Advantages of iron-core linear motors
The most common method of performing linear motion is achieved by converting a rotary movement into a linear movement by means of a mechanical drive train. Hence, a rotary servo motor can be connected to a belt or ball-screw linear axis to provide linear motion instead of rotary motion.

![Figure 1 - From rotary to linear synchronous motor](image)

Another principle used to provide linear motion is to apply the electromagnetic force directly to the load, using a direct drive linear motor. The functional principle behind this type of motor is no different than a rotary servo motor, with the difference being the arrangement of the rotor and stator as shown in the figure on the right.

Since the linear motor can directly apply the force onto the load, it does not suffer from any backlash at all, which is one of the main advantages over conventional linear axis. An implicit advantage of this configuration is that the feedback system directly measures the position of the load, where normally backlash would introduce a certain inaccuracy of the measured position.

Due to the absence of a mechanical drive train, a linear motor does not suffer from mechanical wear. This results in a much longer lifetime, or in other words, a higher reliability. Hence, costs related to downtime and/or servicing are significantly reduced. The simplicity of the design of a linear motor also means ease of installation and maintenance.

Most importantly, performance wise there are several advantages over traditional linear axis. First of all the maximum acceleration and deceleration are much higher. In addition, the combined speed and position accuracy greatly exceeds the performance of traditional linear axis.

Value proposition with linear motors
To get the most out of the advantages of iron core linear motors, they need to be controlled by a capable servo drive. The high dynamic nature of these motors requires that the servo drive is capable of the following:

- High peak torque (3x continuous)
- High bandwidth and robust control loop to meet dynamic performance
- Compatible with feedback system
- Easy to integrate within complete automation system

The Lexium 32 is designed not only for use with Schneider Electric AC-servo motors BMH and BSH, but also for use with 3rd party motors. The peak torque capability (up to 4 times direct current) and high bandwidth control loop (1600Hz) make it very suitable for use with iron core linear motors. The internal resolution of the drive is high enough to deal with high resolution feedback systems, allowing high precision positioning.

When using the Modular version of Lexium 32, there are several encoder interfaces available. Most applicable to linear motors are encoders with either the digital or analogue output, both of which are supported by the Lexium 32. Since this drive is supporting all common fieldbusses, it easily integrates with the automation platform of the application, supporting all common motion operation modes.
Selection criteria for applications with linear motors

Off course linear motion is applicable to many types of applications, found in nearly all segments in the machine building industry. To identify those applications which are typical targets for linear motors, we need to keep in mind the following:

Typical linear motor applications have one or more of the following primary requirements:
- High acceleration/deceleration (> 5G)
- High precision (< 0.05 mm)
- High speed accuracy (+/- 1%)

Secondary requirements can arise from:
- Vibration restrictions
- Hygienic constraints
- Lifetime requirements
- Mechanical constraints

To illustrate this, there are several key applications which incorporate one or more of the above requirements. One of the applications that requires the use of linear motors are non-milling CNC machines, like laser cutters, water jet cutters and plasma cutters. These applications require high dynamic linear motion without any backlash, since the latter can have a significant negative impact on edge quality.

An industry where linear motors are widely used because of precision accuracy and dynamic requirements is the semiconductor industry. In both wafer etch machines, wafer pre- and post process machines and wafer inspection machines, the linear motors excel due to the combination of very high precision combined with high dynamic capabilities. For this segment the requirements on lifetime are very high, due to the absolute minimum allowed downtime for service and repairs.

The high speed accuracy of linear motors is a key factor to its use in the printing industry. Labelling and scanning machines have a very high requirement on speed accuracy, since any variation can have a disastrous impact on end-product quality. Finally most applications in the medical industry have a strict requirement with regard to hygiene. Since the linear motor operates completely contact free, it allows for designs that do not impair hygiene.

Since the Hiwin LMSA11 iron core linear motor has been extensively tested in combination with the Lexium 32 drive, Schneider Electric can provide a qualified solution for this combination of drive and motor.

Although not limited to, Schneider Electric suggests the following combination as AC-servo bundle:

- **LXM32MU60N4**: Lexium 32 Modular servo drive;
  1.5A continuous, 6A peak, 400v/3phase
- **VW3M3402**: Encoder interface card with analogue input;
  1 Vpp, 5 volt power supply
- **LMSA11**: Hiwin Iron-core linear motor;
  21N@2.1A continuous, 289N@6.3A peak
- **Hiwin MAGIC**: Hiwin linear feedback system;
  Magnetic, 1mm pitch, 1V pk-pk SinCos

Specific information for implementation and commissioning for technical personnel is available, allowing rapid integration into the customer’s application.

As iron-core linear motors are getting more affordable these days, we see a steady increase in the number of applications with this technology. This trend is identified for both new applications as a replacement in existing applications.
Conclusion
The first thing to keep in mind about iron-core linear motors is that they are not much different from ordinary rotary servo motors. This means that for the majority of applications, there is no need for a special drive. Thus, the mentioned bundle of Lexium 32 combined with the Hiwin LMSA11 provides a very cost efficient solution to all applications having a requirement for dynamic performance exceeding that of ordinary linear axis.

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Koos Hulskamp, Gunter Hertwig