Vernier Dynamics Cart and Track System with Motion Encoder

(Order Codes DTS-EC and DTS-EC-LONG)

The Dynamics Cart and Track System with Motion Encoder is outfitted for the precise study of dynamics cart motion without the need for ultrasonic motion detectors. Instead of a traditional motion detector, the system makes use of a novel Motion Encoder System.

The system is designed for use in physics and physical science courses for motion and energy experiments.

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

An optional Optics Expansion Kit (order code OEK) converts the track to an optics bench.

Note: Vernier products are for educational use only.

What's Included

- Combination 1.2 m Dynamics Track/Optics Bench*
- 2 Adjustable Two-Foot Levelers
- DTS End Stop
- Rod Clamp
- Motion Encoder Cart with 2 magnetic and 2 plain collision tabs (requires 2 AAA batteries, not included)
- Motion Encoder Cart Receiver‡ (requires interface, not included)
- Plunger Cart with 2 magnetic and 4 plain collision tabs
- 4 pairs self-adhesive hook-and-pile dots
- 2 sets fasteners for force sensor and accelerometer (each set includes 1 large and 2 small thumbscrew fasteners)
- 4 hexagonal cart masses, 125 g each
- Motion Detector Bracket
- Motion Detector Reflector Flag
- 2 Photogate Brackets
- Ultra Pulley Attachment
- Pulley Bracket
- 2 Anti-Roll Pegs

*The Dynamics Cart and Track System with Motion Encoder and Long Track includes the parts listed above but substitutes a 2.2 m track for the 1.2 m track.
‡Compatible interfaces include LabQuest 3 and LabQuest Mini.

Compatible Software

See **www.vernier.com/manuals/dts-ec** for a list of software compatible with the Vernier Dynamics Cart and Track System with Motion Encoder.

WARNING: The Motion Encoder Cart 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.

Getting Started

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. While the battery compartment is open, move the switch to the appropriate distance for the track you are using. Use the 1 m setting for the 1.2 m track and the 2 m setting for the 2.2 m track.
5. Connect the receiver to the interface (LabQuest 3, LabQuest Mini, etc.). Launch the data-collection software (Vernier Graphical Analysis® or LabQuest® App).
6. Turn on the cart by pressing the power button. It will glow blue when the cart is on.
7. Place the cart on the track, wheels in grooves, with the blue light facing the receiver.
8. Begin data collection, and let the cart roll.

Using other Vernier data-collection apps?
Visit **www.vernier.com/get-started/labquest-sensors** or use the QR code.

Need additional information?
Visit the following link: **www.vernier.com/start/dts-ec**

Quick Start

Calibrating the Sensor

Calibration of the Motion Encoder System is not necessary nor is it possible. 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 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 the software. There is no minimum distance between the encoder cart and the receiver.

The positive direction can be reversed so that readings increase as the 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. (**Note**: additional hardware not included with the system is required to use two Motion Encoder Carts on the same track.)

Specifications—Motion Encoder Cart

Measurement Range	
1 m range	1.2 m track
2 m range	2.2 m track
Accuracy and Resolution	1 mm
Temperature range	5 to 80°C (readings not compensated)
Optimum data-collection rate	15–30 Hz

How the Sensor Works

The encoder consists of several parts:

- A 1.2 m or 2.2 m track with an encoder strip along the length of the track
- A dynamics cart with an optical encoder and infrared (IR) transmitter
- An IR receiver that attaches to the end of a track (requires an interface, not included)

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 on the underside of the cart, a change in position with 1 mm resolution can be determined, as well as the direction of travel of the cart. A narrow infrared beam transmits motion data to the 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 affected by reflections from nearby objects.

Because the encoder strip must be continuous, the Motion Encoder System cannot be used with a Track-to-Track Coupler.

Power

The Motion Encoder Cart requires two AAA batteries. Either NiMH rechargeable batteries or alkaline disposable batteries can be used. 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. However, any motion on the track will cause the timer to reset. The receiver is powered by the data-collection interface.

Battery life depends on use and the range setting. Low battery level may cause erratic detection of the cart motion, including incorrect velocity signs. Replace the batteries if this is seen. **Note:** a low battery can power the LED but have insufficient power to report position changes correctly.

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 the high-power setting is not used on a 2.2 m track, 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 purchasing the Motion Encoder Cart and Receiver (order code DTS-MEC) to add a second encoder cart, receiver, and strip to your Vernier Motion Encoder System. A Motion Encoder Cart 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, resulting in 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 apparently 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 required matching of cart to receiver.

