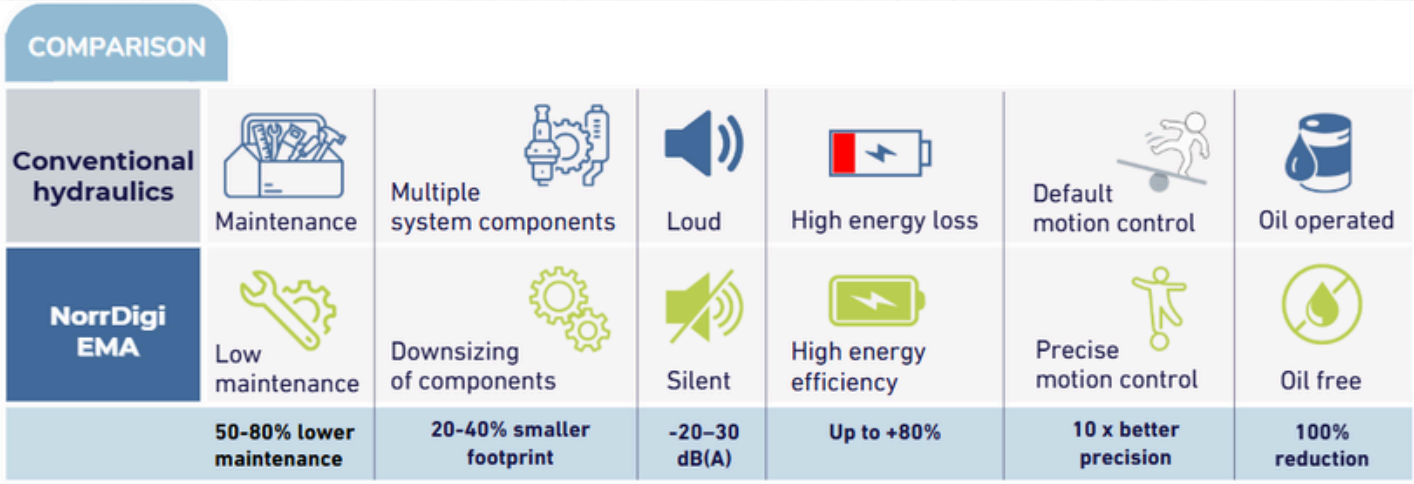
1. Introduction

Electromechanical actuators (EMA) provide a precise and energy-efficient alternative to hydraulic cylinders in demanding motion control applications. By eliminating hydraulic pumps, hoses, and oil circuits, EMA technology reduces system complexity and removes the risk of fluid leakage. This results in a cleaner installation with fewer external components and interfaces.

EMA actuators require minimal maintenance over their lifetime, as there is no requirement for hydraulic oil change, seal replacements, or filter servicing. Integrated screw, bearing and gear systems are designed for long service intervals, ensuring reliability even under continuous duty cycles.

High-resolution position feedback enables sub-millimeter accuracy and repeatability, making EMA suitable for applications requiring controlled motion profiles, synchronization, and advanced positioning. With fully integrated sensor options, the EMA functions as a stand-alone actuator system, capable of direct communication via fieldbus protocols such as CAN or EtherCAT.

In addition, the actuator provides real-time operational data such as load, position, and speed, which can be used for monitoring, diagnostics, and predictive maintenance. This capability supports digitalization initiatives and enhances system-level performance optimization.



