Dynamic Positioning System
1027061

User Guide

cma-science.nl

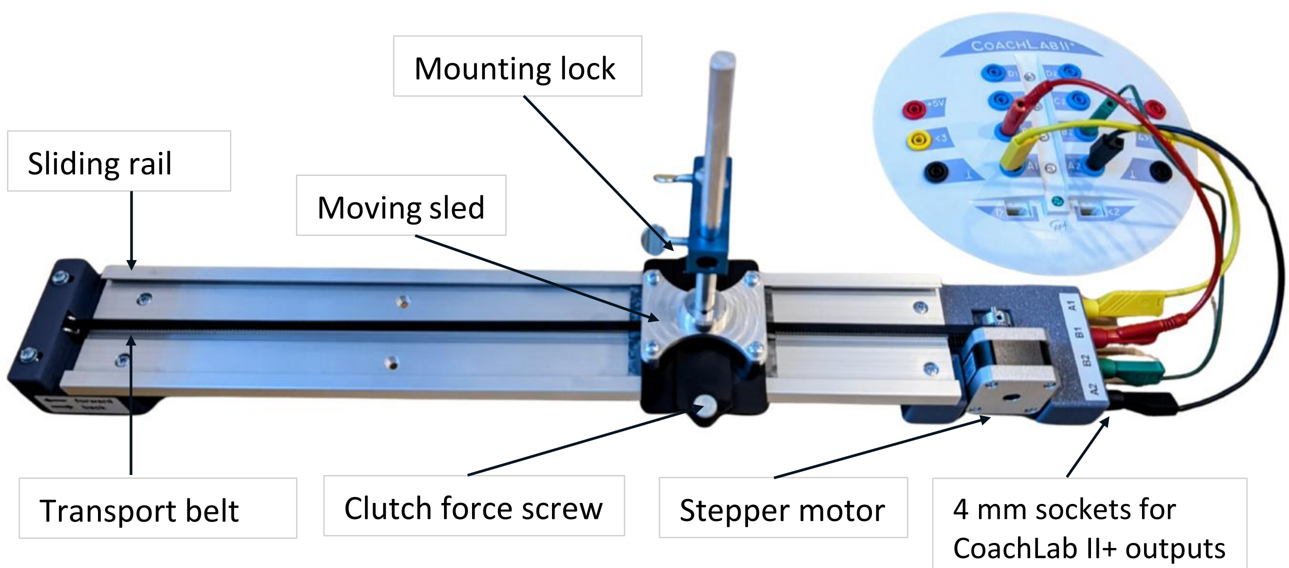
Short description

The Dynamic Position System (1027061) is a controlled-motion system designed for the precise measurement and control of position. Using this device, you can plot distance vs. sensor value easily. For example: a light or sound sensor to investigate inverse square law and diffraction patterns, or a magnetic sensor to study the magnetic field in/around a coil.

Its moving element is a sled that can carry a retort rod or sensor holder. The sled travels along a linear track, driven by a transport belt connected to a stepper motor.
The stepper motor is controlled by the CMA CoachLab II+ interface (006p), which generates the control signals required to drive the motor. A Coach Control program operates the positioning system, providing precise and repeatable control of the sled's position along the track. The system is supplied with a retort rod (Ø 10 mm, length 200 mm) and a rod clamp.

Important: Use the Positioning System only with the CoachLab II+ interface.