Data-Collection Notes for the Motion Encoder System

- 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 area.
- The optical motion encoder can only make relative position measurements, so the zero point is initially determined by the location on the track that the cart is first placed when the power is on. This behavior is very different from the ultrasonic motion detector, which by default uses a fixed origin near the detector.
- 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 that you want to declare as zero. If you want zero to be near the receiver, initially place the cart next to the receiver. There is no minimum distance between the encoder cart and the receiver. To zero the sensor, click or tap the position meter and select Zero.
- It can also be useful to reverse the direction of the coordinate system, so that values increase as the cart moves toward the receiver. To reverse the reading of the sensor cart position, click or tap the position meter and select Reverse.
- High data-collection rates are not useful for the motion encoder. Rates above 30 Hz will produce noisy velocity and acceleration graphs because the cart may appear to be at one position for several time measurements.
- Just like the 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. In LabQuest App, adjust this value by selecting Settings from the File menu. In Graphical Analysis, adjust this value by selecting Session Preferences from the Other Options menu.

Other Dynamics System Parts

Track and Adjustable Leveling Feet

The Adjustable Leveling Feet slide into the end of the track, with the nut in the center slot of the track underside. Use the feet to level the track and adjust the height as desired.

DTS End Stop

The DTS End Stop slides into the top slot from the end of the track. Adjust the position as needed. You can configure the end stop in several ways.

- Swap in magnetic collision tabs for contactless collisions between a cart (also with magnetic tabs) and the end stop.
- Remove the center tab for half-Atwood's setup using the end stop to prevent the cart from striking the pulley bracket during experimentation.
- Connect a spring (not included) to hooks attached to both a cart and the end stop's center tab to investigate simple harmonic motion on an inclined track.

For details on these setups, see **www.vernier.com/til/26889**.

Rod Clamp

The Rod Clamp is used to support the track with a user-supplied ring stand. A 12 mm rod is the maximum size accommodated. Insert the Rod Clamp nut into the side of the track. Adjust the height as desired. See **www.vernier.com/til/15793.**

Plunger Cart

The plunger cart includes a spring-loaded plunger for collisions. To use the plunger, simultaneously press the horizontal button above the plunger and press the plunger in until it locks. To release, press on the pin from the top of the cart. The plunger force can be adjusted by rotating the plunger while it is extended. An uncalibrated scale is visible on the underside of the cart. Use this scale to return to a previous setting.

The Plunger Cart is capable of superelastic collisions. To enable this mode, use a small flathead screwdriver to unlock the dark gray plastic plug below the main plunger. Depress the plug using the screwdriver and rotate one-half turn counterclockwise to unlock. The plunger will extend about 2 mm.

Lock the plunger as before to prepare for a superelastic collision. In a collision, the plug will strike first and trigger the release of the plunger.

To disable superelastic collision mode, use the screwdriver to depress and rotate the plug one-half turn clockwise. This will lock the plug in the flush position.

The plunger cart is a bit more than 260 g. Adding accessories such as sensors or magnetic collision tabs will change the mass.

Collision Tabs

Vernier dynamics carts come with interchangeable collision tabs typically used when studying collisions. Each cart comes with two magnetic tabs and two pairs of self-adhesive hook-and-pile dots, which you can adhere to the blank tabs that come on the cart.

The magnetic tabs are useful in studying elastic collisions. Note that one side of the tab is marked N, indicating the polarity of the magnet. Position the magnetic tabs so that the same polarity faces outward on both the left and right sides of the cart and on both carts. This way, the carts will repel giving you a collision in which the carts never actually touch. The contactless collision will be very nearly elastic, much more so than a collision using a spring or any kind of contact. **Note:** since the magnetic tabs can interfere with experiments that utilize a force sensor, only use the tabs when you need them.

Like the magnetic tabs, the blank tabs have two sides, one marked N and the other plain. Adhere one of the hook or pile dots to the plain side of a blank tab centered on the round part of the tab. These modified tabs are useful in studying inelastic collisions. Position a "hook" tab on the left side of a cart and a "pile" tab on the right. If this is done consistently, any cart will stick to any other, creating a totally inelastic collision when the carts collide. **Note:** the collision tabs can be inserted with either side out, exposing or concealing the hook-and-pile material as needed.

