Gyro Sensor Revisited

By Sanjay and Arvind Seshan

Lesson Objectives

1. Learn about how older and newer generations of gyro sensors effect the calibration process

2. Learn how to how to deal with gyro drift with this updated information about the gyro sensor.

Prerequisites: Data wires, Loops, Logic & Comparison Blocks, Introduction to Gyro
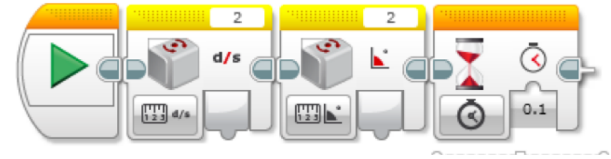
Terms to Know

↗ Reset: Current value of the gyro sensor angle is set to "0". This is what the gyro block with mode set to "reset" does.

↗ Calibration: The gyro calibrates what it considers to be "still". This sets both the current gyro sensor rate and angle to "0". This typically occurs when the gyro is connected.

↗ Some people refer to calibration as a "hard reset". We will call this calibrate through this lesson to reduce the amount of confusion.

Why Revisit the Gyro?

↗ It has been brought to our attention by Mr. Sam Last from North Carolina that certain gyros are acting differently.

↗ On certain newer gyro sensors, the commonly used calibration code for the gyro on the right (switching between angle and rate), does not work (i.e. does not cause the gyro to perform a recalibration).

↗ This is a big issue for anyone using one of the gyro sensors that does not recalibrate with this code.
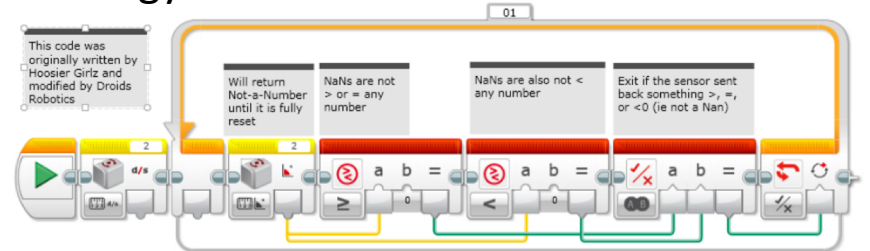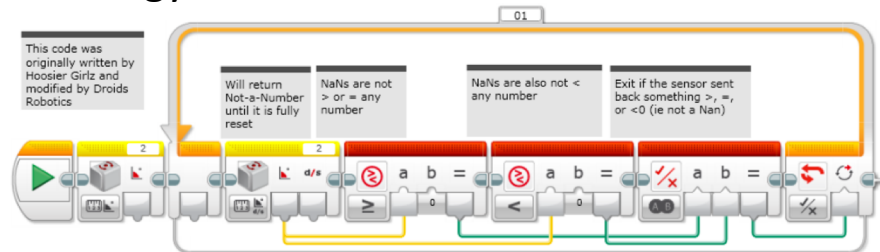
Recalibration Methods from "Intro to Gyro"
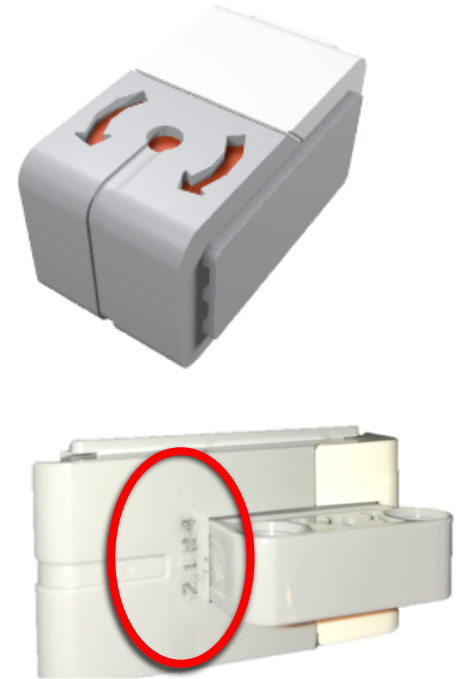
Strategy 1:

Strategy 2:

Strategy 3:

Strategy 4:

Testing the Gyro Sensors

↗ We obtained data from 30+ gyro sensors purchased in various years around the world

↗ Strategy 4 code (from Introduction to Gyro Lesson) provides a simple way to test if you have a sensor that supports recalibration or not.

