Dual-Range Force Sensor

(Order Code DFS-BTA or DFS-DIN)

The Dual-Range Force Sensor is a general-purpose device for measuring pushing and pulling forces. It can be used as a replacement for a hand-held spring scale or mounted on a ring stand. It can also be mounted on a dynamics cart to study collisions. Forces as small as 0.01 newtons and as large as 50 newtons can be measured The Dual-Range Force Sensor can be used for a variety of experiments, including

- Studying force and impulse during collisions
- Studying simple harmonic motion
- Monitoring frictional force
- Studying Hooke's law
- Monitoring the thrust of model rocket engines
- Measuring the force on a dynamics cart
- Measuring the force required to lift a known mass using simple machines

The Dual-Range Force Sensor was designed by Bruce Lee of Andrews University and is manufactured by A.U. Physics Enterprises.

The Dual-Range Force Sensor is designed for use with the following interfaces:

- Vernier LabPro® (for use with computers, TI graphing calculators, or Palm Powered™ handhelds)
- Go! ® Link
- Texas Instruments CBL 2™ or original CBL™ System
- Universal Lab Interface (ULI)
- Serial Box Interface

What is included with the Dual-Range Force Sensor?

Several accessories are included with the Dual-Range Force Sensor:

Thumb Screw

Bumper

Utility Handle

Hook

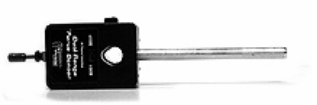
Note: This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications.

Hardware for attaching the Dual-Range Force Sensor to a Vernier dynamics cart is included with the cart.

The Utility Handle provides a convenient handle for the Force Sensor and can also be used to mount it to various clamps.

The Bumper is used mostly for collision experiments or any time you want to measure pushing forces.

With hook for connecting to a string and measuring pulling force



With bumper for collision experiments or measuring pushing force

Using the Dual-Range Force Sensor with a Computer

This sensor can be used with a computer and any of the following lab interfaces: LabPro, Go! Link, Universal Lab Interface, or Serial Box Interface.

1. Connect the Dual-Range Force Sensor, interface, and computer.
2. Start Logger *Pro*® or Logger Lite™ software.
3. The program will automatically identify the Dual-Range Force Sensor, and you are ready to collect data.[1]

Using the Dual-Range Force Sensor with a TI Graphing Calculator

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

1. Using LabPro or CBL 2 and the DataMate program:
   a. Connect the TI graphing calculator, interface, and Dual-Range Force Sensor.
   b. Start DataMate. The Dual-Range Force Sensor will be identified automatically.[2]
   c. You are now ready to collect data.
2. Using the original CBL and the PHYSICS program:
   a. Connect the TI graphing calculator, interface, and Dual-Range Force Sensor.
   b. Start PHYSICS. **Note:** If the date on the opening screen is older than September 2002, download a newer version from www.vernier.com/calc.
   c. Choose SETUP PROBES, enter the number of probes, then choose FORCE, and choose the option that best fits your application.

[1] If your system does not support auto-ID, open an experiment file in Logger *Pro*, and you are ready to collect data.

[2] If your system does not support auto-ID, choose SETUP and set up an experiment.

Using the Dual-Range Force Sensor with a Palm Powered Device

1. Connect the Palm OS handheld, LabPro, and the Dual-Range Force Sensor.
2. Start Data Pro®.
3. Tap New, or choose New from the Data Pro menu. Tap New again. The Dual-Range Force Sensor will be identified automatically.[3]
4. You are now ready to collect data.

How the Dual-Range Force Sensor Works

The Dual-Range Force Sensor uses strain gage technology to measure force, based on the bending of a beam. Strain gages attached to both sides of the beam change resistance as the beam bends. The strain gages are used in a bridge circuit such that a small change in resistance will result in a change in voltage. This voltage change is proportional to the change in force. The switch allows you to select either of two ranges: ±10 N or ± 50 N.

The Two Switch Settings–Resolution and Range

As with any instrument, there is a trade off between accuracy and the range of forces that can be measured. In general, you should use the ±10 N range if you can. If the forces exceed ten newtons, you need to use the ± 50 N range. In normal use, the accuracy with the two different switch settings will be

±10 N	0.01N	Stored Calibration:	slope = –4.9 N/V intercept = 12.25 N
± 50 N	0.05 N	Stored Calibration	slope = –24.5 N/V intercept = 61.25 N

Do I Need to Calibrate the Dual-Range Force Sensor?

