Motion Detector
(Order Code MD-BTD or MD-CBL)

The Motion Detector can be used with a computer or graphing calculator and the following data-collection interfaces to collect distance, velocity and acceleration data:

- Vernier LabPro®
- Texas Instruments CBL 2™
- Texas Instruments CBL™

Students can study a variety of motions with the Motion Detector, including:

- Walking toward and away from the Motion Detector.
- Carts rolling on a table or track.
- Objects in simple harmonic motion, such as a mass hanging on a spring.
- Pendulum motions.
- Air track gliders.
- Objects dropped or tossed upward.
- A bouncing object.

Here are some sample calculator data collected using a Motion Detector:

- Ball Bouncing
- Weight on Spring
- Student Walking

This is motion data collected with Logger Pro® on a computer.

The Motion Detector is packaged with a universal-mounting clamp. Attach the clamp using the thumbscrew on the clamp and the mounting threads on the back of the unit. These threads are also compatible with typical tripod-mounting hardware. Connect the Motion Detector to the appropriate port on the data-collection interface. While it is operating, you will hear a slight clicking sound from the Motion Detector and the green LED will be lit. The minimum range of the Motion Detector is about 0.5 meters (1.5 feet). The maximum range is 6 m.

Using the Motion Detector with a Computer

This sensor can be used with a Macintosh® or PC computer and the Vernier LabPro. Here is the general procedure for using the Motion Detector with a computer:

1. Connect the Motion Detector to the DIG/SONIC port on the interface.
2. Start the Logger Pro software on the computer.
3. You may alternately open an experiment file for the Motion Detector, and you are ready to collect data.

Using the Motion Detector with TI Graphing Calculators

This sensor can be used with a TI graphing calculator and any of the following lab interfaces: LabPro, CBL 2™, or CBL™. Here is the general procedure to follow when using the Motion Detector with a graphing calculator:

1. Load a data-collection program onto your calculator:
   - LabPro or CBL 2: Use the DataMate program. This program can be transferred directly from the 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 PHYSICS program. This program is available free on our web site at www.vernier.com. Load it into a calculator using a TI-GRAPH LINK™ cable and TI-Connect™ or TI-GRAPH LINK software.
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. Be sure to push both plugs firmly.
3. Connect the Motion Detector to any of the sonic ports on the interface.
4. Start the data-collection program, and you are ready to collect data.

Using the Motion Detector with Palm OS® Handhelds

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

1. Connect the Palm OS handheld, LabPro, and the Motion Detector.
2. Start Data Pro.
3. Tap New, or choose New from the Data Pro menu. Tap New again. The Motion Detector will be identified automatically.
4. You are now 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.
Using the Motion Detector with Other Sensors

The Motion Detector can be used with one or more other sensors connected to the interface. Here are some examples of how the Motion Detector can be used for experiments with another sensor:
- With a force sensor to study the relationship between force and motion
- With a force sensor to study collisions and impulse
- With a force sensor to study simple harmonic motion
- With a light sensor to study the inverse square law
- With a magnetic field sensor to study how magnetic field varies with position
- With a second Motion Detector (LabPro only)

How the Motion Detector Works

This Motion Detector emits short bursts of ultrasonic sound waves from the gold foil of the transducer. These waves fill a cone-shaped area about 15 to 20° off the axis of the centerline of the beam. The Motion Detector then “listens” for the echo of these ultrasonic waves returning to it. The equipment measures how long it takes for the ultrasonic waves to make the trip from the Motion Detector to an object and back. Using this time and the speed of sound in air, the distance to the nearest object is determined.

Note that the Motion Detector will report the distance to the closest object that produces a sufficiently strong echo. The Motion Detector can pick up objects such as chairs and tables in the cone of ultrasound.

The sensitivity of the echo detection circuitry automatically increases, in steps, every few milliseconds as the ultrasound travels outward. This is to allow for echoes being weaker from distant objects.

Tips on Getting Good Results with the Motion Detector

The most frequently reported problem with a Motion Detector is that it does not work beyond a certain distance. Here are some things to check if you have this problem:
- Check for a stationary object (chair, table, etc.) in the cone of the ultrasound. This object may be detected when you are trying to study an object further away. If you have trouble with a stationary object causing unwanted echoes, try placing a cloth over it. This minimizes the sound reflection.
- Also note that the cone of ultrasound extends downward from the center line. This can cause problems if you are using the Motion Detector on a hard, horizontal surface. In these cases, try pivoting the head of the Motion Detector to aim it slightly upward.

Other Troubleshooting Tips

- Sometimes other sound sources can cause problems. If there is another source of ultrasonic waves in the same frequency range, this will cause erroneous readings. Examples include motors and fans, air track blowers, the sound made by the air exiting the holes on an air track, and even students making loud noises.
- If the room in which the Motion Detector is being used has a lot of hard, sound-reflecting surfaces, you can get some weird effects caused by the ultrasound bouncing around the room. Standing waves can be set up between the Motion Detector and a sound reflector. Try placing a cloth horizontally just in front of and below the Motion Detector. This sometimes helps eliminate ultrasound that is “skipping” into the Motion Detector.
- Try changing the data collection rate. Sometimes Motion Detectors work better at one data rate than another.
- If you are studying people moving, have them hold a large, flat object (e.g., a large book or a pizza box) as a reflector. If you have an irregular reflecting surface, sometimes the waves will be reflected back to the transducer, and sometimes not. The results will seem erratic.

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.