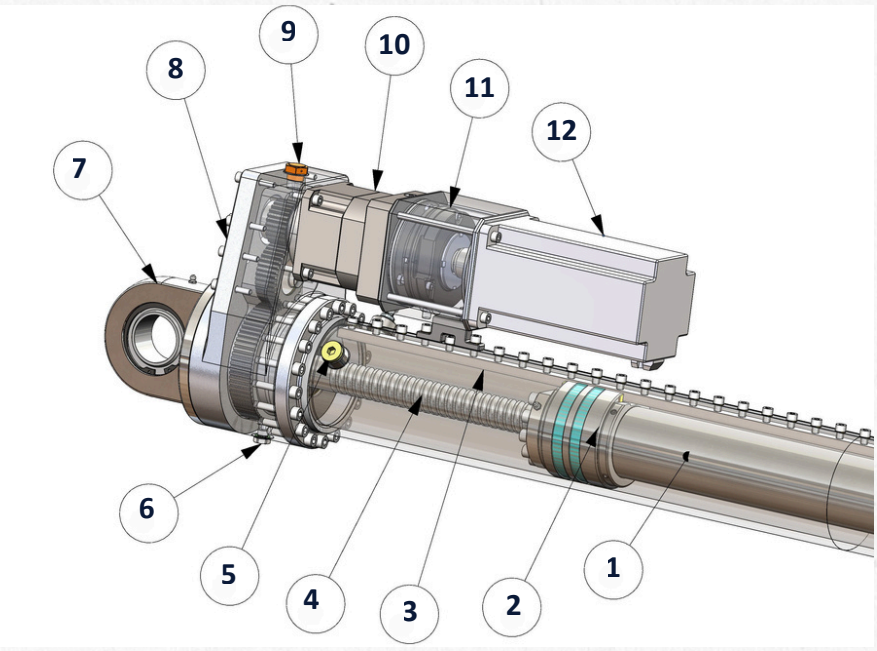
Main Benefits

- **Oil-free operation** – eliminating the risk of leaks and environmental hazards.
- **Maintenance-free for the planned lifetime** – reducing downtime and lifecycle costs.
- **Proven performance** – can be used in harsh environments such as marine and industrial applications, with excellent results.

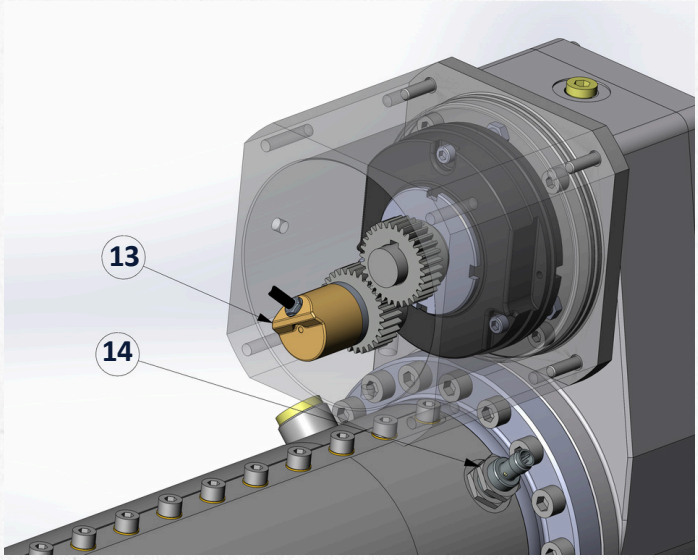
2. Mode of Operation

Electromechanical actuators (EMA) generate linear motion by converting the rotary output of an electric motor into axial displacement via a screw mechanism. Motor torque is transmitted through a gearbox and bearing arrangement to the screw, which drives the actuator rod with high efficiency and minimal backlash. Integrated sensors provide closed-loop feedback of position, force, and speed, enabling precise motion control.

By integrating motor, gearbox, screw, bearings, and sensors into a single enclosed unit, the EMA performs the same function as a hydraulic cylinder—controlled extension and retraction under load—without pumps, hoses, or hydraulic oil. This self-contained design reduces interfaces, simplifies installation, and ensures a clean, accurate, and reliable actuation system.



1. Piston rod
2. Ball nut guide
3. Internal torque support (optional)
4. Ball screw + nut / trapezoidal screw + nut
5. Ball screw lubrication port
6. Parallel gearbox/gearbox
7. Bottom and rod ends
8. Magnetic plug
9. Breather vent
10. Planetary gearbox
11. Brake
12. Motor
13. Encoder
14. Limit switch



