Author: Ştirbu Nichita
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MAGNETIC SLIDER MECHANISM COMBINING POSITION FEEDBACK AND BIOMETRIC SENSING

INTRODUCTION

The presented slider button design (Image 1;2) serves as a versatile interface component for controlling various electronic devices. The device supports a wide range of functions including powering on and off, audio playback control with scrubbing capability, tactile feedback via vibration, camera interface control (optical and digital zoom adjustment, focus management), user interface navigation, volume regulation, and other control methods as envisioned by software developers.

Example (1)

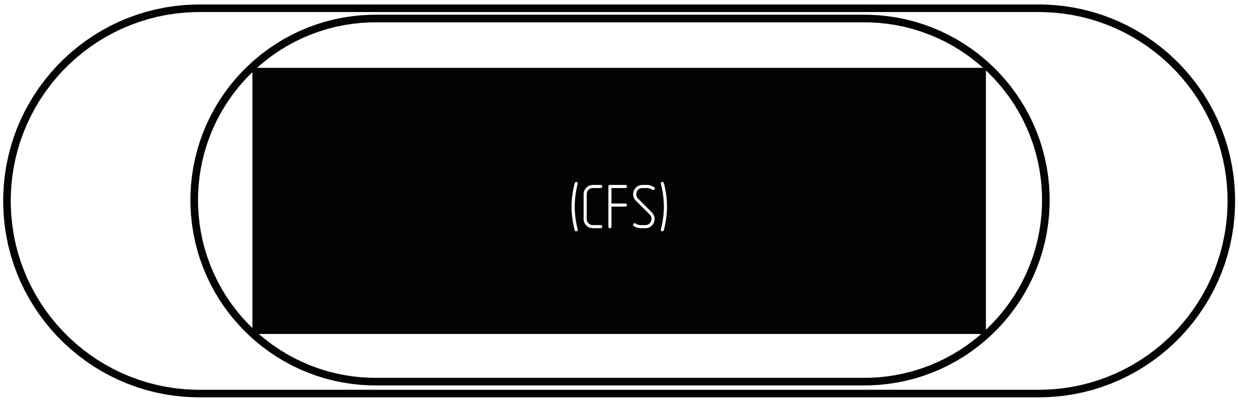
Example (2)

Utilizing a magnetic position sensor based on the analog Hall effect combined with an analog output signal and vibrotactile feedback enables precise positional control and natural interaction in a compact and scalable form factor.

This solution is intended for integration alongside traditional input controls, enhancing device functionality and improving user experience.

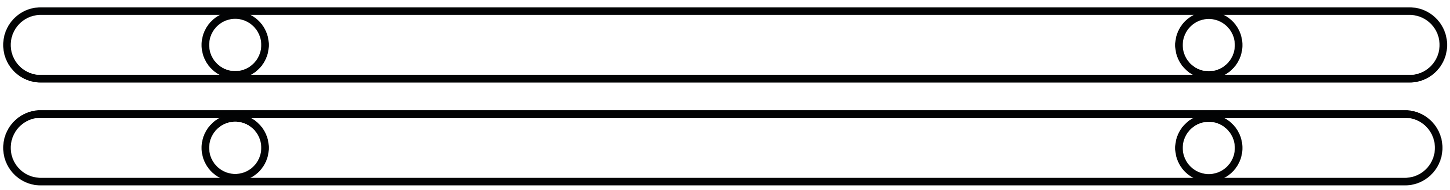
CONSTRUCTION DESCRIPTION

Moving Parts:
The moving component (slider) is composed of two primary materials:
1) A metal base (steel or aluminum) for structural strength and electromagnetic shielding;
2) A matte glass surface in the upper section, positioned above a capacitive fingerprint sensor (CFS).

