

# Using the Vernier Adapter and Vernier Block with Mindstorms

(Updated October 31, 2007)

## Introduction

The Vernier NXT Adapter allows many of our analog (“-BTA”) sensors to work as sensor on the LEGO Mindstorms NXT Robotics System. There are over 30 of these sensors for measuring everything from temperature to force to light level to UV level to pH. For a list of Vernier sensors that can be used with the adapter, check out [www.vernier.com/nxt](http://www.vernier.com/nxt). The adapter started shipping in October 2007. They are sold by both LEGO and Vernier Software & Technology. The device is slightly larger than the LEGO sound sensor. Essentially there is a LEGO NXT socket on one end and a Vernier BTA socket on the other end.

There are a number of movies of early prototypes of this adapter (with a different form factor) being used on projects at <http://www.vernier.com/nxt>.

## Importing the Vernier Sensor Block into Mindstorms

To use this adapter you should use the Vernier Sensor block for Mindstorms software. You will need to download it from [www.vernier.com/nxt/downloads](http://www.vernier.com/nxt/downloads). This block allows you to choose which Vernier sensor you are using from a list and handles calibration of the sensor. It also lets you use the Vernier sensors in other programming blocks such as Loop, Switch, and Wait. The Vernier Sensor block works on either Windows or Macintosh. You will need to import it into Mindstorms software on your computer.

The version of the Mindstorms software must have the Block Import and Export Wizard menu item on the Tools menu. It needs to be either version 1.1 or 1.0 with the Dynamic Block Updater added to it. Start the Mindstorms software and check the Experiment menu. If you see the menu item Block Import and Export Wizard, skip the next three paragraphs.

If you do not have the Block Import and Export Wizard menu item, you need to upgrade your Mindstorms 1.0 software. You can do this in two different ways:

**Upgrade to Mindstorms 1.1.** This is not a free upgrade. In the U.S. it will be \$19.99. It is now shipping. Go to a LEGO web site ([mindstorms.lego.com](http://mindstorms.lego.com), or [legoshop.com](http://legoshop.com) for information on how to purchase the update. There are a number of nice improvements in this version, including speed increases. If you install this new version you will then have the Block Import and Export Wizard menu item.

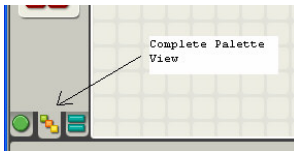
**Add the Dynamic Block Update to Mindstorms 1.0.** This is a patch applied to your Mindstorms 1.0 software. It is a free upgrade. The Dynamic Block Update can be downloaded from LEGO's web site at <http://mindstorms.lego.com/support/updates>. Download the appropriate version (there are Mac and Windows) and run the installer for the Dynamic Block Update. The Dynamic Block Update is a compressed file of about 40 Megabytes. Download the file and expand it. Find and run the setup file to do the installation.

To install the Vernier Sensor block into Mindstorms follow the procedure below:

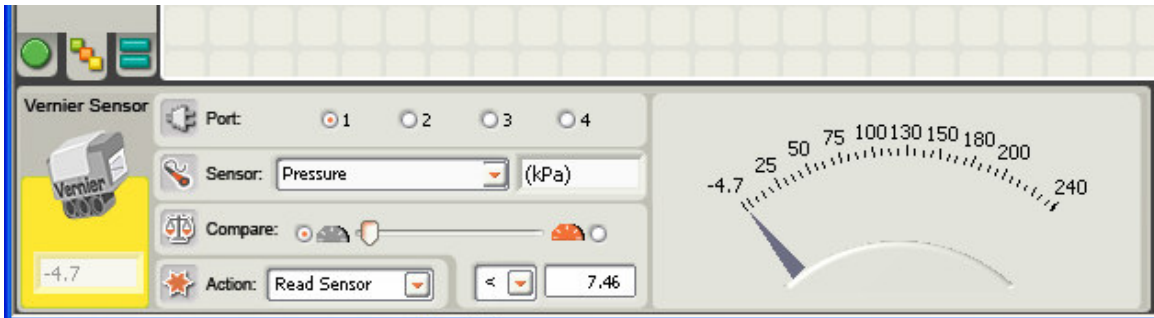
Start Mindstorms and choose Block Import and Export Wizard from the Tools menu. Choose Browse and navigate to the Vernier Sensor Block folder wherever you have downloaded it on your computer. Select Vernier Sensor and choose OK. After a few seconds, the words “Vernier Sensor” should appear as the name of the block to import. Click on the name “Vernier Sensor” and then change the Palette from Advanced to Sensor. We want to have the Vernier Sensor block to appear on the Sensor palette of Mindstorms. With the words Vernier Sensor selected and the palette set for Sensor, click on Import. In a few seconds the Vernier Sensor block should be imported into your version of Mindstorms.