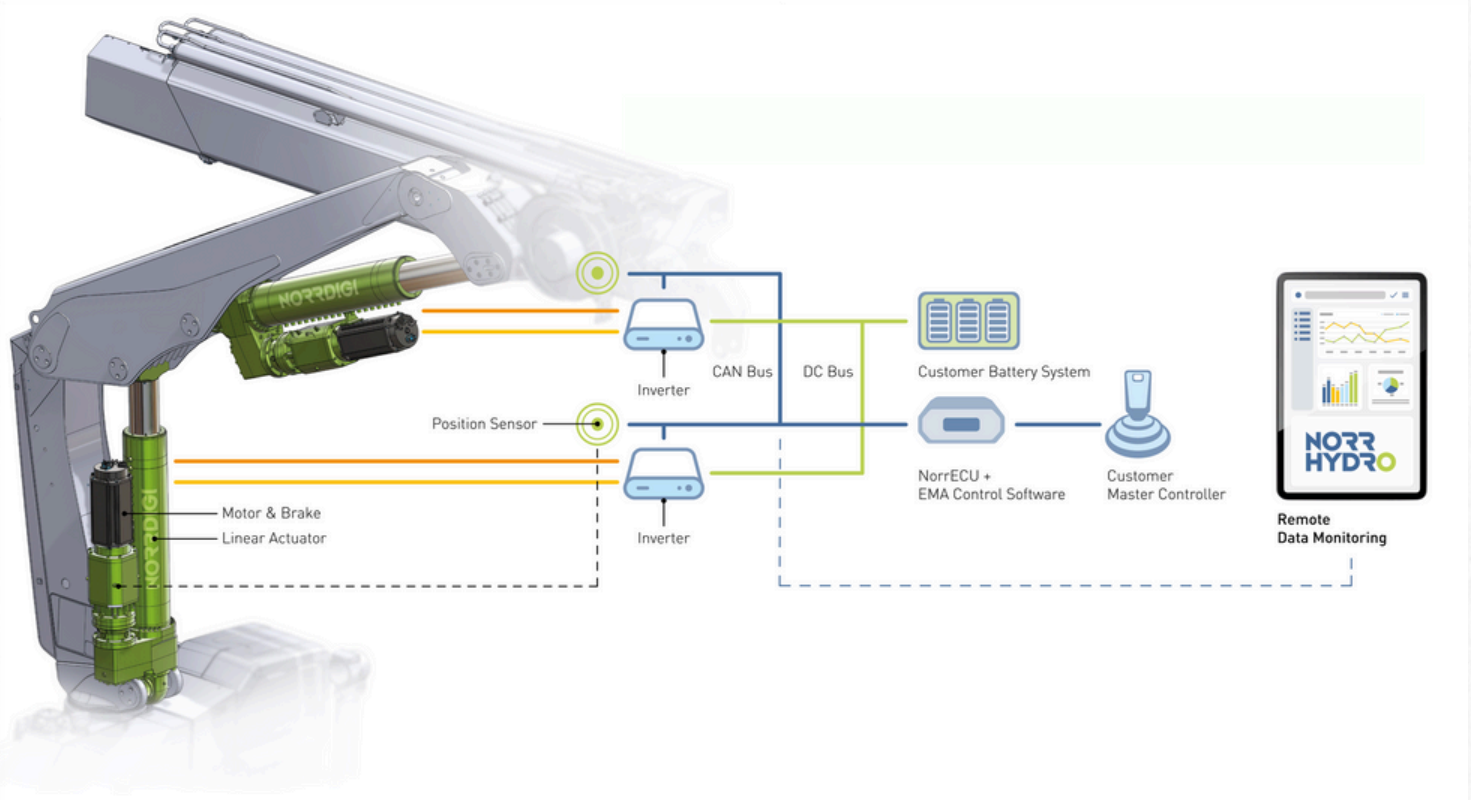
Main features:
Force: 10 – 3000 kN
Power: 0,1 – 300 kW
Stroke: max. 5 m
Speed: max. 1 m/s
Efficiency: 70-80 %

3. Controls, Motor and Drive Options

We specialize in delivering robust and adaptable EMAs across a wide range of industries. While the mechanical actuator is manufactured as our core product, we also offer integrated solutions including motors, drives, and electronics. Most of the applications can be covered with the three main categories of motor & drive systems we support:

1. **Induction motor and VFD (Variable Frequency Drive)**
2. **Servo systems**
3. **Systems for mobile applications**

While these categories utilise different components, they typically share a similar system layout. All the am. systems have an electric motor powered by a drive/inverter and sensors integrated into the actuator. The sensor signals are utilised by the drive/inverter and higher-level control logic to precisely control the motion of the actuator. Below example presents a typical system-level layout of EMA system in mobile applications.