  ↗ On sensors that perform the recalibration, it takes 3 seconds to run this code.

  ↗ On sensors that do not perform the recalibration, the code runs in < .1 seconds.

  ↗ We added some timer code to test a gyro sensors by running three recalibrations and averaging to see how long they take.

  ↗ We thought the problem may be related to the code on the bottom of the gyro (shown in red circle) – so, we recorded this as well.

There is a correlation with the codes printed on the gyros themselves and whether or not they recalibrate correctly.

All gyro sensors ending in N2 and N3 worked. All gyro sensors ending in N4, N5, N6, N7 and N8 did not work.

We have personally tested on N3, N4, N6 and N8. Tests on the others were conducted by friends.

Note: If you complete this lesson and discover new numbers to add to the list (especially any N7 and N8), please email them to us at team@ev3lessons.com.

Sample Gyro Sensor Codes
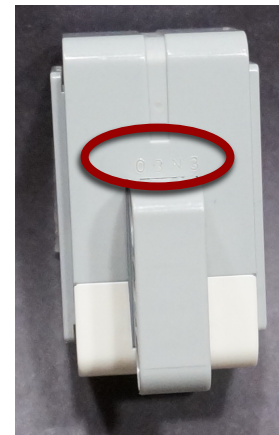
Old Type	New Type	
18N2	09N4	03N6
20N2	15N4	05N6
48N2	20N4	06N6
	21N4	15N6
01N3	38N4	17N6
02N3	39N4	20N6
03N3	50N4	21N6
04N3		23N6
05N3	13N5	29N6
06N3	17N5	
16N3	21N5	06N7
17N3	22N5	23N7
19N3	27N5	28N7
42N3	28N5	
43N3	36N5	10N8
44N3	45N5	
45N3		
47N3		
49N3		
50N3		
51N3		

What Sensor Version Do You Own?

↗ <u>Method 1:</u> You can look for the tiny code printed on the gyro sensors and look at the last two Letter-Digit combination

↗ <u>Method 2:</u> You can run the test code we have provided for you on EV3Lessons→ Advanced and it will tell you which sensor you have and if the traditional recalibration or an alternative recalibration method is needed.

    ↗ http://ev3lessons.com/en/ProgrammingLessons/advanced/GyroRevisited.ev3

See next slide for zoomed in versions

"N3"

"N5"

Photo Credit:
Thomas Madeya

Gyro Sensor Revisited

Slides: PPTX, PDF
EV3 Code to test your sensor

Close up View of the Sample Codes

"N3"

"N4"

"N5"

"N6"

- *Wherever this presentation mentions N4, the result has been confirmed for N5, N6, N7 as well.*
- *Wherever this presentation mentions N3, the result has been confirmed for N2 as well.*

Photo Credit: "N5" and "N6" Images by Thomas Madeya

What if Don't Own an N2/N3 Sensor?*

Hardware Solution

↗ Unplug and re-plug your gyro sensor while making sure your robot is still

↗ This technique requires access to the EV3 ports and is prone to failure since you may shake the robot as you re-plug the wire.
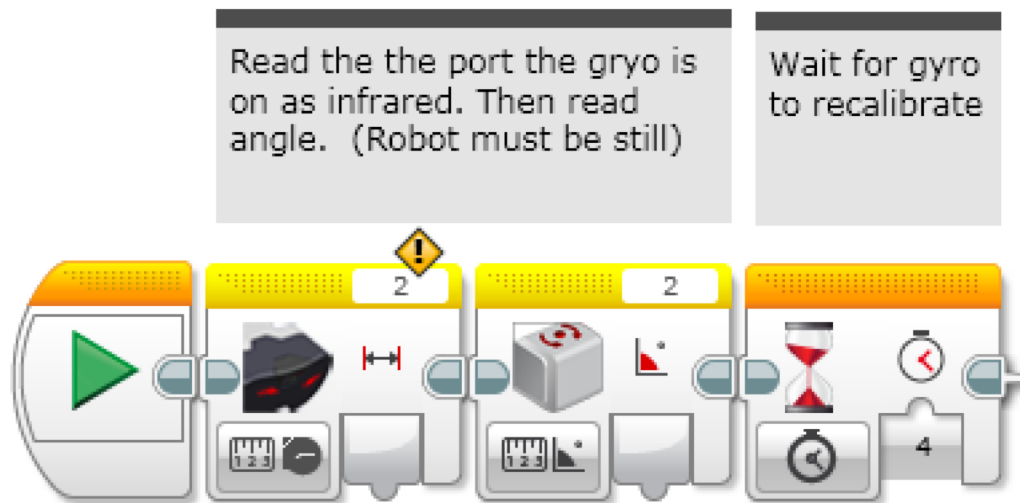
Software Solution

↗ If you read the port the gyro is connected to as an infrared sensor and then read it again as a gyro sensor, it seems to force a recalibration of the gyro.