The DTS End Stop also includes both magnetic and blank collision tabs along with hook-and-pile dots that can be set up the same way as those on the carts.

Fasteners for Force Sensor and Accelerometer

The supplied fasteners are used to attach sensors to the cart, typically a force sensor or accelerometer.

Hexagonal Cart Mass

The four hexagonal 125 g masses are used to change the mass of the cart for dynamics experiments. The encoder cart mass is nominally 320 g, but additions such as magnetic collision tabs and sensors increase the total mass. As a result, it is best to weigh the cart as used when the mass is important.

The four masses can be used one at a time or in combination on either cart. The mass trays on the sides allow the addition of masses without removing sensors. It is not necessary to keep the carts balanced with the same mass on each side.

Motion Detector Bracket

Any Vernier motion detector can be attached to the supplied Motion Detector Bracket. The Motion Detector Bracket has a pin to locate motion detectors having a hinged head on the bracket. There is a mounting screw at the bracket end furthest from the pin that is used to secure the bracket in the track center groove. A second mounting screw passes through the oval slot near the pin and screws into the attachment threads on the motion detector.

See **www.vernier.com/til/2426** for details on using the Motion Detector Bracket. When the motion detector is not attached to the bracket, its mounting screw can be stored in the threaded hole near the pin.

Most Vernier motion detectors should be placed so that the sensor is at least 15–20 cm from the end of the track.* The carts can then be detected properly all the way to the end of the track. The cart mode is appropriate for the dynamics system.

*Older motion detectors with a hinged head that lack a range switch must be at least 45–50 cm from a cart in order to read properly. For these motion detectors, the full length of the track may not be used.

Motion Detector Reflector Flag

Some users prefer to enhance the reflectivity of the cart when using an ultrasonic motion detector. Use of the Motion Detector Reflector Flag makes the orientation of the detector less critical, but its use is optional.

The Motion Detector Reflector Flag attaches to the end of the Plunger cart. Insert magnetic collision tabs and snap the flag against the end of the cart, with the metal inserts against the magnet tabs. Place the cart on the track with the flag toward the motion detector.

Photogate Bracket

Photogate Brackets attach to the side of the track. It can be helpful to first remove one of the adjustable feet before attaching a photogate bracket. With the nut loosely on the T-handled bolt, slide the nut into the side channel of the track, then replace the foot. Attach the photogate using the supplied wing bolt in the long slot. Adjust the gate height so the beam intercepts the desired portion of the target, such as a Cart Picket Fence. For a video showing this, see **www.vernier.com/til/17104**.

Pulley Bracket and Ultra Pulley Attachment

The Pulley Bracket and Ultra Pulley can be attached to the end of the track to create a half-Atwood machine using user-supplied masses and string. The pulley bracket and pulley can be assembled with or without a Photogate.

Insert the oblong nut into the bottom slot of the track and tighten. To attach the pulley without a Photogate, use the short bolt to attach the pulley. Adjust the height of the pulley as needed to keep the string level. See **www.vernier.com/til/15443** for a video showing installation.

To include a Photogate, use the long bolt to attach the pulley and photogate to the bracket. See **www.vernier.com/til/2076** for a video showing installation.

Use of Sensors and Additional Accessories

The following examples show various sensors attached to a Vernier dynamics cart. Sensors, other than the motion encoder cart itself, are not included with the Vernier Dynamics Cart and Track System with Motion Encoder.

Attach a force sensor

1. Place the sensor over the two silver pins as shown on the cart top panel. Older force sensors may require moving the pins to the wide spacing option.
2. Use the large fastener bolt to secure the sensor to the cart as shown.
3. Configure the force sensor as needed with a hook or bumper.

See **www.vernier.com/til/3974** for installation details.

Attach the Accelerometer (ACC-BTA)

1. To attach an accelerometer, place the sensor over the mounting holes as shown on the cart top panel.
2. Use two small fastener bolts to secure the sensor to the cart as shown.

Attach a force sensor and accelerometer in combination

The Dual-Range Force Sensor and the 25-*g* Accelerometer can be used simultaneously using the same procedures.

When using a Go Direct Force and Acceleration Sensor (order code GDX-FOR) you need only the one sensor. To get both force and acceleration measurements, activate both the Force and the X-axis acceleration sensor channels in the data collection software.

Attach a Cart Fan

The Cart Fan (order code DTS-CFAN) can be used to provide a constant force for kinematics and dynamics experiments.