Device overview

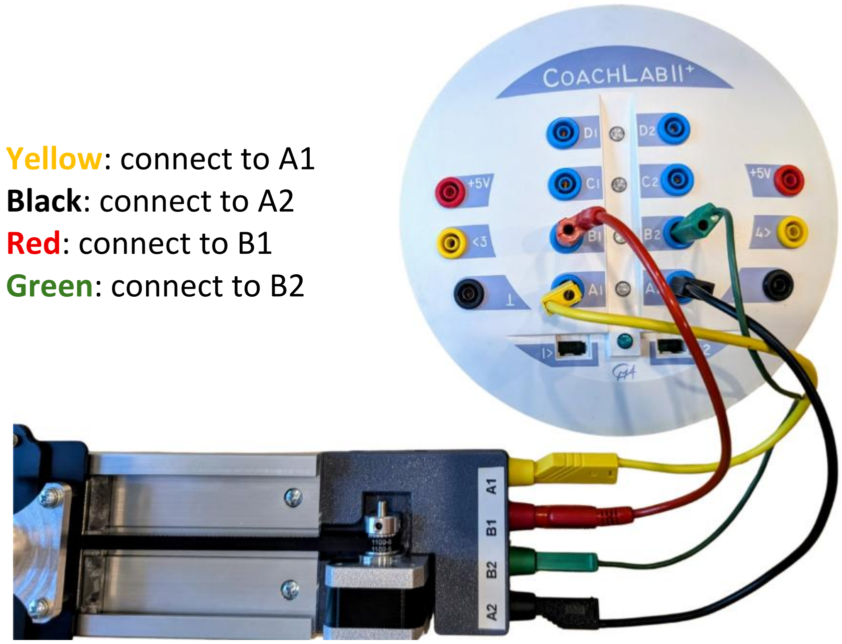


Adjustment of the clutch force

The clutch force of the sled can be adjusted to protect sensitive components. When the clutch force is set to its maximum, a hard impact may cause the stepper motor to produce a rattling or chattering sound as it loses synchronization. Whenever possible, adjust the clutch force only to the level required for the experiment.
Turn the clutch force adjustment screw clockwise to increase the clutch force and counterclockwise to decrease it.

Connecting to the CoachLab II+

To ensure correct operation, the device must be connected to the outputs of the CoachLab II+ interface as shown on the photo. The label on the device indicates the correct connections.



Calibration

The device is driven by a stepper motor, where each step moves the sled 0.2 mm horizontally (5 steps = 1 mm). The sled moves at a constant speed, which can be set via the control program.
In Coach 7, the **Dynamic Positioning System (1027061)** actuator, with the appropriate calibration is included in the Actuator Library.

Using the system

- Connect the CoachLab II+ interface to the computer and start Coach 7.
- Connect the Dynamic Positioning System to the CoachLab II+ outputs as described above.
- On the **Dashboard**, under **Control**, select the **Control of Dynamic Positioning System** activity. This activity is preconfigured for the device.
- The **Dynamic Positioning System** actuator is already placed on the on-screen CoachLab II+ panel.
- Connect the sensor you want to use to Input 1. The corresponding graph will appear automatically on the right. It displays the quantity measured by the sensor against the position of the sled (calculated from the number of steps the sled has moved; 5 steps = 1 mm).
- In the **Program** window you, will see a command list with just one command **Move**. This command controls the movement of the sled. You define the motion using the following parameters:

  Distance - enter the distance the sled should travel in millimetres.
  Direction - select either **Forward** or **Back**, as indicated on the device label.

Speed - set how fast the sled should move.

Create your control program by typing or by selecting parameters from the command list.

- Click the green **Start** button to run the program. Once started, the positioning system will begin moving and will collect sensor data at each step.

Since the Dynamic Positioning System is driven by a stepper motor, you can also use a more general activity for controlling devices connected to the CoachLab II+ interface. In this case, select the appropriate activity under **Control** on the dashboard: **Programming with CoachLab II+ interface**.

- Right-click the A1 output on the CoachLab II+ panel on the screen and choose **CMA Dynamic Positioning System (1027061)** from the Coach Actuator Library.
- Then connect the sensor(s) you want to use to the CoachLab II+ interface.
- Click the **Select Variables** button in the toolbar of the Program window and select the program variable **StepsAB**, which represents the number of steps the sled has moved. This allows you to use this variable in the Data Table.
- Add a new **Formula Variable** to your Data Table. Give it a name, for example **Position**, and use the formula **StepsAB / 5** to calculate the distance the sled has moved in mm (5 steps = 1 mm). You can then use this variable in your graph.
- In the **Program** window create your control program using the general **StepMotorAB** command by defining:

  Number of steps (each step equals 0.20 mm),

  Direction (Forth or Back),

  Speed (from 1 to 10).