↗ See the next 4 slides for updated recalibration code (Strategies 5-8) that can be used for the "N4" and up sensors.

↗ Can be used with "N3" and below as well.

↗ Note: Did not work reading the sensor as color, ultrasonic, touch or temperature.

As we discover more solutions, this slide will be updated.

Recalibration Strategy 5

First, reading the gyro as an IR sensor and then as a gyro causes the gyro to recalibrate.

Second, add a wait block to give the sensor a bit of time to fully recalibrate. Our measurements show that 4 seconds is safe. Note that the Strategy 1 code in Intro to Gyro, recalibration only took 0.1 seconds.
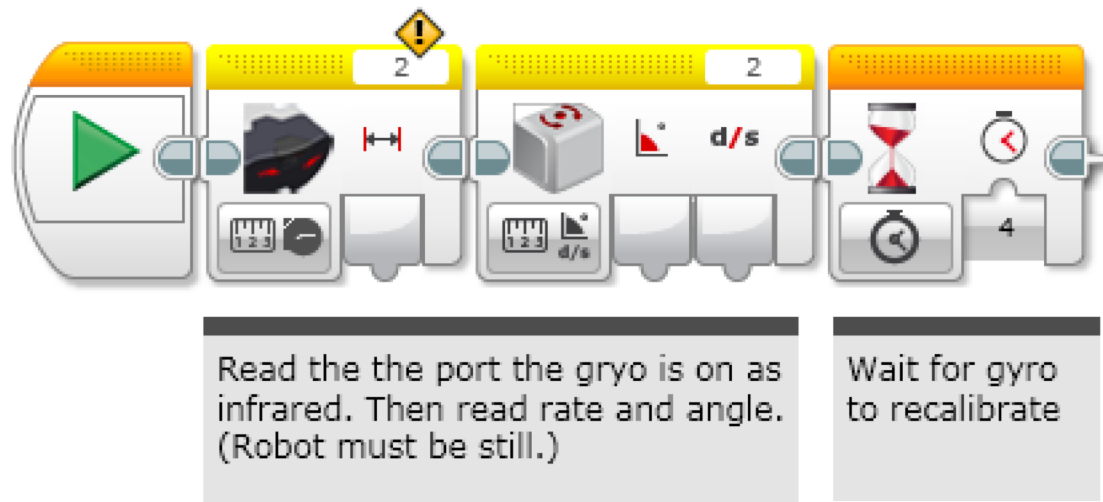
Read the the port the gryo is on as infrared. Then read angle. (Robot must be still)