1. Use the two included half-inch 10-32 screws to connect the Mounting Plate to the accelerometer mounting holes on the cart. For additional security, use the included half-inch ¼"-20 screw to connect the Mounting Plate to the force sensor mounting hole. For detailed installation instructions and a video, see **www.vernier.com/til/22132**.
2. Insert the Cart Fan(s) into the appropriate mounting position(s) for your experiment. The Cart Fan can be mounted pointing forward or backward. The mounting bracket can be rotated off axis in 15° increments.

Attach a Cart Picket Fence

Insert the cart picket fence into one of the grooves on the top of a dynamics cart. The Picket fence can be oriented with either the single 50.0 mm bar or the thirteen 5.0 mm pickets oriented up. The Cart Picket Fence is used with photogates (not included).

Attach an Eddy Current Brake

The Eddy Current Brake (order code DTS-ECB) can be used to investigate magnetic braking systems like those used on high-speed trains. As the cart moves over the track, the magnets in the Eddy Current Brake create an electromagnetic drag on the cart that is proportional to the cart's speed. To mount the Eddy Current Brake on the cart, remove the collision tabs from one end of the cart.

Attach a Friction Pad

The Friction Pad DTS (order code DTS-PAD) can be used to investigate how the carts move under a consistent friction force. Setting the friction amount is as simple as turning a knob. To mount the friction pad on the cart, remove the collision tabs from one end of the cart.

General Tips for the Vernier Dynamics Cart and Track System

- Do not wrap the cable tightly around the Motion Encoder Cart Receiver for storage. Repeatedly doing so can damage the wires and is not covered under warranty.
- Only install the magnetic collision tabs when you know you want to use them. They will interfere if you perform an experiment with a force sensor, since the force sensor will then not read the total force acting on the cart.
- The magnetic collision tabs are designed for fairly gentle collisions. If the cart is moving too quickly, the magnetic forces may cause the magnetic tabs in the cart to pop out of position or the cart to jump off the track to the side. If this happens, use a lower initial velocity for the cart.
- Keep the track clean; if it is dirty the carts will not roll smoothly. However, do not use an alcohol-based cleaner, as this will remove the ink from the centimeter scale on the track.
- Use lower speeds and lower inclines than you might initially choose; the physics is the same and students will have more time to observe what is happening.
- Attach the track feet, sliding in at least 30 cm before inserting the Motion Detector Bracket.
- Remove one of the track feet before attaching a Photogate bracket.

Suggested Experiments

Measure Cart Acceleration

The basic motion of a cart on a ramp can be studied. This is Experiment 3, "Cart on a Ramp" from *Physics with Vernier*. 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*.

Investigate Newton's Second Law

Use a force sensor and accelerometer on a cart to record both applied force and acceleration. The two will be proportional. This is Experiment 9, "Newton's Second Law," from *Physics with Vernier*.

Alternatively, set up a half-Atwood machine with a hanging mass and a pulley at the track end. Measure the acceleration of a cart as a function of the hanging mass. This is Experiment 4, "Newton's Second Law," from *Advanced Physics with Vernier – Mechanics*.

Measure Fan Cart Acceleration

Add an Encoder Fan Cart (order code CART-FEC) or a Cart Fan (order code DTS-CFAN) to observe the motion of a cart under constant thrust. This is Experiment 2, "Accelerated Motion," from *Vernier Video Analysis: Motion and Sports*.

Measure Cart Acceleration with Friction

Add a Friction Pad (order code DTS-PAD) to a cart and observe the motion of the cart with varying frictional forces. This is Experiment 3, "Newton's First Law," from *Advanced Physics with Vernier – Mechanics.*

Investigate Impulse and Momentum

Add a force sensor and a Bumper and Launcher Kit (order code BLK) to observe the relationship between momentum and impulse. Find the impulse by integrating under a force vs. time graph. This is Experiment 10, "Impulse and Momentum," from *Advanced Physics with Vernier – Mechanics.*

Investigate Conservation of Energy

Add a Vernier motion detector or a second encoder cart to observe a change in energy due to a collision between two carts. This is Experiment 18, "Momentum, Energy, and Collisions," from *Physics with Vernier*.

