Motion Encoder Cart and Receiver

(Order Code DTS-MEC)

The Motion Encoder Cart and Receiver is an add-on product to be used with an existing Vernier Dynamics Cart and Track System or Vernier Dynamics System. It cannot be used on its own.

The encoder system allows the precise study of dynamics cart motion without the use of ultrasonic motion detectors. The system consists of several parts:

- A track with an encoder strip along the length of the track
- A dynamics cart with an optical encoder and infrared (IR) transmitter
- A receiver, attached to the end of a track

The encoder strip consists of alternating black and white bars with a 4 mm period, allowing the optical sensor to detect the passage of the bars as the cart moves. With two sensors appropriately placed, a change in position with 1 mm resolution can be determined, as well as the direction of travel. A narrow infrared beam transmits motion data to a receiver.

No alignments or adjustments are necessary, as the receiver attaches firmly to the track, and the cart rides in slots on the track. The IR beam is not disturbed by reflections from nearby objects.

The system is designed for use in physics and physical science courses for motion and energy experiments. An optional Optics Expansion Kit (order code OEK) converts the track to an optics bench.

Some typical experiments done with the system include

- Motion under zero acceleration
- Motion under constant acceleration with the ramp inclined
- Inelastic collisions using the included hook-and-pile tabs
- Elastic collisions using the included magnetic bumpers

What's Included

- Motion Encoder Cart with two magnetic and two plain collision tabs
- Motion Encoder Receiver
- Motion Encoder Strip for application to 1.2 m or 2.2 m track
- Mounting hardware for Dual-Range Force Sensor and accelerometers

One-Time Assembly Instructions

Motion Encoder Strip Application

The track must have an encoder strip applied for the cart to determine its motion. The strip is applied immediately next to the center slot, between the slot and the numeric scale on the top surface of the track.

1. Clean the track surface with a damp cloth and allow it to dry.
2. Pull about 10 cm of backing off of the strip.
3. Align the strip next to the center slot, within 1 cm of the track end. The strip need not extend all the way to the end of the track, but it can.
4. Carefully press down the strip, working your way along the track and removing the backing as you go. Keep the strip edge right next to, but not hanging over, the center slot. Do not stretch the strip.
5. Remove the rest of the backing, and press the strip down on the full length of the track.
6. Trim any excess strip from the track end.

If the track is to be used with a second encoder system, apply a second strip to the other side of the center slot.

Compatible Software and Interfaces

See www.vernier.com/dts-mec for a list of interfaces and software compatible with the Motion Encoder Cart and Receiver.

WARNING: The Motion Encoder Receiver is not compatible with the Texas Instruments TI-Nspire Lab Cradle. Connecting the Receiver to the Lab Cradle will render the Cradle inoperative, requiring repair by Texas Instruments.

Using the Motion Encoder System

1. Attach the receiver to the end of the track, matching the encoder strip on the track to the markings on the receiver.
2. Place the track on a level surface.
3. Insert two AAA batteries (not included) into the encoder cart.
4. Connect the receiver to an interface such as a LabQuest® 2. If using a computer, connect the interface to your computer and launch Logger *Pro*®.
5. Turn on the cart by pressing the power button. It will glow blue when the cart is on.
6. Place the cart on the track, wheels in grooves, with the blue light facing the receiver.
7. Begin data collection, and let the cart roll.

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.

Specifications

Measurement range	
1 m range	1.2 m track
2 m range	2.2 m track
Accuracy and resolution	1 mm
Optimum data-collection rate	15–30 Hz

Calibration

No calibration of the Motion Encoder Cart and Receiver is necessary. The printed bars on the track determine the scale, and the cart encoder counts the passage of the bars. Available units are meters and feet, selectable in the software.

In contrast, it is possible and desirable to zero the encoder. Unlike an ultrasonic motion detector, there is no way for the system to have an unchanging reference position; it can only count bars from the point at which the encoder cart is placed on the track. As a result you may want to move the cart to the receiver end of the track and zero the reading in software.

The positive direction can be reversed, so that readings increase as the encoder cart moves toward the receiver. A reversed coordinate system is helpful when using two Motion Encoder Systems to monitor the motion of two encoder carts, so that the positive direction is the same in both cases.