You should not have to perform a new calibration when using the Dual-Range Force Sensor in the classroom. We set the sensor to match our stored calibration before shipping. You can simply use the appropriate calibration file that is stored in your data-collection program from Vernier. In many cases, you can load an experiment file that is designed for use with the Dual-Range Force Sensor and you are ready to collect data. You need to select the correct file (10N or 50 N) to match your selected range setting on the sensor.

The sensor is sensitive enough to measure the weight of the sensor hook. To minimize this effect, simply place the sensor in the orientation in which it will be used (horizontal or vertical) and choose zero in the software. This will define the current situation as 0 N of force.

If you want to improve the calibration, it is easy to recalibrate. Simply follow the same procedure used in calibrating most Vernier sensors–a two point calibration. One of the points is usually with no force applied. Select the calibration option in the program you are using and remove all force from the sensor. Enter **0** as the first known force. Now apply a known force to the senor. The easiest way to do this is to hang a labeled mass from the hook on the end of the sensor. Enter the weight of the mass (note: 1 kg applies a force of 9.8 newtons). For calibration using the ±10 N

[3] If your sensor does not auto-ID, tap Setup and set up an experiment.

range, we recommend using 300 g of mass (2.94 N) for the second calibration point. For calibration using the ± 50 N range, we recommend using a 1 kg mass (9.8 N) for this second calibration point. Be careful not to exceed the selected range setting during calibration. If you plan to use the Dual-Range Force Sensor in a different orientation (horizontal vs. vertical) than calibrated, zero the Force Sensor to account for this. This additional step makes the sensor ready exactly zero when no force is applied.

Mounting on a Ring Stand

The Dual-Range Force Sensor is designed to be mounted on a ring stand in several different ways. Use a 13 mm rod extended through the hole in the Dual-Range Force Sensor. Tighten the thumb screw.

Mounted for vertical data collection

Mounted for horizontal data collection

Mounting on a Dynamics Cart

The Dual-Range Force Sensor was designed for easy mounting on a Vernier or PASCO dynamics cart.

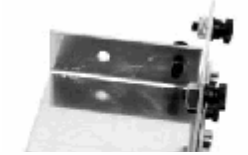
Vernier Dynamics Cart

First mount the T-nut to the cart and tighten. Then mount the Dual-Range Force Sensor to the T-nut using the thumb screw.

Accessory Adapters (sold separately)

Dynamics Track Adapter (DTA-DFS)

This adapter extends the versatility of your force sensor by increasing mounting possibilities. It is designed to attach to either a Vernier Dynamics Track or a PASCO Dynamics Track. Multiple mounting options allow for sensor-to-sensor or sensor-to-cart collision measurements. Includes two magnetic bumper attachments.



Air Track Adapter (ATA-DFS)

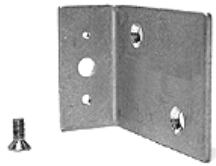
Allows the Dual-Range Force Sensor to be mounted on the end of an air track for collision studies. Compatible with most air tracks distributed or made by PASCO Scientific, Central Scientific, or Daedalon Corporation. Includes two magnetic bumpers.

Force Table Adapter (FTA-DFS)

Use your Dual-Range Force Sensor with your force table for resolution of vector experiments. Includes mounting clamp for tables up to ¾ inch thick.

PASCO Cart Adapter (PCA-DFS)

This adapter is designed to attach the Dual-Range Force Sensor to a PASCO dynamics cart.



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 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. If you purchased a DFS-DIN to connect the sensor to a ULI or Serial Box Interface, the auto-ID feature is not supported.

Some Suggested Experiments

Collision Experiments

Screw a vertical rod through the hole in the Dual-Range Force Sensor. Collide the dynamics cart into the stationary collision bumper on the Dual-Range Force Sensor. This experiment requires a lab interface that can sample fast enough to get many readings during the collision of the cart/glider and the Dual-Range Force Sensor.

If you want to compare the integral of the force *vs.* time graph with the change in momentum of the cart/glider there are two ways to do so:

1. Use a Motion Detector to make graphs of the motion and the force at the same time.
2. Use a photogate and timing software to measure the speed of the cart before and after the collision.

Studying Friction

Use the Dual-Range Force Sensor as a replacement for a spring scale. Run a string from the Dual-Range Force Sensor to a block of wood. Measure the force as you pull the block along a horizontal surface. You can investigate how frictional force is affected by surface area and type of surface. You can also compare static and dynamic friction.

Simple Harmonic Motion

Mount the Dual-Range Force Sensor and hang a mass from a spring connected to the beam as shown here. Start the mass oscillating and plot the force *vs.* time. A sinusoidal graph will be produced. Using most programs, you can plot graphs of the motion of the mass and monitor force at the same time. This allows you to compare the phase of the force and motion graphs.

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.

Measure. Analyze. Learn.

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