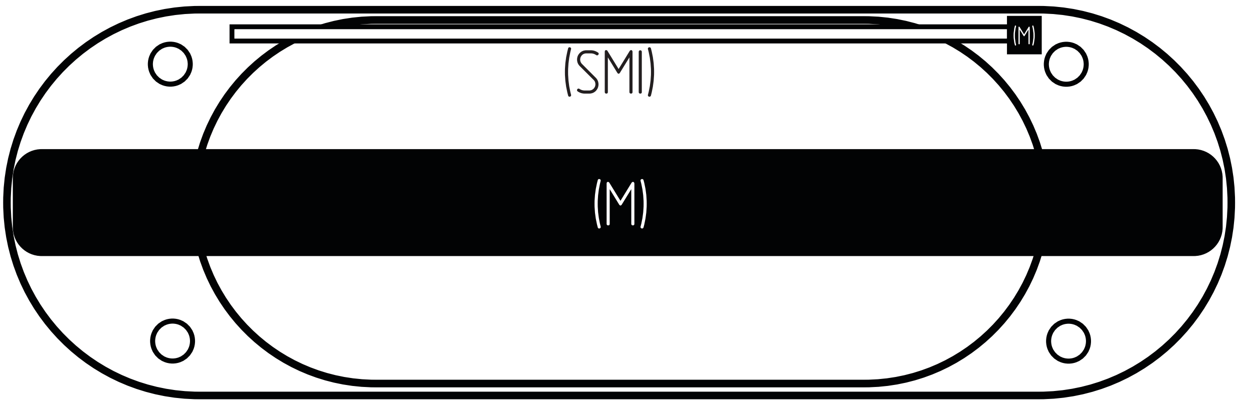


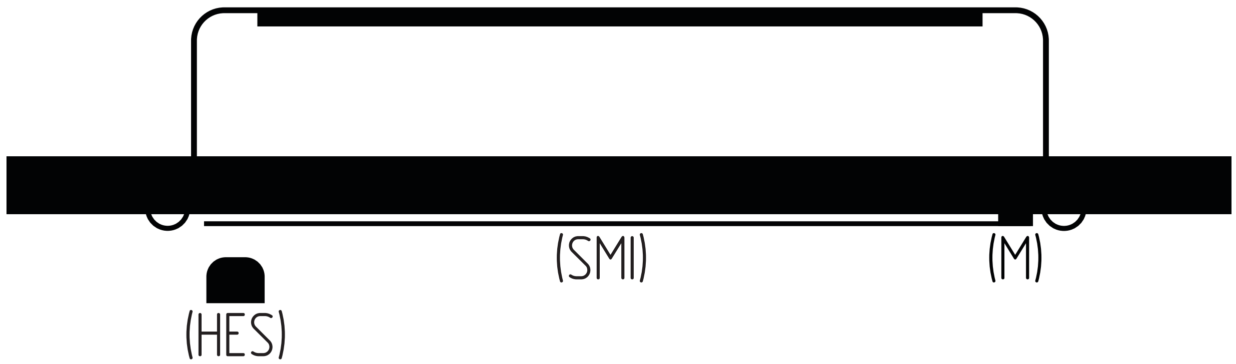
Slider inside

The slider travels linearly along two precision guides using four ball bearings (two per guide), functioning as linear rolling supports. These guides are made of polyamide or brass, providing stable alignment and preload against movement, reducing mechanical play and vibration.



Mounted on the moving part are 24 neodymium magnets (M), evenly spaced along the length of travel. Additionally, a thin strip of soft magnetic iron (SMI) is positioned to create a magnetic field gradient. This strip interacts with a stationary analog Hall effect sensor (HES), enabling continuous position detection along the slider's path.