Because the encoder strip must be continuous, the optical motion encoder cannot be used with a Track-to-Track Coupler (order code T2T-VDS).

Power

The Motion Encoder Cart requires two AAA batteries. Either NiMH rechargeable batteries or alkaline disposable batteries can be used. The receiver is powered by the interface.

Turn on the cart by pressing the clear power button on the cart endcap. It will glow blue when power is on. Press again to turn off. The cart will turn itself off after 20 minutes of inactivity. Any motion on the track will cause the timer to reset.

Battery life depends on use and the range setting. Low battery levels may cause erratic detection of the cart motion, including incorrect velocity signs. Replace the batteries if this is seen.

Range Setting of the Motion Encoder Cart

The IR transmitter on the cart has two power levels available. The default 1 m setting conserves battery power. If the cart is used on a 2.2 m track, set the cart to the higher 2 m power level. If this setting is not used, the receiver will not reliably sense the position of the cart at the far end of the track. The switch is located inside the battery compartment.

Use of Two Vernier Motion Encoder Systems on the Same Track

Some experiments require measuring the motion of two carts. This can be done by adding a second Motion Encoder Cart and Receiver (order code DTS-MEC). A Motion Encoder Receiver is placed at either end of the track, and two Motion Encoder Carts are used on the track, each with its transmitter facing the unobstructed receiver. A second encoder strip must be applied to the track, one on either side of the center slot.

Consider reversing the direction of one receiver so that the same direction is positive for each system. Put the carts together, and zero both systems. This will put the carts on the same coordinate system; if they move together in contact, their position readings will be the same.

Use of Multiple Vernier Motion Encoder Systems in the Same Room

Because of the narrow IR beam used for signaling between the cart and receiver, interference should be rare. However, if one apparatus is interfering with another, the problem can be resolved by repositioning one of the tracks.

All Motion Encoder Carts are interchangeable; that is, there is no matching of cart to receiver.

Data-Collection Notes for the Motion Encoder System

- The optical motion encoder can only make relative position measurements, so that the zero point is initially determined by the location on the track that the cart is first placed when the power is on. If you want zero to be near the receiver, initially place the cart next to the receiver. This behavior is very different from the ultrasonic Motion Detector, which by default uses a fixed origin near the detector.
- The motion encoder is nearly immune to interference, but it cannot work if the IR beam between the cart and receiver is blocked. Keep your hand away from this region.
- Since the zero position (origin) of the encoder depends on where the cart is placed initially, it is often useful to zero the encoder in the software. Place the cart in the position you want to declare as zero. On LabQuest, tap the Meter screen to access the zero command. In Logger Pro, use the toolbar button.
- It can also be useful to reverse the direction of the coordinate system, so that values increase as the cart moves toward the receiver. Do this from the Meter screen on LabQuest, or by using the sensor popup menu in the Set Up Sensors dialog box for your interface in Logger Pro.
- High data-collection rates are not useful for the motion encoder. Rates above 30 Hz will produce noisy velocity and acceleration graphs because of few counts during each time period.
- Just like the ultrasonic Motion Detector, it can be useful to adjust the number of points used to calculate derivatives for velocity and acceleration graphs. Higher values create quieter graphs, while lower values result in more temporal detail. Adjust this value in LabQuest preferences or in Settings For… from the File menu in Logger Pro.

Suggested Experiments with the Vernier Motion Encoder System

The Vernier Motion Encoder System can be used wherever a Motion Detector could have been used with a cart and track. The encoder depends on the presence of the track, so *only* cart and track experiments can be performed.

Measure Cart Acceleration

The basic motion of a cart on a ramp can be studied. For example, perform Experiment 3 from *Physics with Vernier*, "Cart on a Ramp." Or, repeat Galileo's experiment of determining *g* using an object and a ramp. This is Experiment 4 "Determining *g* on an Incline" from *Physics with Vernier*.

Newton's Second Law

Use a force sensor on the encoder cart to record both applied force and acceleration. The two will be proportional.