## Using the Vernier Sensor Block

To use the Vernier Sensor block, choose the Complete Palette display option.



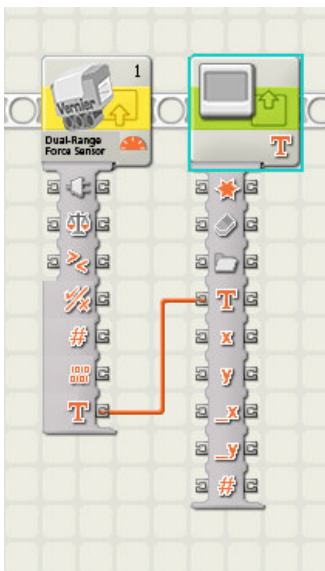
Click on the yellow Sensors palette and you should see the Vernier Sensor block, along with all the LEGO sensors. Drag the Vernier Sensor to the program area. When you click on the Vernier Block the configuration panel below is displayed. To use the Vernier Sensor block you need to specify which of the Vernier sensors you are using from the pull down list.



Each Vernier sensor that works with the NXT adapter has at least one entry. In a few cases, a sensor has more than one range, and it has an entry for each range. Examples include the Dual-Range Force Sensor and Magnetic Field Sensor. The STS and TMP temperature probes support temperature measurement using the Fahrenheit scale with a separate entry.

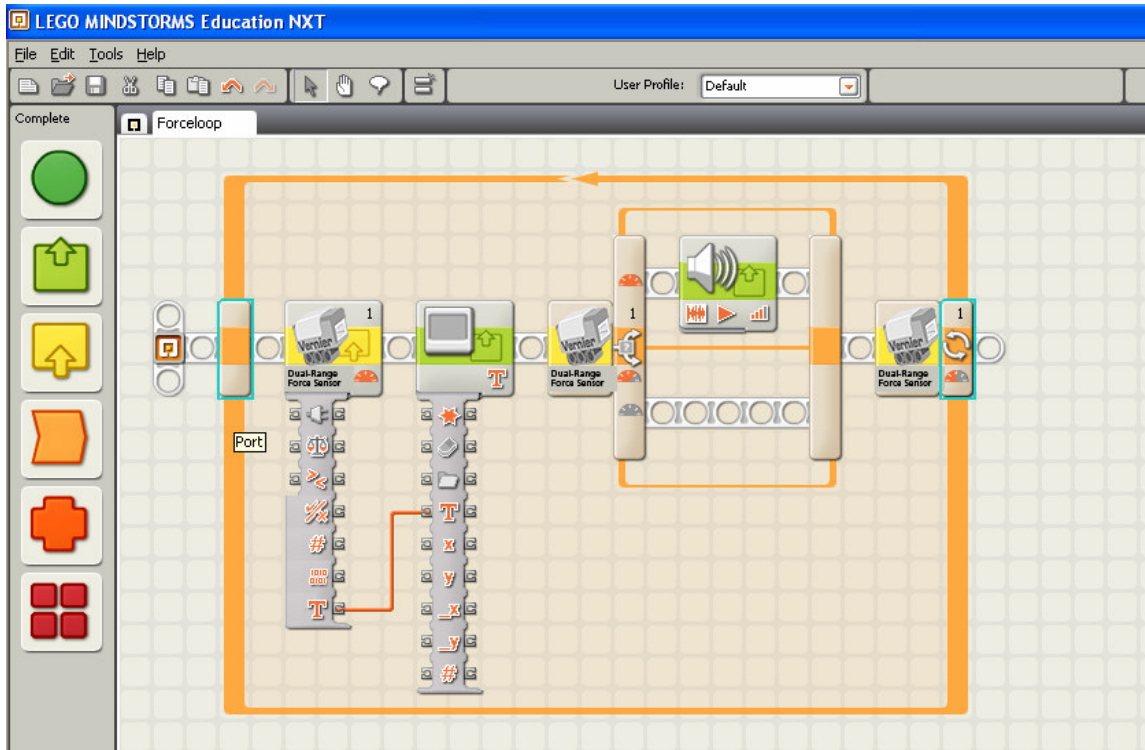
You also need to make sure that the correct Port is selected. By default, Port 1 will be selected. Once you make the connection to an NXT (by USB or Bluetooth) the reading from the sensor will be displayed in the configuration panel, both numerically and on a meter.