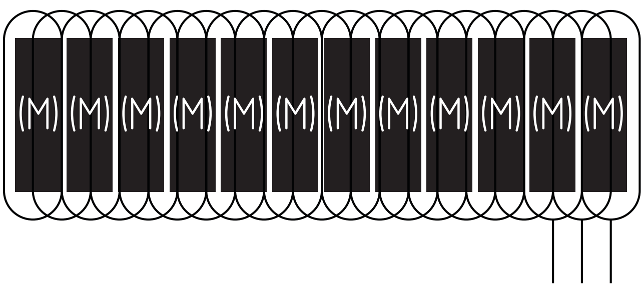


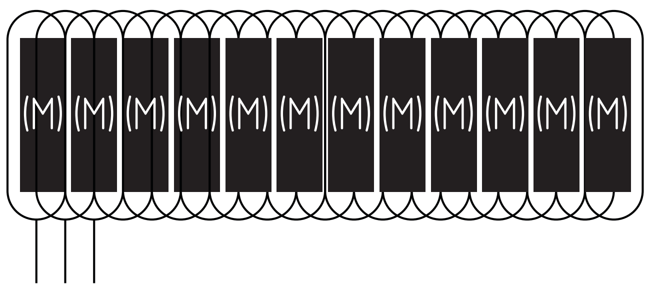


Fixed Part

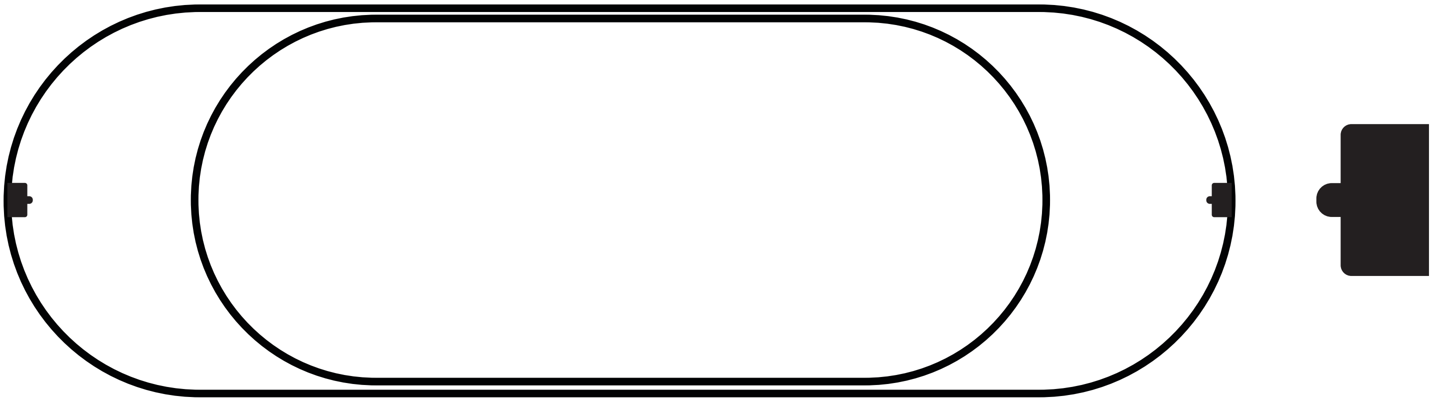
The stationary housing contains two sets of electromagnetic coils, each consisting of three phases (six phases total).

Each phase can be controlled independently using sinusoidal or other waveform signals. These coils generate dynamic magnetic fields that interact with the 24 embedded magnets to actuate the slider precisely.





To define and calibrate the limits of motion, the mechanism includes two mechanical limit switches (endstops) that detect the uppermost and lowermost slider positions during initialization or reset procedures.