Or, set up a half-Atwood machine with a hanging mass and a pulley at the track end opposite the receiver. Measure the acceleration of the encoder cart as a function of the hanging mass.

Measure Fan Cart Acceleration

Add an Encoder Fan Cart (order code CART-FEC) to observe the motion of a cart under constant thrust.

Measure Cart Acceleration with Friction

Add a Friction Pad (order code DTS-PAD) to the encoder cart and observe the motion of the cart with varying frictional forces.

Momentum-Impulse

Add a force sensor and a Bumper-Launcher Kit (order code BLK) to observe the relationship between momentum and impulse. Find the impulse by integrating under a force *vs*. time graph.

Conservation of Energy

Use two Vernier Motion Encoder Systems to observe a change in energy due to a collision between two carts.

Conservation of Momentum

Use two Vernier Motion Encoder Systems to observe a change in momentum due to a collision between two carts. Try different kinds of collision: elastic, inelastic, totally inelastic.

Products Related to the Vernier Dynamics Cart and Track System with Motion Encoder

Vernier Dynamics System (order code DTS)

Vernier Dynamics Cart and Track System is a low-friction anodized 1.2 m track and optics bench combination designed for kinematics, dynamics, and optics experiments. It includes two carts.

Vernier Dynamics Cart and Track System with Long Track (order code DTS-LONG)

The long version of the Vernier Dynamics Cart and Track System includes a 2.2 m track instead of the 1.2 standard track.

Track (order code TRACK)

The Combination 1.2 m Track/Optics Bench comes with the Encoder System Strip installed.

Replacement Parts

Motion Encoder Receiver (order code MEC-BTD)

The receiver attaches to the end of the track and connects to an interface, such as a LabQuest 2.

Motion Encoder Cart (order code DTS-CART-MEC)

This is the complete Motion Encoder Cart, with no assembly required.

Motion Encoder Long Track Strip (order code METS-LONG)

The strip can be attached to an existing track without an encoder strip, or it can be attached as a second strip for use with two encoder systems.

Motion Encoder Transmitter Parts (order code MECT)

The transmitter assembly is used to upgrade an existing cart to a Motion Encoder Cart.

Suggested Accessories

Bumper and Launcher Kit (order code BLK)

The Bumper and Launcher Kit includes accessories to integrate the Dual-Range Force Sensor with the Vernier Dynamics System or Vernier Motion Encoder System, allowing for many interesting experiments in momentum-impulse study.

Dual-Range Force Sensor (order code DFS-BTA)

The Dual-Range Force Sensor measures pushes and pulls up to 50 N.

Wireless Dynamics Sensor System (order code WDSS)

The WDSS is a wireless force sensor and accelerometer.

Ultra Pulley (order code SPA)

The pulley can be attached to the end of a track using the Pulley Bracket to make a half-Atwood machine.

Pulley Bracket (order code B-SPA)

The pulley bracket allows easy attachment of an Ultra Pulley to the end of a Vernier track.

DTS Cart Friction Pad (order code DTS-PAD)

The DTS Cart Friction Pad attaches to the cart end using the collision tab slots. It adds an adjustable pad that rubs on the track, adding a controlled amount of friction to the cart motion. Use it to study frictional forces.

Encoder Fan Cart (order code CART-FEC)

The three-speed Encoder Fan Cart is a large fan on a light-weight cart. It offers students the ability to perform kinematics and dynamics experiments with constant acceleration, variable mass, variable thrust, and variable thrust angle. The cart includes a Motion Encoder Transmitter.

Optics Expansion Kit (order code OEK)
The Vernier-Optics Expansion Kit extends the Vernier Dynamics System or Vernier Motion Encoder System for use in optics experiments.

Color Mixer (order code CM-OEK)
The Vernier Color Mixer Kit consists of a three-color LED illuminator with power supply, a lens, and a double-sided screen. Experiments in additive and subtractive color mixing can be easily and conveniently carried out using this kit. The intensity of the red, blue and green LEDs can be smoothly controlled from the light source.

Diffraction Apparatus (order code DAK)
Use the Diffraction Apparatus to map light intensity versus position for many-slit geometries.

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 falls, abuse, or improper use.

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