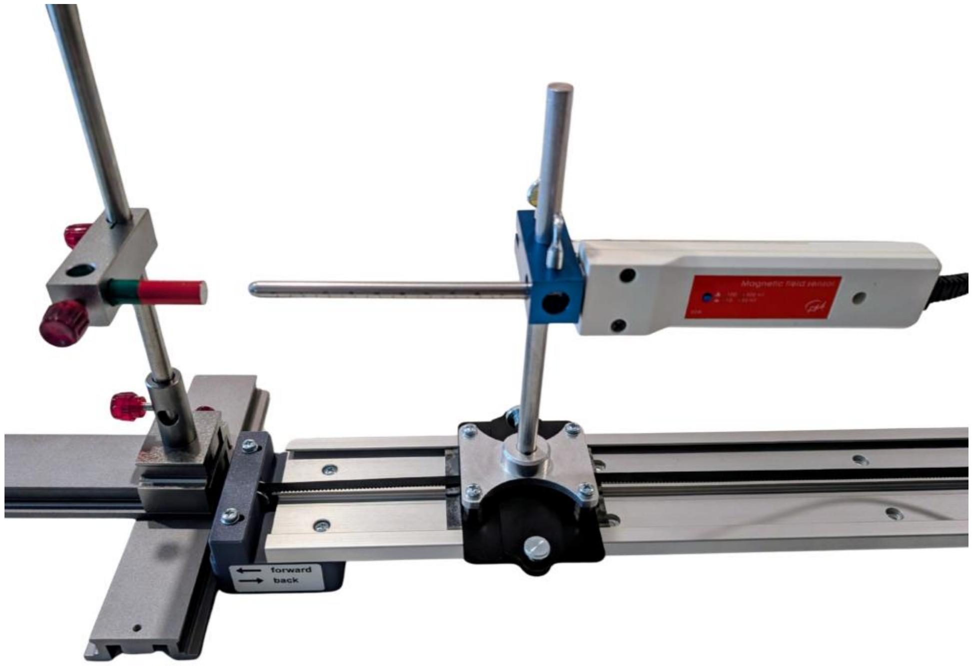
  Create your control program by typing or by selecting parameters from the command list.

Example of experiments

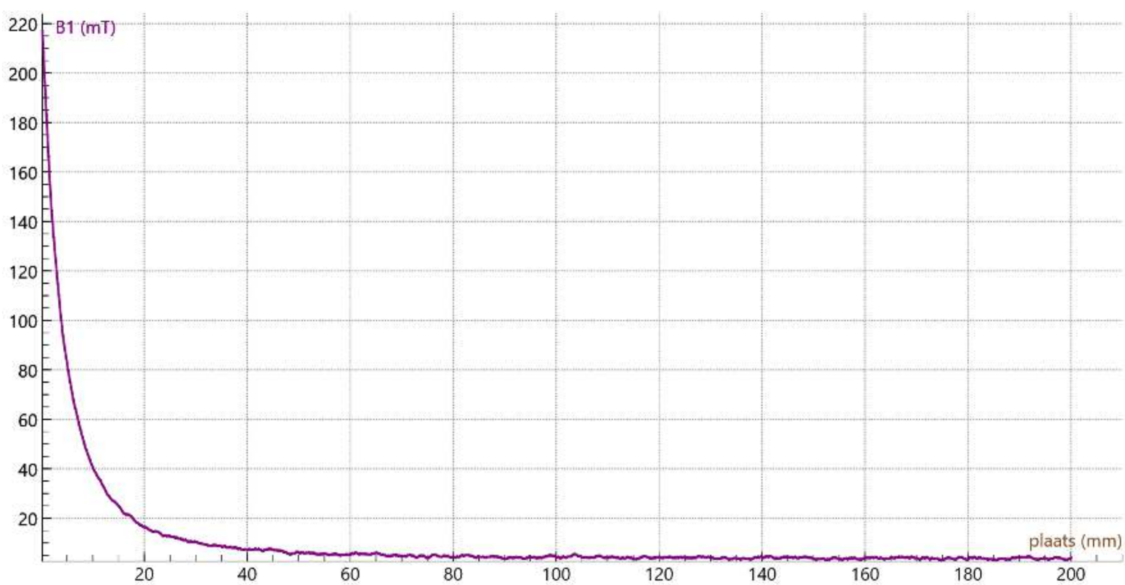
The positioning system allows accurate control of position along a linear track. A sensor mounted on the sled is moved, and its position is recorded. This allows physical quantities to be measured as a function of position.

Magnetic Field of a Magnet

Mount a magnetic field sensor on the sled of the positioning system. Place a permanent magnet along the track, aligned with the direction of motion. Move the sensor along the axis of the magnet while recording magnetic field strength and position simultaneously.