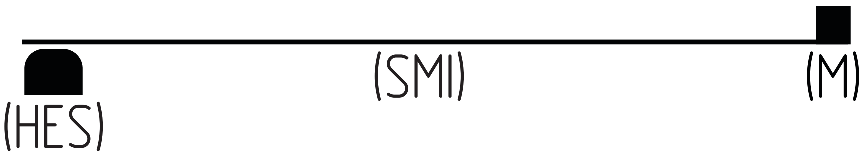


Return Mechanism

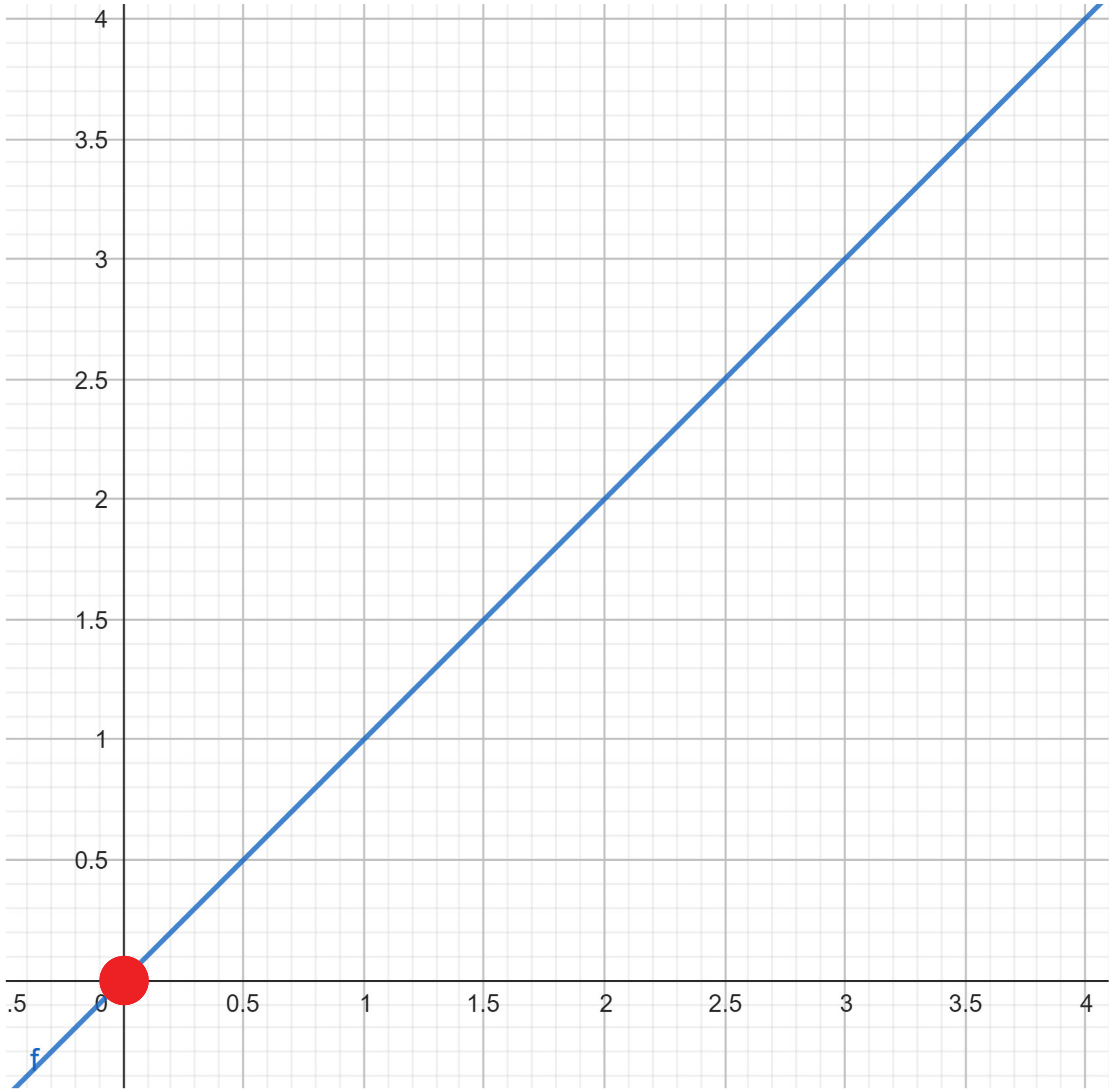
Between the moving and fixed components are low-tension return springs that automatically restore the slider to a central (neutral) position when not actively engaged. This provides symmetrical tactile behavior and ensures consistent user feedback.