3.1. Induction motor and VFD systems

AC induction motors are proven technology in many industries and can be equipped to withstand harsh conditions in outdoor applications. Modern VFDs, PLCs and additional actuator sensors provide a flexible product to suit various control tasks. Typically, the actuator is equipped with limit switches and/or an encoder. A holding brake is typically integrated into the motor.

Typical Applications:

- Marine and offshore systems
- Industrial equipment

Key Features:

- Rugged and reliable for demanding environments
- EMA speed, position or force Control
- VFD-controlled EMAs offer easy integration with existing systems via standard industrial communication protocols such as Profibus, Profinet, Modbus, Ethernet/IP and CanOpen
- Cost-effective solution for systems with low to moderate requirements for actuator performance and precision

Induction Motors

- Ingress protection up to IP66
- Various options, including holding brake, cooling fan, heating element (for condensing environment)

VFDs

- Single-phase or three-phase supply
- Fieldbus and I/O option modules
- Wide range of control features

Sensors

- Speed or absolute position encoders for closed-loop control
- Limit switches for end-of-stroke sensing
- Load pins for precise force measurement

Typical range	Single-phase	Three-phase
Nominal Power	1–3 kW	1–60 kW
Peak Power	2 × nominal	2 × nominal
Supply Voltage	200–240 VAC	380–690 VAC

3.2. Servo systems

An EMA powered by a servo motor provides superior control performance. Servo motors can be equipped with a variety of encoders. As a result, no additional sensors are needed for the actuator. Servo drives provide a wide range of control features and can be integrated into various automation systems.

Typical Applications:

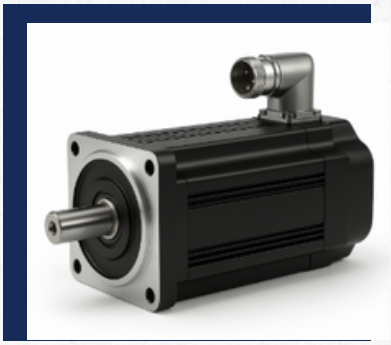
- Industrial equipment
- Process automation

Key Features:

- High dynamic performance and precise controllability
- Closed-loop feedback for advanced motion control features
- Integration to automation systems via standard industrial communication protocols such as EtherCAT, Profinet, Modbus, Ethernet/IP and CanOpen
- High power density and efficiency
- Synchronous movement of multiple actuators
- Advanced safety features according to application requirements (up to SIL3/PLe)

Servo Motors

- Ingress protection up to IP67
- Integrated multiturn encoder for absolute position and speed feedback
- Integrated holding brake



Servo Drives

- Single-phase or three-phase supply
- Options include various field buses, I/O and functional safety options

Sensors

- No additional encoder needed
- Proximity switches for redundant stroke limiting
- Load pins for precise force measurement

Typical range	Single-phase	Three-phase
Nominal Power	1–2 kW	1–30 kW
Peak Power	3 × nominal	3 × nominal
Supply Voltage	200–240 VAC	380–690 VAC

3.3. Systems for mobile applications

In mobile machines, hydraulic cylinders can be replaced by an EMA powered by a motor & inverter designed for mobile applications. High energy efficiency in combination with great controllability and low maintenance are essential in building clean battery electric machines with an increased level of automation. A holding brake and sensors for position and force sensing can be included in the actuator.

Typical Applications:

- Construction equipment
- Material handling

Key Features:

- Battery-powered low-voltage (24-96 VDC) or high-voltage (100- 800 VDC) systems
- High energy efficiency and energy recuperation
- Closed-loop feedback for great controllability and safety features
- Integration to machine systems via CanOpen (or SAE J1939)

Mobile Motors

- Ingress protection up to IP67
- PM or IM type
- Encoder for close-loop speed control

Mobile Inverters

- Suitable for the most demanding environments
- Protected against dust and water (IP65)
- Air or liquid cooling

Sensors

- Absolute position encoder for precise position control and redundant speed feedback
- Proximity switches for end-of-stroke sensing
- Load pins for precise force measurement

