How a Linear Axis Works

A linear axis is more than a motor — it is a complete motion module: a **drive**, a **guide**, a **carriage**, an **encoder**, and a **mounting**. This page explains the anatomy of a NILAB linear axis and how it produces motion. Use it together with the How a Tubular Linear Motor Works page, which explains the motor itself.

The anatomy of a linear axis

Component	Role	Typical NILAB implementation
Drive	Generates the force along the axis	Tubular linear motor (GDM, MCSS), ironcore linear motor (LM, NL-BCJ), belt (ULCO)
Guide / rails	Keeps the carriage on the axis and carries the load	WON recirculating ball guides (LF seal), profile guides, T-slot profiles (ULCO)
Carriage / slide	Moves the payload; supports the load	Carriage with integrated guides and rails
Encoder	Provides position feedback	Magnet-type encoder (GDM), SIN/COS / ABZ / Hiperface / SSI (LM), absolute encoder (RM)
Mounting	Connects the axis to the machine frame	Base, flange, bellows, cable chain, T-slots

How the axis produces motion

- The **drive** generates force **directly along the axis** — there is no gearbox, lead screw, or belt between the motor and the load (except in belt-driven units like ULCO). This gives **zero backlash** and very high dynamic response. - The **guide** keeps the carriage on the axis and carries the load; it determines the **stiffness** and the **natural frequency** of the axis. - The **encoder** gives the position feedback that the servo drive or motion controller needs for closed-loop control.

Axis vs bare motor

A bare motor needs a guide, carriage, and encoder to become a usable axis. An **integrated axis** (GDM, LM, RM, MCSS, ULCO, NL-BCJ) is delivered ready to install — it already includes the guide, carriage, and encoder, and is matched to the motor.

Key performance factors

- **Guide stiffness** — determines the load capacity and the natural frequency of the axis; keep it high to avoid exciting vibrations (see Machine design: lowest natural frequency ≥ ~200 Hz). - **Force** — rated force (Fr) and peak force (Fp); for belt-driven units (ULCO) the belt also limits force and speed. - **Precision** — depends on the guide quality and the encoder resolution (SIN/COS with interpolation, absolute encoders). - **Speed and acceleration** — direct-drive tubular/ironcore axes are fast and dynamic; belt-driven units (ULCO) run quieter but have a lower speed and force limit.

Related pages

* Linear axes selection * Multi-axis systems * How a tubular linear motor works * Machine design

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