OPERATING PRINCIPLE
AND
MAGNETIC FIELD PHYSICS

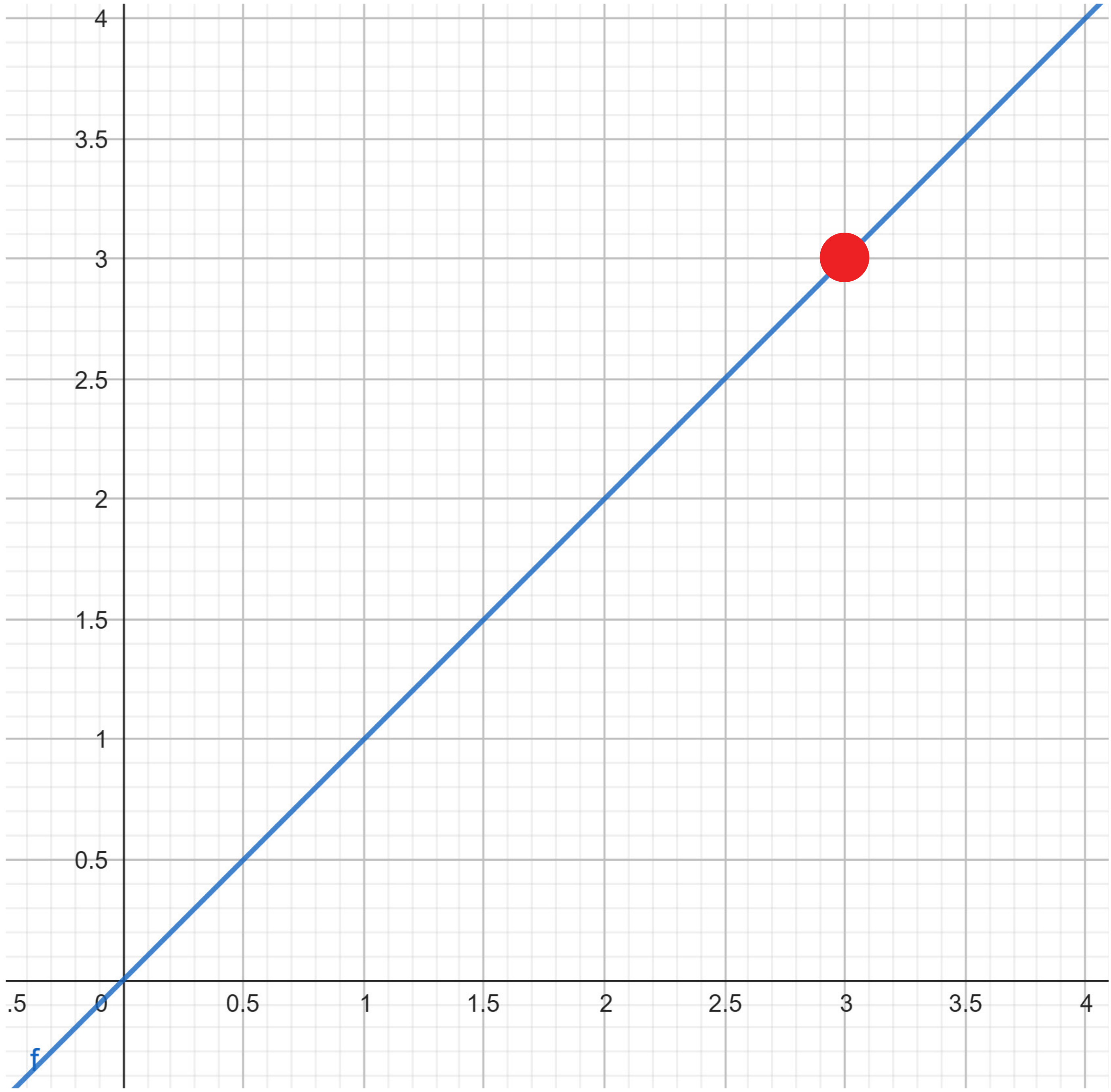
Positioning System Based on Magnetic Field Gradient:
The slider’s position is determined using an analog Hall effect sensor located on the stationary part of the mechanism. The magnetic field detected by the sensor changes due to the movement of a strip of soft magnetic iron fixed to the moving part. This strip acts as a directional magnetic conduit, spreading the localized magnetic field from a single magnet mounted on the slider.



As the slider moves, the magnetic field density within the sensor’s detection area changes accordingly. Due to the geometry and material properties of the system, a stable magnetic gradient is formed along the axis of movement. The analog Hall sensor converts this gradient into a continuous voltage signal that is proportional to the slider’s position.



(When the magnet is located at the far end of the travel range relative to the Hall sensor, the output signal approaches zero on the position graph.)



(When the magnet reaches its closest point to the Hall sensor, this is represented on the position graph as a high signal value.)

Within the operating range, the signal approximates a linear function, providing high positional accuracy and allowing for further analog or digital signal processing. The corresponding graph of output voltage vs. position typically forms a sloped linear segment within the effective range and saturates outside the motion boundaries.