Control System

- A complete EMA system, incl. control, can be provided
- Quick start into testing instead of developing control logic from scratch

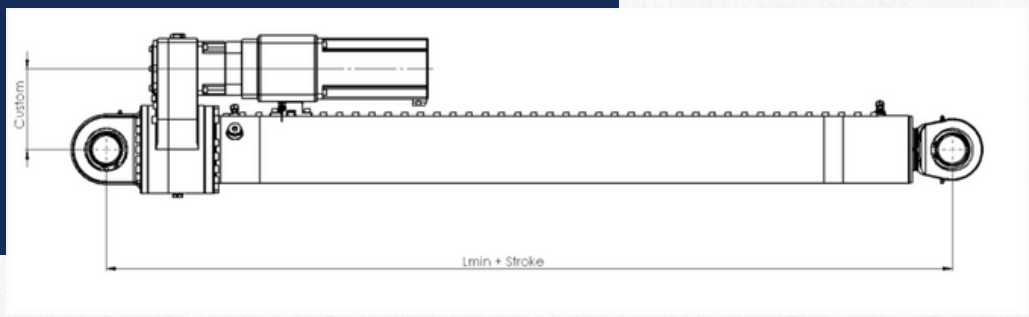
Typical range	Low-voltage	High-voltage
Nominal Power	1–40 kW	10–100 kW
Peak Power	3 × nominal	3 × nominal
Supply Voltage	24–96 VDC	100–800 VDC

4. Cylinder Design

We primarily design cylinders based on the U- and I-model configurations. Additional options include X-, Z-, and L-models. The most suitable model is selected according to the application requirements.

Parallel gear systems are designed in-house, with spur gears as standard solution. If the application requires a special configuration, a planetary gear can also be designed.
A wide range of cylinder variations can be developed to meet different needs.

U-Shape



I-Shape

Technical Capabilities

Our electro-mechanical cylinders are engineered for demanding applications, offering a wide performance range and precise adaptability:

- Force capacity: 10–2,300 kN dynamic (motion) and up to 10,000 kN static load capacity
- Power range: 0.1–300 kW, enabling motion speeds up to 1,000 mm/s (speed depends on the ratio of load to available power)
- Stroke length: standard designs up to 5,000 mm, with longer strokes possible through detailed engineering
- Positioning accuracy: up to ±0.01 mm, depending on system structure
- Acceleration: ball screw acceleration up to 12 m/s² (limited by size class)
- Efficiency: overall system efficiency is typically 70–80%, depending on the application

Stroke length	Screw diameter	16–40	40–80	100–160	200
	Ground thread	0.7–5 m	Up to 5 m	Up to 5 m	Up to 2.5 m
	Roller thread	Up to 5 m	Up to 5 m	NA	NA

Higher values duable on special request

5. Operations and maintenance

The ball screw is primarily designed for grease lubrication, which is the preferred option. In special cases, oil lubrication can also be applied. The ball screw is delivered pre-lubricated with KP2K-30 grease. For operating temperatures below –10 °C, we recommend cold-resistant greases such as Klüberplex BEM 34-132. The duty cycle may be limited by heat generation depending on the power load.

Maintenance Intervals

The duty cycle and operating conditions determine the maintenance requirements. Service needs are tailored to the customer's specific application.

- Light-duty use: long maintenance intervals, typically 1–3 years
- Normal operation: annual maintenance intervals

Typical maintenance tasks include ball screw lubrication and gearbox oil replacement.

