Using the Vernier Sensor NXT.vi

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Introduction

With the introduction of the Vernier NXT Sensor Adaptor (BTA NXT), it is now possible to connect most Vernier Analog (BTA) Sensors to the LEGO NXT Robotic Invention Systems brick. The Vernier Sensor Adaptor allows the NXT to communicate with the sensor and measure a variety of physical properties. Over thirty types of sensor are supported, empowering a wide variety of scientific, engineering, and educational uses for the NXT system.

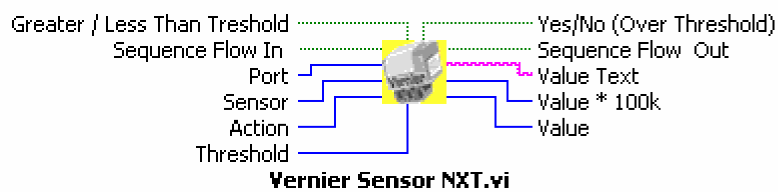
A LEGO Mindstorms G-Block is available for download from the Vernier website (http://www.vernier.com/nxt/downloads.html) permitting a simple introduction to using the Vernier Sensors with the NXT. For those users who wish to program the NXT directly in the LabVIEW environment the Vernier Sensor NXT.vi enables access to the functionality of supported sensors. It may be also be downloaded from the same site.

Installing the VI

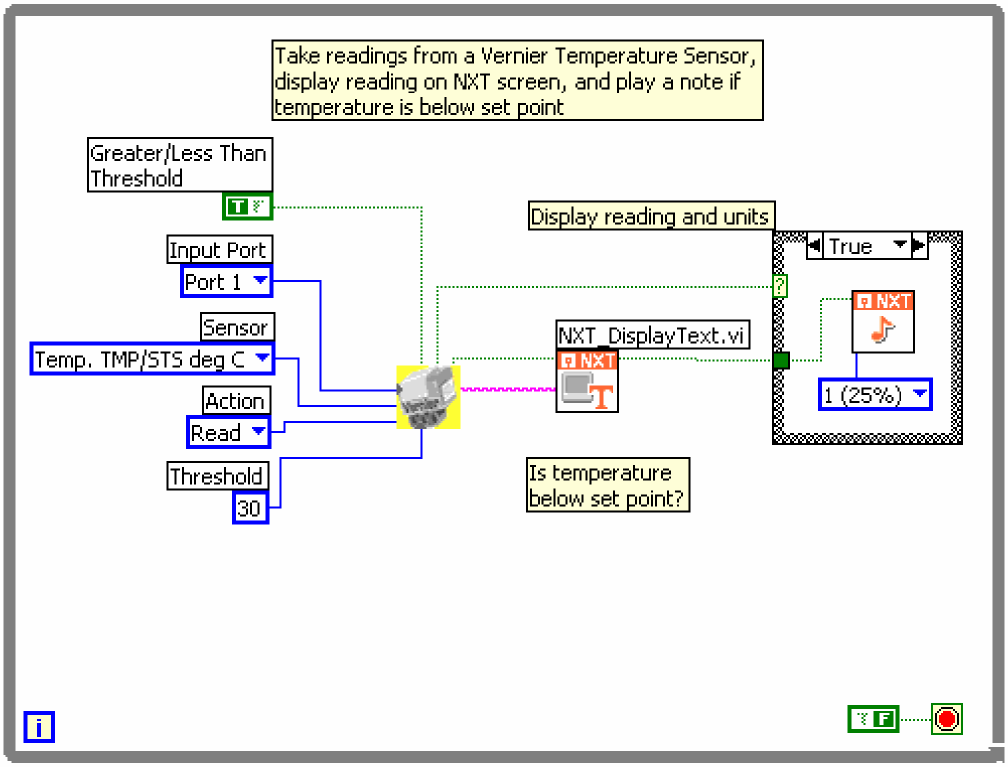
The Vernier Sensor NXT download will work with LabVIEW versions 7.1 and later. The download takes the form of a zipped folder. After unzipping the folder place it into the user.lib folder under the LabVIEW directory. This will allow the Vernier Sensor NXT.vi and the example VIs to appear on the Functions Palette in LabVIEW.

Wiring the VI

The terminal connections to the Vernier Sensor NXT vi are shown in the context help screen below.



The individual input and output connections are discussed in their own sections below. The vi is most easily wired by using the wiring tool on each desired input and output terminal to create a constant connected to the terminal by right clicking on the terminal and selecting create and constant from the menu. The constant then provides the correct selection choices to the vi for the desired measurement. For the threshold terminal, simply type the desired control value of the physical property under measure. A table of the supported sensors and their measurement ranges is provided in Appendix A. An example of the vi being used with a temperature sensor and displaying the values on the NXT screen is shown below. A tone sounds if the temperature is below the set point.



Once the Vernier Sensor NXT.vi is incorporated into your application or NXT program, it may be downloaded to the NXT using the NXT terminal on the tools menu of LabView.

> ***Note: At the time of writing, when the Vernier Sensor NXT.vi or another vi containing it is compiled for the NXT the compiler returns a warning that there is a floating point variable that will be treated as an I32. Ignore this warning; it does not affect the function of the vi. We have been unable to find the source of this warning in the vi. Should you figure it out, please let us know and we will fix our master copy.***

Input Controls

Sequence Flow in

This is the sequence flow input. The Labview NXT Toolkit provides a special Boolean control called a Sequence Flow Boolean. The names of these controls must start with Sequence Flow. A sequence flow Boolean on one vi is wired to one on another vi the program to control the flow of the program. This is very similar to the way the sequence beam way is used in the LEGO Mindstorm G programming environment.