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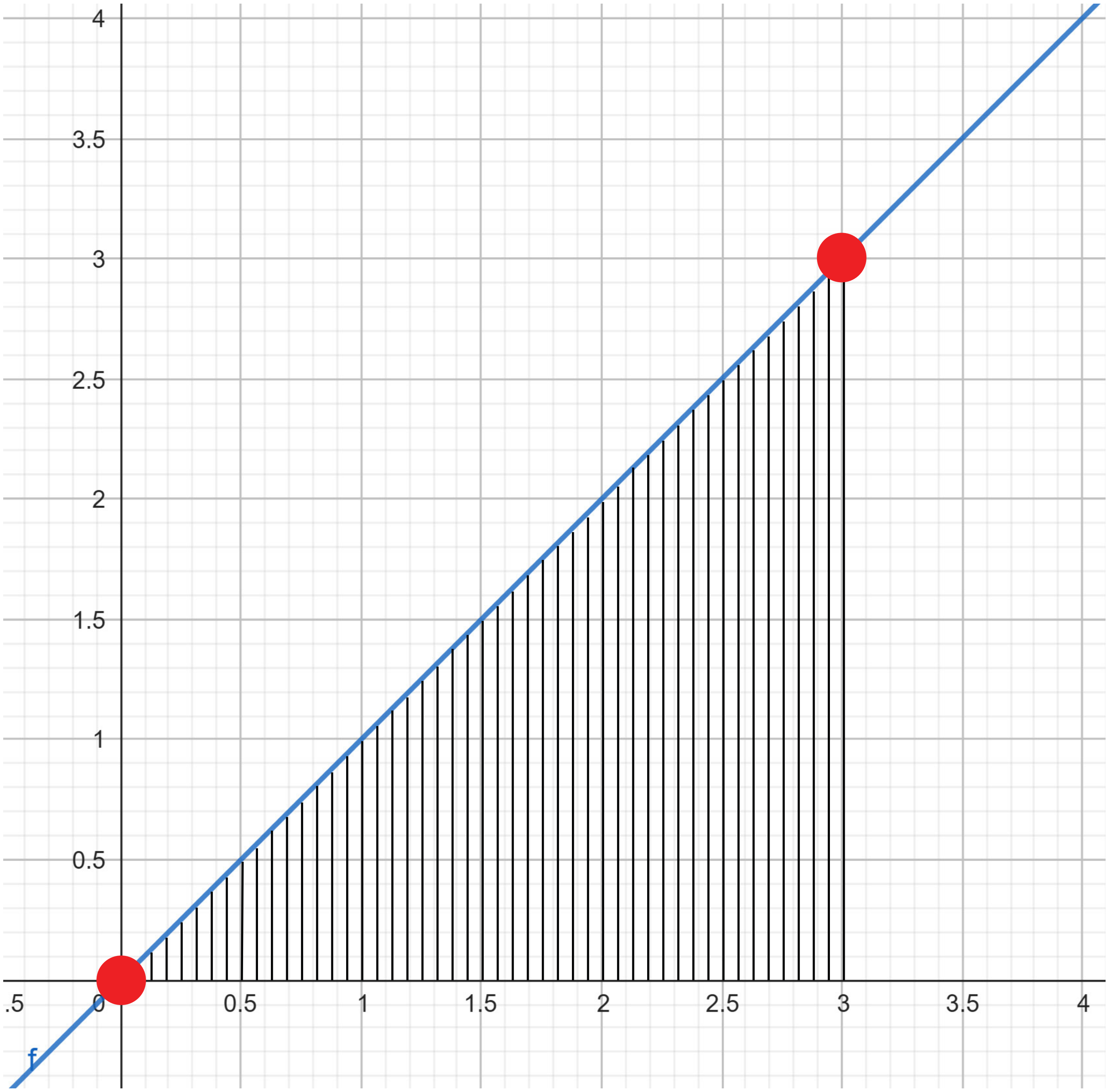
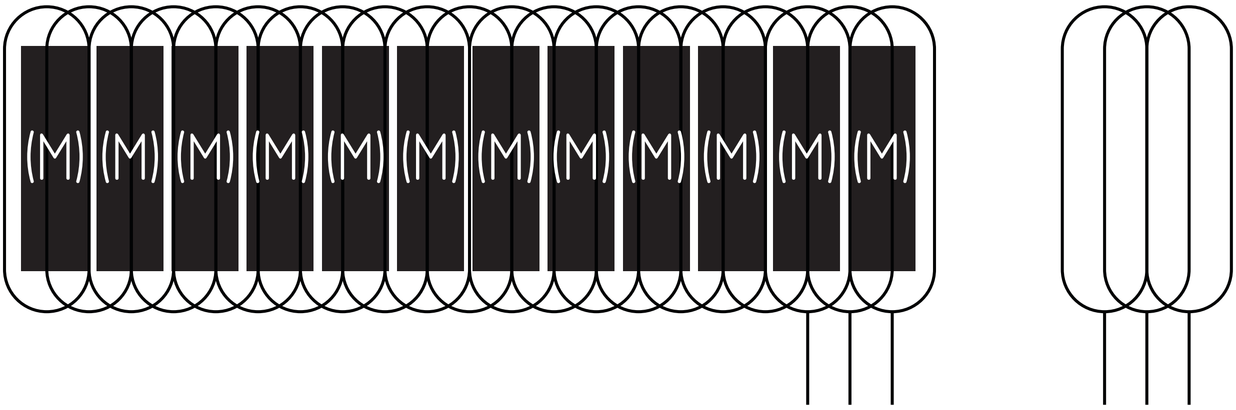
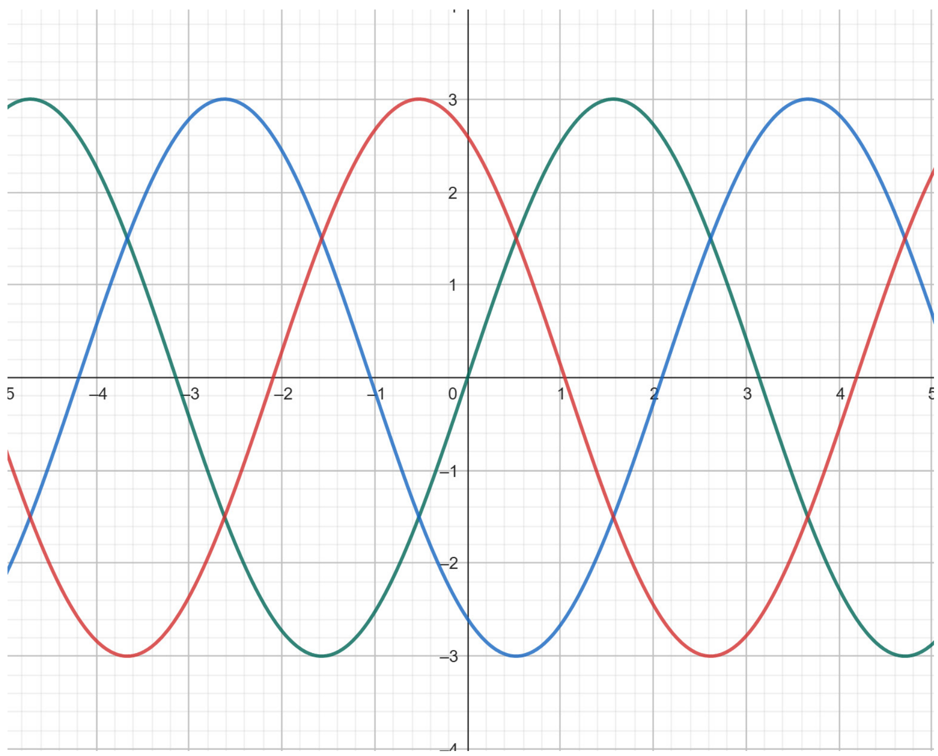


