# Force Plate
## (Order Code FP-BTA)

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.

**Note:** Vernier products are designed for educational use. Our products are not designed nor are they recommended for any industrial, medical, or commercial process such as life support, patient diagnosis, control of a manufacturing process, or industrial testing of any kind.

## What's Included

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.

## Compatible Software

See **www.vernier.com/manuals/fp-bta** for a list of software compatible with the Vernier Force Plate.

## Getting Started

1. Connect the sensor to the interface (LabQuest Mini, LabQuest 2, etc.).
2. Start the appropriate data-collection software (Logger *Pro*, Logger Lite, LabQuest App) if not already running, and choose New from File menu.

See the following link for additional connection information:

**www.vernier.com/start/fp-bta**

## Using the Product

### Zeroing the Sensor

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.

### The Two Switch Settings – Resolution and Range

The Force Plate has a range switch located on the side of the plate, next to the cable exit. 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 850 N range if you can. If the forces exceed 850 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 or LabQuest will be 1.2 N for the –1000/+3500 N range and 0.3 N for the –200/+850 N range.

### The Handles – Pushes and Pulls

The Force Plate includes two handles and four screws. You can attach the handles to either the top or bottom of the plate. Do not step on the Force Plate when the handles are attached. Threaded holes for the handles are available on the bottom. For use on the top, you must remove four screws. We recommend attaching the handles on the bottom of the Force Plate. You may find it helpful to loosen all the screws on the bottom before attaching the handles, and then tightening after the handle screws are started.

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**: the maximum force in extension is much less than the maximum force in compression.

## Videos

View videos related to this product at **www.vernier.com/fp-bta**

## Calibrating the Sensor

### Optional Calibration Procedure

For most experiments, you do not have to calibrate the Force Plate. A stored calibration is used when the software is started. Select the desired range of the sensor, and then start the data-collection program.

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. The weight should be at least 25% of the range used for the plate (200 or 850 N); for example, exercise weights could be used. Enter the weight of the mass (**Note**: 1 kg weighs 9.8 N). Do not exceed the selected range setting during the calibration.

Calibrations are usually retained only for the current session. Restarting the software, opening a new file, or choosing New from the File menu will reset the calibration to the default calibration. To retain calibrations across sessions, consult the instructions or help files appropriate to your software. See also **www.vernier.com/til/2342/**

- For instructions for Force Plate calibration using Logger *Pro* computer software, see **www.vernier.com/til/2341**
- For instructions for Force Plate calibration using LabQuest App, see **www.vernier.com/til/3394**

- For instructions for Force Plate calibration using Graphical Analysis with a Chromebook, see **www.vernier.com/til/3631**
- For instructions for Force Plate calibration using Graphical Analysis with an iOS or Android device, see **www.vernier.com/til/3630**

## Specifications

| | |
|---|---|
| Force range | –850 to +3500 N or –200 to +850 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 | 1.2 N or 0.3 N |
| 10-bit resolution | 4.8 N or 1.2 N |
| Dimensions | 28 cm by 32 cm by 5 cm |
| Calibration function | Slope (gain): 1000 N/V or 250 N/V<br>Intercept (offset): –1000 N or –250 N<br>Force = $V_{out}$* 1000 N/V – 1000 N (3500 N range)<br>Force = $V_{out}$* 250 N/V – 250 N (850 N range) |

## Care and Maintenance

Do not wrap the cable tightly around the Force Plate for storage. Repeatedly doing so can irreparably damage the wires and is not covered under warranty.

## Suggested Experiments

- 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 *vs*. time graph, determine an acceleration vs. time graph. Integrate to find velocity and position vs. time graphs. Construct a plot of force vs. 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.
- 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.
- Investigate the forces involved during the technique known as "unweighting" during ski or snowboard turns. Can you easily cut your apparent weight?
- 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 (1999).
2. N.P. Linthorne, "Analysis of Standing Vertical Jumps Using a Force Platform," Am. J. Phys. 69(11), 1198-1204 (2001).
3. Haugland, "Physics Measurements for Sports," Phys. Teach. 39. 350–353 (Sept. 2001).


## Troubleshooting

For troubleshooting and FAQs, see **www.vernier.com/til/1416**

## Repair Information

If you have watched the related product video(s), followed the troubleshooting steps, and are still having trouble with your Vernier Force Plate, contact Vernier Technical Support at support@vernier.com or call 888-837-6437. Support specialists will work with you to determine if the unit needs to be sent in for repair. At that time, a Return Merchandise Authorization (RMA) number will be issued and instructions will be communicated on how to return the unit for repair.

## Accessories/Replacements

| Item | Order Code |
|---|---|
| **Force Plate Handles** | FP-HAN |

## 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. This warranty covers educational institutions only.

## Disposal

When disposing of this electronic product, do not treat it as household waste. Its disposal is subject to regulations that vary by country and region. This item should be given to an applicable collection point for the recycling of electrical and electronic equipment. By ensuring that this product is disposed of correctly, you help prevent potential negative consequences on human health or on the

environment. The recycling of materials will help to conserve natural resources. For more detailed information about recycling this product, contact your local city office or your disposal service.


The symbol, shown here, indicates that this product must not be disposed of in a standard waste container.


Vernier

MEASURE. ANALYZE. LEARN.™

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