Input Port

This control selects the NXT port connected to the Vernier NXT Sensor Adaptor (BTA NXT). The range is 1 to 4.

Sensor

The Sensor control lets the vi know what type of Vernier Sensor is being used and automatically loads the correct calibration information and units for the sensor.

Action

The Action Control determines whether the sensor should be read, zeroed, or reset at a given point in the program. See the section "Using the Zero/Calibrate and Reset Functions" below for information on these actions.

Threshold

Each sensor has the ability to be triggered above or below a set threshold. The trigger point is entered into this control as a numeric value in the correct units for the physical property under measure. A table of the correct units and the range of measurement for each supported sensor is included in Appendix A.

Greater/Less Than threshold

This is a Boolean control that determines if the sensor should trigger (i.e. return a True value) if the reading is below or above the threshold. A value of True will make the sensor return True if the reading is below the Trigger Point setting.

Output Terminals

Sequence Flow Out

This is the sequence flow output. The Labview NXT Toolkit provides a special Boolean control called a Sequence Flow Boolean. The names of these controls must start with Sequence Flow. When a sequence flow Boolean on one vi is wired to one on another vi the program treats this wire in exactly the same way as the sequence beam in LEGO's Mindstorm G programming environment is treated.

Value Text

This output takes the reading for the sensor connected to the NXT converts it to a text string and concatenates the appropriate units to the measurement. It is very useful for displaying the value measured on the NXT display and is more accurate than the Reading output which due to the lack of a floating-point processor in the NXT brick. Decimal readings can be displayed using this text output.

Value * 100,000

The NXT block uses a fixed point processor to perform its calculations. To maintain the precision of the Vernier Sensor in use the readings from the sensor are multiplied by 100,000 inside the vi. This output gives you access to that quantity at its full precision.

Value

The Reading output is the numerical value of the quantity under measure. It is expressed as the size of the physical quantity in the correct units. This is a simple output useful for beginning students to use in the programs they are creating. However, note this output will always be a whole number, any fractional part of the measurement will be truncated.

Yes/No (Over Threshold)

This is a Boolean output that returns a value of True if the conditions set by the Threshold and Greater / Less Than inputs are met.

Using the Zero/Reset Functions

Zeroing Most Sensors

Using the Action control, you can set the Vernier Sensor vi to Zero/Calibrate. This provides a way to adjust the calibration of the particular sensor you are using. For example, if an accelerometer is not reading 0 m/s^2 when it is at rest, you can adjust it so it correctly reads zero. Build a program with Vernier Sensor NXT vi at the beginning. Choose Zero/Calibrate on this vi. 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 vi 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 vi 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 program on the NXT requires that all Vernier Sensor vi use the same calibration file. If you adjust the calibration on one Vernier Sensor vi, you change the calibration of all Vernier Sensor vi 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.

Changing Sensor Calibrations

In the Vernier Sensor NXT vi the calibrations for all supported voltage-linear sensors are stored as a one dimensional array of cluster variables in the "Sensor Control" sub vi. This is derived from the text document "Vernier Sensor calibrations.txt" which is part of the Vernier Sensor Mindstorms Block. The STS-BTA and TMP-BTA sensors use a thermistor and have a non-linear calibration which is stored in the one dimensional table internal to the "Temperature Case Structure" located in the vi. Remaking either array requires use of simple but special programs. Please contact us if you think you need to adjust these values.

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

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Appendix A
Supported Sensors and Range of Measurement

Sensor Name	Minimum	Maximum	Units
Accelerometer 5g	-50	50	m/s^2
Accelerometer 25g	-250	250	m/s^2
Barometer	81	110	kPa
Charge 0.5V	-5	5	nC
Charge 2V	-20	20	nC
Charge 10V	-100	100	nC
Colorimeter	0	100	%T
Conductivity 200	0	200	uS/cm
Conductivity 2000	0	2000	uS/cm
Conductivity 20k	0	20000	mS/cm
Current	-0.6	0.6	mA
Dissolved Oxygen	0	15	mg/l
Electrode Amplifier	-450	1100	mV
Flow Rate	0	4	mm/s
Force 10N	-10	10	N
Force 50N	-50	50	N
Force Plate 850 N	-200	850	N
Force Plate 3500 N	-1000	4000	N
Hand Dynamometer	0	600	N
Instr. Amp. 20mV	-20	20	mV
Light 600	0	600	lx
Light 6000	0	6000	lx
Light 150k	0	150	klx
TI Light	0	1	relative
Mag. Field 0.3 mT	-0.32	0.4	uT
Mag. Field 6.4 mT	-10	5	uT
ORP	-450	1100	mV
Oxygen Gas	0	27	ppt
pH	0	14	pHx10
Pressure	0	210	kPa
Relative Humidity	0	100	%
Salinity	0	50	ppt
Soil Moisture(New)	-20	50	%
Soil Moisture(Old)	-20	50	%
Sound Level Meter	0	130	dB
Temp. TMP/STS deg C	-40	135	deg C
Temp. TMP/STS deg F	-40	275	deg F
Temperature EL	-50	150	deg C
Thermocouple	-200	1400	deg C
Turbidity	0	200	NTU
UVA	0	20000	mW/m^2

UVB	0	1000	mW/m^2
Voltage DVP	-6	6	V
Raw count	0	1024	Counts