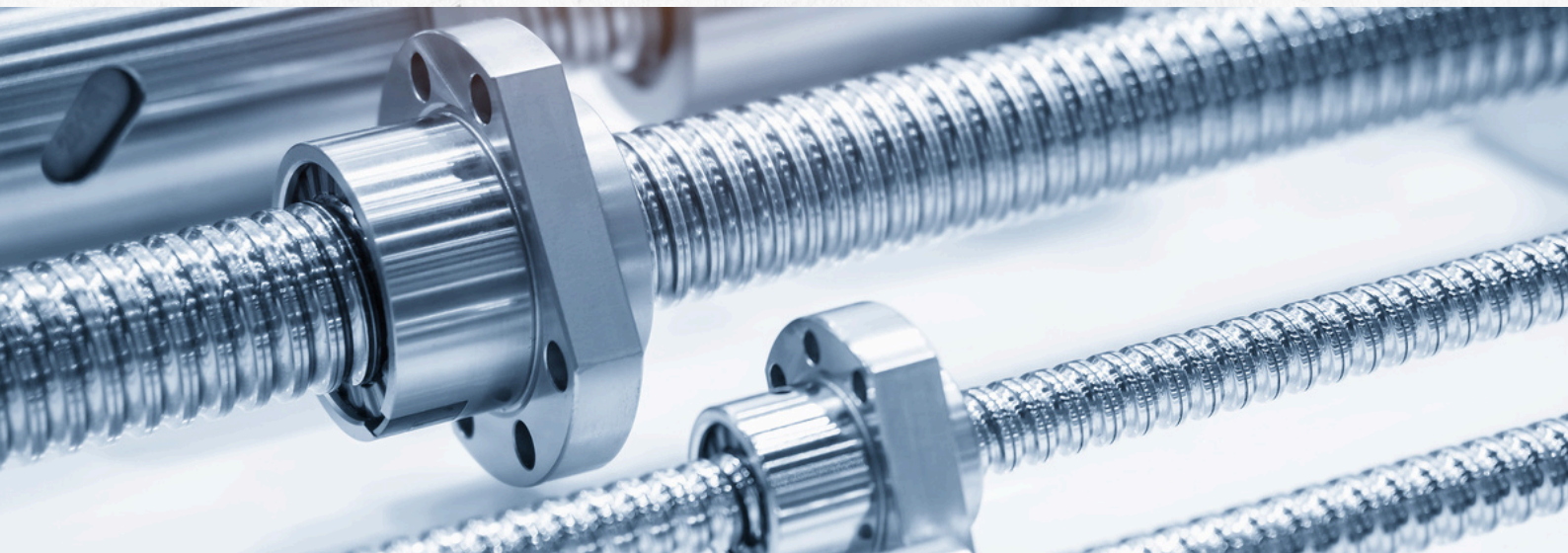
Operating Temperature Range

Each cylinder is designed and specified according to the customer's application requirements. The selection of lubrication and components ensures reliable operation across a wide range of environments.

- With cold-resistant oil: operating temperatures from –30 °C to +50 °C
- With standard oil: operating temperatures from –16 °C to +50 °C

For applications with low duty cycles, even higher temperatures can be tolerated. By tailoring the lubrication and mechanical design to the customer's needs, we ensure optimal performance and durability in both extreme cold and demanding heat conditions.

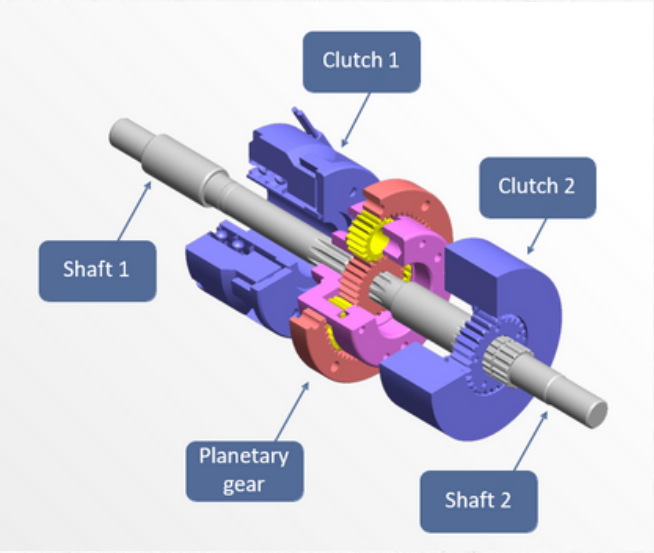
Note: The motor has a different operating temperature range, which is defined case by case depending on the application.



6. SSG - Seamless Shift Gearbox

The seamless shift gear (SSG) is an innovative automatic gear system designed to operate with two or more gear ratios, enabling seamless adaptation between speed and force demands. It utilizes electromagnetic clutches with electric controls, ensuring smooth and precise gear transitions under varying load conditions.