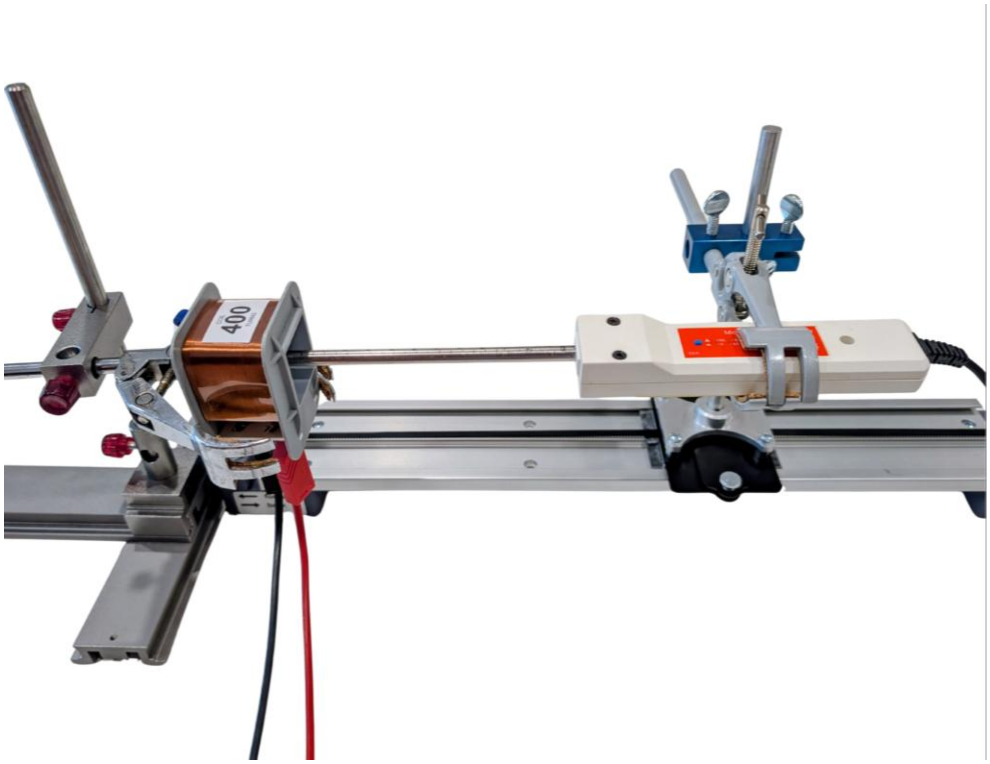
The resulting data show the magnetic field strength as a function of distance from the magnet.



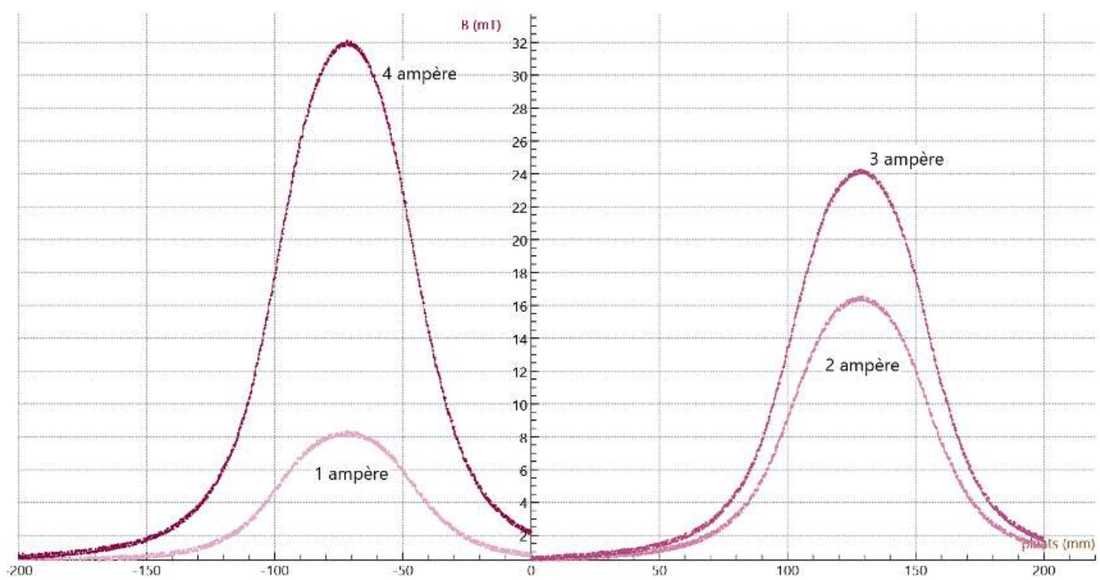
Magnetic Field Inside a Coil

Mount a magnetic field sensor on the sled of the positioning system. Place a coil or set of coils along the track. Move the sensor through and along the coil while recording magnetic field strength as a function of position. Repeat the measurement for coils with different numbers of turns and for different current values.