Wait for gyro to recalibrate

Note for "N3" sensor users: in the rest of your program, you should only use the "angle" modes of the gyro. Using the "rate" or "rate and angle" mode will cause the gyro to recalibrate. "N4" sensor users can change modes without causing a recalibration. Mode changes do "reset" the angle to 0.
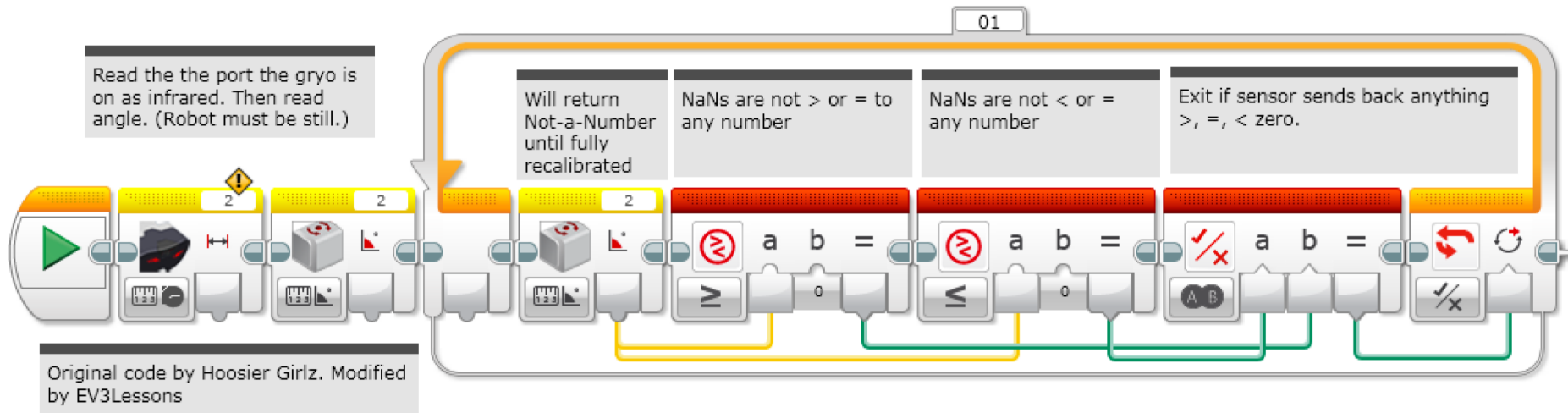
Recalibration Strategy 6

This version of the calibration leaves the gyro in rate+angle mode. This is useful for "N3" users if you use the rate output.

This version takes a little bit longer (4 vs. 3 seconds) than the Strategy 2 code in Intro to Gyro.

Note for "N3" sensor users: in the rest of your program, you should only use the "rate + angle" modes of the gyro. Using the "angle" or "rate" mode will cause the gyro to recalibrate. Also, ***DO NOT*** use the gyro reset mode - this forces the gyro into angle mode which will cause a long 3 second recalibration. "N4" sensor users can change modes without causing a recalibration. Mode changes do "reset" the angle to 0.
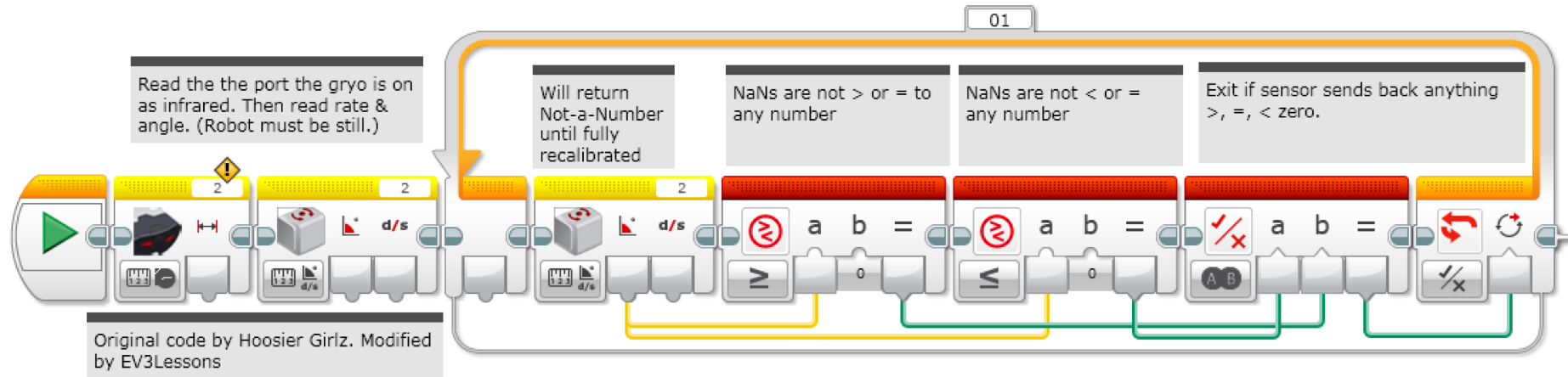
Read the the port the gryo is on as infrared. Then read rate and angle. (Robot must be still.)

Wait for gyro to recalibrate

Recalibration Strategy 7

Read the the port the gryo is on as infrared. Then read angle. (Robot must be still.)

Will return Not-a-Number until fully recalibrated

NaNs are not > or = to any number

NaNs are not < or = any number

Exit if sensor sends back anything >, =, < zero.