This intelligent gearing solution is ideal when both high velocity and high force are required within the same application — but not simultaneously. By automatically selecting the optimal gear ratio, the SSG allows the use of a smaller motor without compromising performance or energy efficiency, delivering significant benefits in compactness and cost.



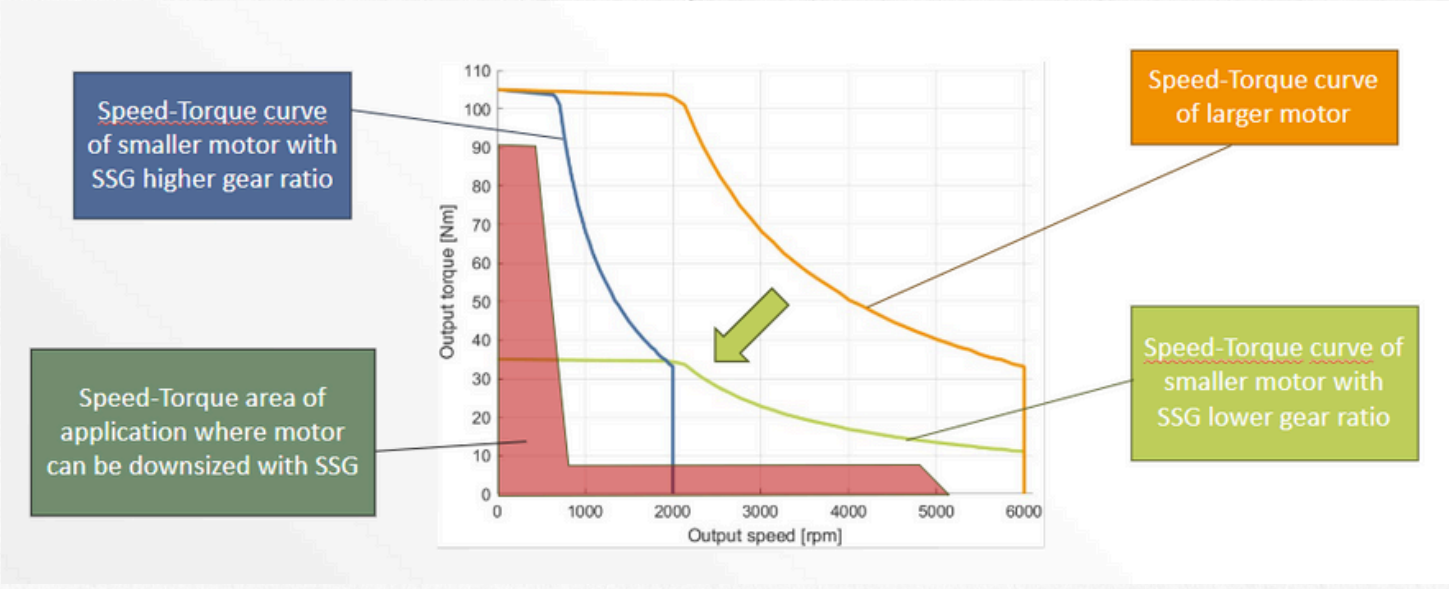
Key Features:

- Mounted between the motor and the parallel gearbox in EMA
- The system changes gear automatically during the movement based on motor speed and torque
- Smooth shifting without a drop in torque, vibration or pull
- Innovative housing and an interchangeable gear module provide improved serviceability and customization
- SSG is fully customizable to match the application requirements

Sensors & control system:

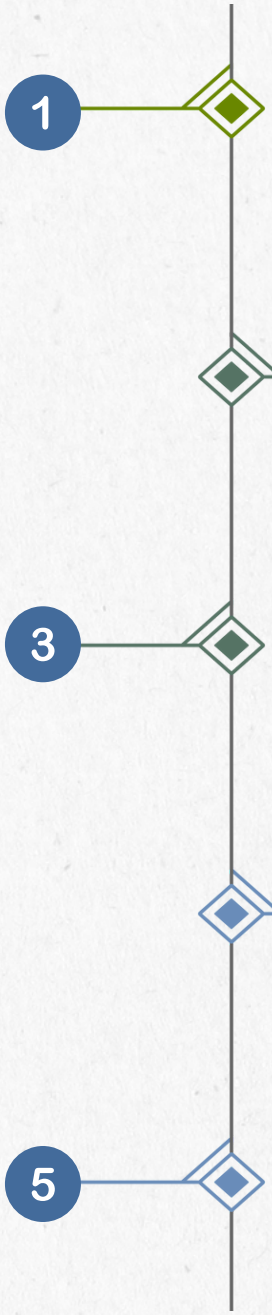
- Additional absolute encoder on SSG output shaft for precise position control
- Temperature sensor for monitoring SSG temperature
- Norrhdyro provides complete control system for SSG
- Control system ensures smooth shifting as well as seamless integration with motor and brake control