(An example of the digitized output signal is illustrated in the graph.)

ELECTROMAGNETIC MOTION CONTROL

Each phase winding is controlled individually using sinusoidal or other periodic waveforms (e.g., square or triangular signals). Applying phase-shifted signals across the coil groups generates a traveling electromagnetic field that interacts with the permanent magnets embedded in the slider. This interaction produces linear motion through alternating magnetic attraction and repulsion.





(The graph presents a representative waveform configuration for driving a three-phase linear actuator.)

This method of actuation is analogous to the operation of a linear synchronous motor with electronic excitation. The presence of two symmetrical coil arrays ensures balanced force distribution, enhanced positional stability, and enables advanced control functions such as active holding or automatic return of the slider to its central (neutral) position when required.

AREAS OF APPLICATION

The proposed linear slider mechanism can be implemented across a wide range of compact electronic devices, where precise user input, enhanced tactile feedback, and spatial efficiency are critical.
Due to its scalable construction and flexible configuration, the system is well suited for integration into the following categories:

1) Smartphones and Mobile Devices
Side-mounted interaction module for compact gesture input
Zoom, volume, or media navigation
Enhances accessibility and one-handed usability

2) Professional and Consumer Cameras
Physical control over zoom, focus, and aperture parameters
Integration into lenses or grip modules for precise adjustments
Haptic click emulation for intuitive analog-style control

3) Gaming Devices and Controllers
Analog-style input with tactile feedback for throttle, aiming, actions
Customizable zones with spring-loaded return for centered controls
Space-saving alternative to large joystick modules

4) Wearables and Audio Equipment
Control interface for volume, noise-canceling levels, or playback
Thin integration into headphone stems or smartwatch bezels

5) IoT Devices and Smart Home Interfaces
Scene control or brightness adjustment
Mode switching with haptic confirmation
Simplified interface for minimalist designs

TERMS OF USE AND OPENNESS OF THE TECHNOLOGY

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