Investigate Conservation of Momentum

Add a Vernier motion detector or a second encoder cart to observe a change in momentum due to a collision between two carts. Try different kinds of collisions: elastic, inelastic, totally inelastic. This is Experiment 11, "Momentum and Collisions," from *Advanced Physics with Vernier – Mechanics.*

Upgrade the Dynamics Cart and Track System

The Dynamics Cart and Track System can be upgraded by adding an additional motion encoder cart.

Motion Encoder Cart and Receiver (order code DTS-MEC)

This option includes a fully assembled Motion Encoder Cart, the Motion Encoder Cart Receiver, and track strip.

Motion Encoder Cart Upgrade Kit (order code DTS-MEU)

This kit allows you to upgrade the plunger cart to a Motion Encoder Cart. It also includes the required Motion Encoder Cart Receiver and track strip.

Go Direct Sensor Carts (order code GDX-CART-G and GDX-CART-Y)

Go Direct Sensor Carts have built-in force and acceleration sensors in addition to the motion-encoded fifth wheel for monitoring the motion of the cart.

Accessories and Replacement Parts

Optional Accessories—System Accessories

Item	Order Code
Bumper and Launcher Kit	BLK
Cart Fan	DTS-CFAN
Cart Picket Fence	PF-CART
Clay-holder Bumpers with Clay	CLAY-BMPRS
Eddy Current Brake	DTS-ECB
Encoder Fan Cart	CART-FEC
Friction Pad DTS	DTS-PAD
Hanging Mass Set 250 g	PHY-HM250
Hoop Bumpers	HOOPS-BLK
Magnetic Bumpers	MG-BMPRS
Spring Set	SPRINGS

Optional Accessories—Sensors

Item	Order Code
25-g Accelerometer (requires use of interface)	ACC-BTA
Dual-Range Force Sensor (requires use of interface)	DFS-BTA
Go Direct Force and Acceleration	GDX-FOR
Go Direct Motion	GDX-MD
Go Direct Photogate	GDX-VPG
Go! Motion	GO-MOT
Motion Detector (requires use of interface)	MD-BTD
Motion Encoder Cart Upgrade Kit (requires use of interface)	DTS-MEU
Photogate (requires use of interface)	VPG-BTD

* Supported interfaces include LabQuest 3 and LabQuest Mini.

Optional Accessories—Optics

Item	Order Code
Color Mixer Kit	CM-OEK
Diffraction Apparatus (requires use of interface)	DAK
Go Direct Light and Color	GDX-LC
Light Sensor (requires use of interface)	LS-BTA
Mirror Set for Optics Expansion Kit (requires Optics Expansion Kit)	M-OEK
Optics Expansion Kit	OEK
Polarizer/Analyzer Set (requires Optics Expansion Kit)	PAK-OEK

* Supported interfaces include LabQuest 3 and LabQuest Mini.

Replacement Parts

Adjustable Two-Foot Leveler	AL-VDS
Anti-Roll Pegs (10 Pack)	VDS-ARP10
Combination Track/Optics Bench – 1.2 m	TRACK
Combination Track/Optics Bench – 2.2 m	TRACK-LONG
DTS End Stop	DTS-END
Dynamics Cart and Track System Fasteners for Force Sensor and Accelerometer	DTS-ACC
Dynamics Cart Replacement Tabs	DTS-TABS
Mass DTS (4 Hexagonal)	DTS-MASS
Motion Detector Bracket	DTS-MDB
Motion Detector Reflector Flag	DTS-FLAG
Motion Encoder Cart	DTS-CART-MEC
Motion Encoder Cart Receiver	MEC-BTD
Motion Encoder Long Track Strip	METS-LONG
Photogate Bracket	PGB-VDS
Plunger Cart	DTS-CART-P
Pulley Bracket	B-SPA
Rod Clamp	RC-VDS
Ultra Pulley Attachment	SPA

Troubleshooting

For troubleshooting and FAQs, see **www.vernier.com/til/3153**

Repair Information

If you have watched the related product video(s), followed the troubleshooting steps, and are still having trouble with your Vernier Dynamics Cart and Track System with Motion Encoder, contact Vernier Technical Support at support@vernier.com or call 888-837-6437, or contact us using the chat on our website, www.vernier.com. 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.

Warranty

Warranty information for this product can be found on the Support tab at **www.vernier.com/dts-ec**
General warranty information can be found at **www.vernier.com/warranty**

Disposal

When disposing of the Encoder Cart, 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 Science Education
13979 SW 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. 8/20/2026

Printed on recycled paper