Force Plate

(Order Code FP-BTA or FP-DIN)

The Force Plate is a special-purpose force sensor for use with Vernier LabPro®, Go!™Link, Universal Lab Interface (ULI), Serial Box Interface, CBL 2™, and the original CBL™. Designed for much higher forces than the Dual-Range Force Sensor, the Force Plate can measure the forces developed during stepping, jumping, and other human-scale actions. For example, you can perform the following kinds of experiments:

- Observe the change in normal force during an elevator ride.
- Measure the impulse delivered by the floor during a jump.
- Measure the reaction force as a student leans against a wall.

What is included with the Force Plate?

The Force Plate includes one pair of handles. They can be attached either to the top or the bottom of the Force Plate. Do not step on the Force Plate when the handles are attached.

Using the Force Plate with a Computer

This sensor can be used with a computer and the LabPro, Go! Link, ULI, or Serial Box interfaces.

1. Connect the Force Plate, computer interface, and computer.
2. Launch the data-collection software.
3. The program will automatically identify the Force Plate, and you are ready to collect data.[1]

Using the Force Plate with TI Graphing Calculators

This sensor can be used with a TI graphing calculator and any of the following interfaces: LabPro, CBL 2, or CBL.

1. Load a data-collection program onto your calculator:
   - LabPro or CBL 2 - Use the DataMate program. This program can be transferred directly from LabPro or CBL 2 to the TI graphing calculator. Use the calculator-to-calculator link cable to connect the two devices. Put the calculator into the Receive mode, and then press the Transfer button on the interface.
   - Original CBL - Use the CHEMBIO program. This program is available free on our web site, www.vernier.com. Load the program into a calculator using TI Connect™ software and a TI-GRAPH LINK™ cable.
2. Use the calculator-to-calculator link cable to connect the interface to the TI graphing calculator using the I/O ports located on each unit. Push both plugs in firmly.
3. Connect the Force Plate to an available analog port on the interface. In most cases, Channel 1 is used.
4. Start the data-collection program, and you are ready to collect data.

[1] If your system does not support auto-ID, open an experiment file or set up your data-collection software manually for a Force Plate, and you are ready to collect data.

Using the Force Plate with Palm OS® Handhelds

This sensor can be used with a Palm OS handheld and the LabPro.

1. Use the cable supplied in your Data Pro package to connect the interface to the Palm OS device. Be sure to push both plugs in firmly.
2. Connect the Force Plate to an available analog port on the LabPro. In most cases, Channel 1 is used.
3. Start Data Pro.
4. Tap New. Tap New again. You are ready to collect data.

NOTE: This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications.

Zeroing

In some situations you may want to zero the Force Plate, because changing the physical orientation of the sensor will change the reading when no force is applied. After you have set up your experiment, use your data-collection software to zero the sensor. Also, in the case of experiments involving large impact forces, you may need to zero the reading *after* one impact has taken place.

Specifications

- Force range: –800 to +3500 N or –200 to +800 N, where positive value is a compression force
- Maximum non-damaging force: 4500 N (1000 lb) compression or 900 N (200 lb) pull evenly distributed
- 12-bit resolution (LabPro, Go! Link, ULI): 1.2 N or 0.3 N
- 10-bit resolution (CBL 2, CBL): 4.8 N or 1.2 N
- Dimensions: 28 cm by 32 cm by 5 cm
- Calibration function:
  slope (gain): 111N/V or 250 N/V
  intercept (offset): –1000 N or –250 N
  Force = V_{out} * 1000N/V – 1000N (3500 N range)
  Force = V_{out} * 250N/V – 250N (800 N range)

This sensor is equipped with circuitry that supports auto-ID. When used with LabPro, Go! Link or CBL 2, the data-collection software identifies the sensor and uses pre-defined parameters to configure an experiment appropriate to the recognized sensor. This greatly simplifies the setup procedures for many experiments. Auto-ID is required for the Quick Setup feature of LabPro and CBL 2 when the unit operates remotely from the computer or calculator.

The Two Switch Settings: Resolution and Range

As with any instrument, there is a trade off between resolution (the smallest force that can be measured) and the range of forces that can be measured. In general, you should use the 800 N range if you can. If the forces exceed 800 N, you will need to use the 3500 N range. In normal use, the resolution with the different switch settings when used with a LabPro will be 1.2 N for the –1000/+3500 N range and 0.3 N for the –200/+800 N range.