The collected data can be used to investigate the relationship between magnetic field strength, current, and coil geometry, and to verify Ampère's law $B = \mu_0 \frac{NI}{L}$



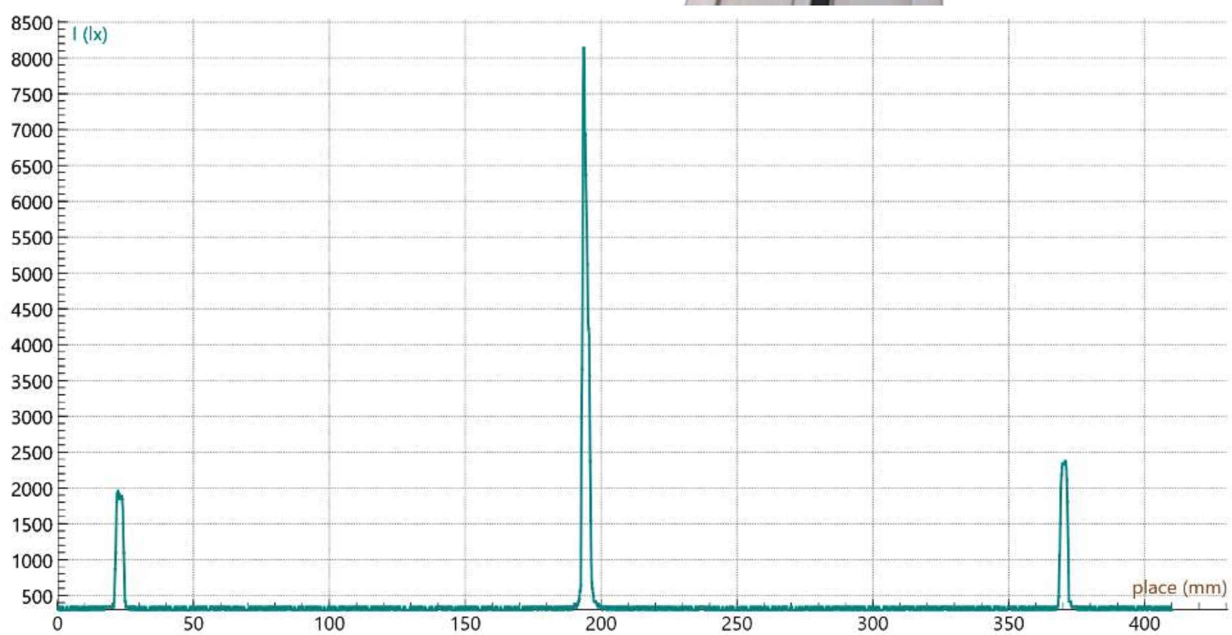
The resulting data show the magnetic field distribution in coils for different current values.



Interference of a Laser Beam with a Diffraction Grating

Mount a light sensor on the sled of the positioning system. Align a laser beam perpendicular to a diffraction grating. Move the sled stepwise along the direction perpendicular to the diffraction pattern while recording light intensity and position simultaneously. The interference maxima correspond to the diffraction fringes.

Using a grating with a known number of lines per millimeter, the wavelength of the laser can be determined from the measured positions of the maxima. Alternatively, a known laser wavelength can be used to determine the grating spacing.



Other suggested experiments

- Determine surface tension with a force sensor (using a surface tension ring, rope and pulley)
- Experiment with Biot-Savart Law using a magnetic field sensor (using coils with different diameters)
- Measure properties of elastic band with a force sensor
- Measure radiation as a function of distance to the radioactive source.

Technical Specifications

Moving distance	405 mm
Resolution	1 step – 0.02 mm
Weight sliding rail	2 kg
Retort rod mount	Ø = 10 mm
Dimensions	580 x 120 x 50 mm
Speed	5 speed levels via software
Connection to outputs of CoachLab II+	4 mm sockets Yellow socket to A1 output Black socket to A2 output Red socket to B1 output Green socket to B2 output

N.B.: Failure to use the positioning system according to these regulations may result in damage the electronics of the positioning system.

Warranty

The Dynamic Position System (1027061) is warranted to be free from defects in materials and workmanship for a period of 3 years from the date of purchase provided that it has been used under normal laboratory conditions. This warranty does not apply if the sensor has been damaged by accident or misuse.

***Note:** This product is designed for educational purposes only.*
It is not intended for industrial, medical, research, or commercial applications.

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