Downsizing the motor by using SSG



7. NorrDigi EMA project steps

NorrDigi EMA projects are primarily made according to customer requirements. Carefully selected solutions are tailored to the provided specifications. The typical design process of an electro-mechanical cylinder is as follows:



Specification

Customer input:

- Stroke
- Speed
- Force
- IP rating
- Work cycle

Dimensioning

- Drawings
- Dimensions
- Motor
- Drives
- Control logic

Quotation

Budgetary quote submission

- Prototype price
- Serial production price
- Non-recurring engineering (NRE) cost
- Optional features

Prototyping

- Purchase order received
- Procurement start
- Production start
- Delivery date

Delivery & testing

- Final testing
- Delivery to site
- Commissioning
- Tuning

Norrhydro's team will be closely involved in all steps in the EMA projects.

8. Specification form

EMA-cylinder specification

date: _____

General information

Customer _____

Contact person _____

Application description _____

1. Actuator Dimensions & Mounting

Stroke [ ] mm

Structure _____
Note: Annex 1, Structure Options

Mounting type _____

2. Load and Motion Profile

Max. Force Positioning [ ] kN

Max. Speed [ ] mm/s

Accuracy [ ] mm

Resting period between cycles [ ] s

Please provide cycle diagram a separate file (see example on next page)

3. Lifetime requirements

Planned service life [ ] years

No. of cycles during service life [ ] pcs

4. Operating environment

Ambient temperature [ ] C

Relative Humidity _____

Required IP rating

Surface treatment _____

Rod treatment _____

Contamination (dust, fluids, corrosive environment etc.) _____

5. System Interface

Interface with existing control system (e.g., PLC, fieldbus, I/O) _____

Power supply (voltage, phase, frequency) _____

6. Actuator Options

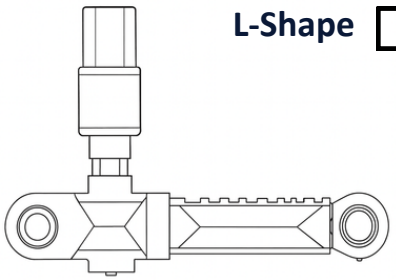
Sensors _____

Brake _____

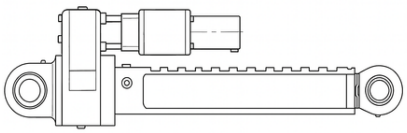
Other Information

Please select structure option

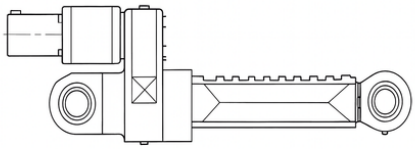
L-Shape ☐



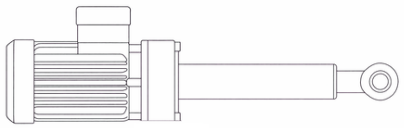
U-Shape ☐



Z-Shape ☐



I-Shape ☐



An example of an cycle diagram

Motion Profile

Accel. [mm/s²]	Speed [mm/s]	Deccel. [mm/s²]	Pos. [mm]	Pos. [mm]	Pause [s]
20	40	20	200	400	
20	40	20	400	200	
0	0	0	200	200	2
40	80	40	200	600	
40	80	40	600	200	

Load Profile

Force Dur. [s]	Force [kN]	Force [kN]
7	100	200
9	-20	-20
7	200	200
7	-20	-20

Application Information

Pause between cycles [s]	0
Lifetime [cycles]	20000
Load inertia [kg]	0
Load held still by	brake