To display a value on the NXT screen, including the proper units, use blocks connected as shown below:



Note that we are wiring directly from the Value String connector on the Vernier Sensor data hub to the Text input of the Display block data hub. This saves the trouble of using the Number to Text Block. It also has the advantage of displaying the reading with the decimal rounding set appropriately and with the proper units. You can use the Value output on the Vernier Sensor data hub, then convert it to text, and display it. When you use the Value output for displaying the reading it will always be rounded to the nearest integer and the units will not be displayed.

Note that all the Loop, Wait, and Switch blocks work fine using the Vernier Sensor. You just choose sensor and then Vernier Sensor. The threshold can be set as you would expect. Below is a simple program that displays the reading from a Dual-Range Force Sensor, Makes a sound if the force is greater than a threshold, and loops until the force is less than a threshold.



## Zeroing and Calibration with the Vernier Sensor Block

Using the Action control, you can set the Vernier Sensor block to Zero/Calibrate. This provides a way for you to adjust the calibration of the sensor you are using. For example, if an accelerometer is not reading 0 acceleration when it is at rest, you can adjust it so it correctly reads zero. Build a program with Vernier Sensor block at the beginning. Choose Zero/Calibrate on this block. When you download and run the NXT program, have the accelerometer oriented as you plan to use it and at rest. When this block of the program executes the reading will be adjusted so that the acceleration is defined as 0. This adjustment will be used in all other Vernier Sensor blocks in the program. This zero adjustment is saved in the Vernier Sensor.cal file on the NXT and will be used until you reset it to the default value. You can do this by choosing Calibrate from the Tools menu of the Mindstorms computer program, or by using the Vernier Sensor Block set for Reset action, as described below.

This same concept works for all sensors except the Stainless Steel Temperature Probe (TMP-BTA) and the Surface Temperature Probe (STS-BTA). For the pH probe (PH-BTA), zeroing has a special procedure which is explained below.

Using the Action control, you can also set the Vernier Sensor block to Reset. This provides a way for you to restore the calibration of the sensor to its default setting. Build a program with Vernier Sensor block at the beginning. Choose Reset on this block. When you download and run the NXT program and the block executes the calibration will be set to the default setting.

Note that zero/calibration action and reset actions work on all Vernier Sensors (except TMP and STS temperature probes) being used by the Mindstorm program. The way calibration is handled with the Vernier Sensor block on the NXT requires that all Vernier Sensor blocks use the same calibration file. If you adjust the calibration on one Vernier Sensor block, you change the calibration of all Vernier Sensor blocks used later in the program. This applies to sensors connected to different channels and even to different types of sensors. This means you should probably not use the Zero/Calibration action when you have two Vernier sensors of different types in one program. Even if you are using two of the same type of sensor, force for example, zeroing one force sensor may not properly zero the other one.

## **Zero/Calibration with a pH sensor**

Since there is no such thing as 0 pH, we have an alternative way to adjust the calibration of the Vernier pH sensor. This calibration adjustment depends on the use of a pH 7 buffer. This is a solution available in most science classrooms that is made to have a pH of exactly 7.0. Build a program with Vernier Sensor block, set for pH, at the beginning. Choose Zero/Calibrate on this block. When you download and run the NXT program, have the pH sensor in the pH 7 buffer. When this block of the program executes the reading will be adjusted so that the pH reads exactly 7.0.

An alternative way to calibrate a Vernier Sensor for use with the LEGO NXT, is to edit the file Vernier Sensor calibrations.txt. This is a text file which you can open on a computer and edit to change the calibrations used by the NXT. See the document Adjusting Calibrations in the Vernier Sensor block folder for details on this.

For information on Vernier products, check out <http://engineering.vernier.com>.

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