The Handles—Pushes and Pulls

The Force Plate includes two handles with captive screws. You can attach the handles to either the top or bottom of the plate. With handles in place, you can support the unit by hand for pushing on a wall or other large object, or you can attach an optional second pair of handles for pulling experiments (order code FP-HAN). Note that the maximum force in extension is much less than the maximum force in compression.

Do I Need to Calibrate the Force Plate? No!

You should not have to perform a new calibration when using the Force Plate. You can use the appropriate calibration file that is stored in your data-collection program from Vernier.

1. If you are using Logger *Pro* software (version 2.2.1 or newer) on a computer with a ULI or Serial Box Interface, open an experiment file for the Force Plate, and its stored calibration will be loaded at the same time. Note: If you have an earlier version of Logger *Pro* 2, an upgrade is available from our web site, www.vernier.com.
2. The DataMate calculator program will automatically load calibrations for this sensor.
3. The Data Pro Palm OS application will automatically load calibrations for this sensor.
4. The PHYSICS and CHEMBIO programs (for CBL), version 8/15/02 or newer, have stored calibrations for this sensor. Go to our web site to download a current version.
5. Any version of DataPro has stored calibrations for this sensor.

In many cases, you can simply load an experiment file that is designed for use with the Force Plate and you are ready to collect data. You need to select the correct file (3500 N or 800 N) to match your selected range setting on the sensor. If you do not have these calibration files, contact Vernier and we will send them to you. Be sure to specify which interface and software you are using.

If you want to improve the calibration, it is easy to recalibrate following the same procedure used in calibrating most Vernier probes—a two-point calibration. One point is your zero, with no force applied to the sensor. Set the Force Plate on a level surface. Select the calibration option of the program you are using and remove all force from the Force Plate. Enter **0** (zero) as the first known intensity. Now apply a known force to the Plate. The easiest way to do this is to put an object of known weight on the Plate. To obtain a good calibration, the weight should be at least 25% of the range used for the plate (200 or 800 N); for example, exercise weights could be used. Enter the weight of the mass (note: 1 kg weighs 9.8 N). Be careful not to exceed the selected range setting during the calibration.

Suggested Experiments

1. Analyze a crouched jump. Start with knees bent, hands on hips. Do NOT lower your body further; jump up only. Do not move arms. This very artificial jump is easier to analyze than a natural jump.
   a. Use the impulse of the force to find the change in momentum; find the jumper’s velocity at take-off to estimate the jump height.
   b. Use the flight and kinematics to find the jump height.
   c. From the force versus time graph, determine an acceleration versus time graph. Integrate to find velocity and position versus time graphs. Construct a plot of force versus position, and use that to determine the work done on the jumper’s center of mass by the floor. Since that work shows up as kinetic energy, use the energy to find the velocity at take-off.

2. Repeat the above analysis for a natural jump, beginning with standing straight, crouching down, and then jumping. You will be able to jump higher this way, but the analysis will be more complex.
3. Do expensive running shoes measurably reduce heel strike force?
4. Compare the measured impulse to the mechanical work done when lifting a large weight.
5. Investigate the forces involved during the technique known as “unweighting” during ski or snowboard turns. Can you easily cut your apparent weight by a factor of two? Four?
6. How does the force of your foot on the ground vary during walking?
7. Investigate the forces developed by jumping onto the Force Platform.
8. Use an additional pair of handles so that two students can hold the Force Plate, one on each face. Measure the force of one student pushing or pulling on another student.
9. Hang the Force Plate on the wall and measure the reaction force as you lean on the plate. Does the wall push back on you?
10. Take the Force Plate on an elevator ride. Stand on the Force Plate, and record the force of the elevator floor on your feet as a function of time. Explain. Can you determine the speed of the elevator from the data?

References

1. R. Cross, “Standing, Walking, Running, and Jumping on a Force Plate,” Am. J. Phys, 67(4), 304-309 (1998).
2. N.P. Linthorne, “Analysis of Standing Vertical Jumps Using a Force Platform,” Am. J. Phys. 69(11), 1198-1204 (2001).
3. O.A. Haugland, “Physics Measurements for Sports,” Phys. Teach. 39 350-353 (Sept. 2001).

Warranty

Vernier warrants this product to be free from defects in materials and workmanship for a period of five years from the date of shipment to the customer. This warranty does not cover damage to the product caused by abuse or improper use.

Vernier

Vernier Software & Technology
13979 S.W. Millikan Way • Beaverton, OR 97005-2886
Toll Free (888) 837-6437 • (503) 277-2299 • FAX (503) 277-2440
info@vernier.com • www.vernier.com

Rev. 7/26/05