

## Adjusting Calibrations using Vernier Sensor Calibrations.txt,

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The file Vernier Sensor Calibrations.txt, which is in the Vernier Sensor folder you downloaded is a simple text file with a structure like this:

Number	Sensor Name	Intercept	Slope	Units	Round
18	Force Plate ñ 3500	-100000000	487500	(N)	0
19	Hand Dynamometer	-1929580	85515	(N)	120
20	Instrument Amplifier	0	487	(mV)	0
...					

Each Vernier sensor that works with the NXT adapter has at least one row in the file. In a few cases, a sensor has more than one range, and it has a row 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 row in the file. The sensor name (with switch setting if there is more than one calibration), the units, and the number of digits to the right of the decimal to be displayed when the readings are displayed are all listed. Two other numbers, the slope and intercept used in calibration, are also listed. For all Vernier sensors that work with the NXT adapter except the Stainless Steel Temperature Probe (TMP-BTA) and the Surface Temperature Probe (STS-BTA), the calibration is linear. This means that the relationship between the raw count from the NXT and the reading of the sensor is linear. These values are related by this equation:

$$\text{Sensor Reading} * 100\,000 = \text{Raw Count} * \text{Slope} + \text{Intercept}$$

The 100 000 factor is included because the NXT does not have a floating point processor, so we want to be working with large integers, and avoiding decimal numbers when doing calibration calculations. Basically we do all the calculations and come up with readings 100 000 times the correct reading. We then use string manipulation on the NXT to display the value correctly using the Value String output on the data hub.

We have carefully set the values of the slope and intercept for each of the sensors in the Vernier Sensor calibrations.txt file. If you want to adjust this calibration, you can open the Vernier Sensor calibrations.txt file with a word processor or spreadsheet program, edit the values and resave it. Note that you should make a backup of the whole Vernier Sensor folder before you make any changes.

After you have made changes to the Vernier Sensor calibrations.txt file and saved them, you need to re-import the Vernier Sensor block into your Mindstorms program before the changes will take effect.

Calibration is done in a different way for the Stainless Steel Temperature Probe and the Surface Temperature Probe. These sensors use thermistors and a resistor in a voltage divider circuit. The relationship between raw count and temperature is complex. For these sensors we use the Steinhart-Hart equation to determine the temperature from the raw count. The Slope and Intercept values in the Vernier Sensor calibrations.txt file have different uses. To adjust the calibration follow the procedure below:

**First adjust the readings near 0 ° C.** If you want to adjust the temperature mostly at the low temperatures, you need to adjust the slope number in the Vernier Sensors.txt file. This number is used in a complex way. It is set as negative of the power supply voltage of the NXT (in millivolts). The slope number affects the calibration curve in the area near 0 ° C most strongly. If the slope is reduced in absolute value by 10 mV (e.g. -4911 is changed to -4901), the temperature displayed on the Mindstorms programming screen at 0 ° C will be reduced by approximately 0.2 ° C

**Next, adjust the values near 100 ° C.** The Intercept value is 102,800 by default, but it can be changed to add a multiplicative correction. To proportionally increase all the temperature readings, you increase this value. To decrease all the temperature readings, you decrease the intercept. Changing the intercept by 1,000 causes a change of one percent in the 0 ° C to 100 ° C Calibration Slope (for example 100 ° C becomes 101 ° C and 10 ° C becomes 10.1 ° C). Note that this change affects all temperature readings.