Original code by Hoosier Girlz. Modified by EV3Lessons

This version of the calibration leaves the gyro in angle mode. This is probably the most common way to use the gyro. This code takes about 4 sec to run (vs. 0.1 sec for the Strategy 3 code in Intro to Gyro)

Note for "N3" sensor users: in the rest of your program, you should only use the "angle" modes of the gyro. Using the "rate" or "rate and angle" mode will cause the gyro to recalibrate. "N4" sensor users can change modes without causing a recalibration. Mode changes do "reset" the angle to 0.

Recalibration Strategy 8

Read the the port the gryo is on as infrared. Then read rate & angle. (Robot must be still.)

Will return Not-a-Number until fully recalibrated

NaNs are not > or = to any number

NaNs are not < or = any number

Exit if sensor sends back anything >, =, < zero.

Original code by Hoosier Girlz. Modified by EV3Lessons.

This version of the calibration leaves the gyro in rate+angle mode. This is useful for "N3" users if you use the rate output.

Note for "N3" sensor users: in the rest of your program, you should only use the "rate + angle" modes of the gyro. Using the "angle" or "rate" mode will cause the gyro to recalibrate. Also, ***DO NOT*** use the gyro reset - this forces the gyro into angle mode which will cause a long 3 second recalibration. "N4" sensor users can change modes without causing a recalibration. Mode changes do "reset" the angle to 0.

Discussion

↗ The new gyro calibration strategies in this lesson work for either the N2-N3 or N4-N8 sensors

↗ Note that all the new recalibrations take about 3-4 seconds. This is significantly more than the previous strategy 1 and 3 (in the Intro to Gyro lesson) which left the gyro in angle reading mode (0.1 sec vs. 3-4 secs)

  ↗ Therefore, if you have older N2 and N3 gyros, you might want to use the old code that took less time to recalibrate.

↗ The newer N4-N8 sensors allow you to use different gyro modes inside a program without causing a recalibration.

↗ *Conclusion: There was a hardware change between the N3 and N4 gyros. The older gyros likely use* ISZ-655 (a single axis gyro chip).
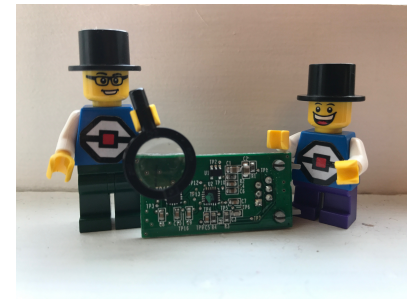
What is Going On?

↗ Thanks to the community sending in all the codes on the gyro sensors, it does appear that there is a date code on every gyro sensor.
45N5 = [Week][Factory/Electronics][Year] = Week 45, N, 2015

↗ By running EV3Dev, David Lechner, was able to identify that newer sensors have some additional secret modes enabled by the new hardware inside the sensor. The newer sensors have a dual-axis gyro chip so it can measure angle and rate about a second axis (parallel to the cable)
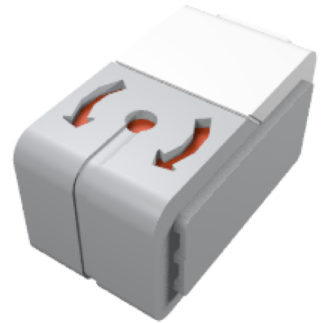
↗ Note: These modes are *not accessible* through the standard EV3-G Gyro block even if you own the newer gyro sensors. The modes are referred to as "TILT-ANG" and "TILT-RATE" in the sensor itself.

   ↗ Watch https://youtu.be/KjlT0BUJr-w for how David Lechner discovered the different modes.

Credit: This information on this slide was provided by David Lechner and Jorge Pereira

What Does This Mean for Calibration?

➚ Lechner believes that with N4, N5, N6, N7 and N8 sensors, since there are new (hidden) modes that measure rotation around a different axis, the sensor no longer resets when switching modes from angle to rate.

➚ The IR Sensor Block works in our solution code because it forces the sensor communication to timeout and causes the sensor to reset. This is because the LEGO firmware handles the IR sensor differently (longer timeout).

Credit: This information on this slide was provided by David Lechner and Jorge Pereira

Credits

↗ This tutorial was written by Sanjay Seshan and Arvind Seshan

↗ More lessons at www.ev3lessons.com

↗ Thank you to Mr. Sam Last for first reporting this issue to us.

↗ Thank you to David Lechner for investigating and discovering the hidden modes of the newer sensor.