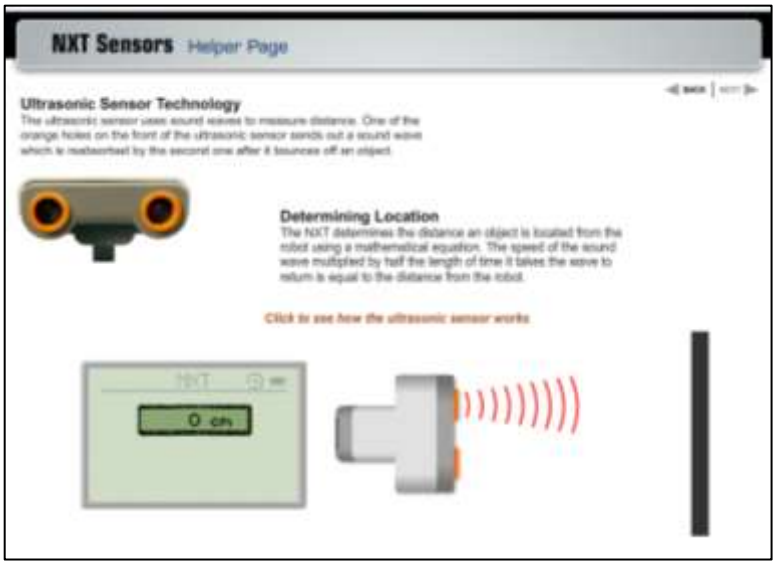
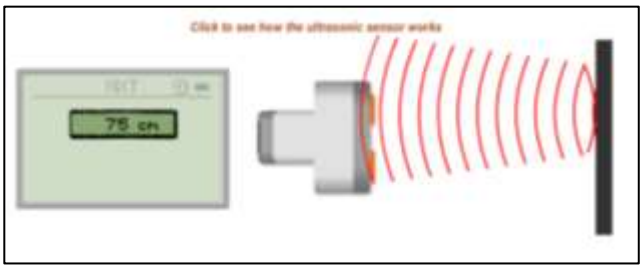
Introduction to the Lego NXT Robot with Sensors and Tetrix Metal Hardware:

Robotics uses both Computer Science programming skills along with engineering, especially electrical and mechanical. Robots use computer programs to run the instructions, and usually have motors and sensors.

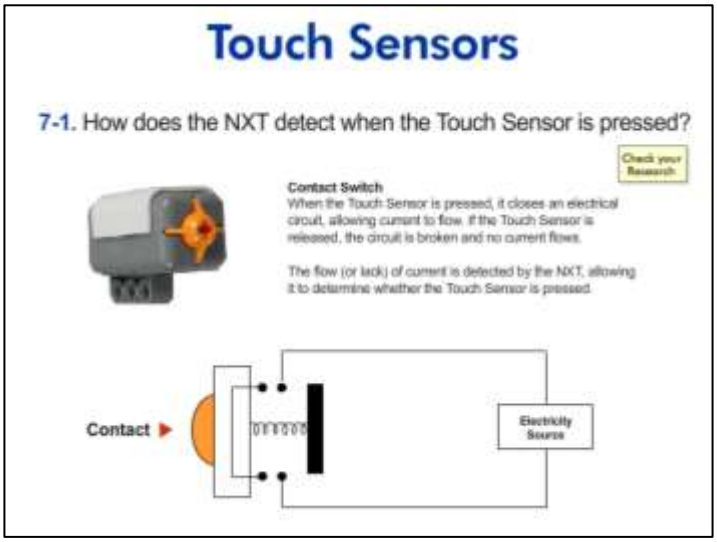
Some types of Lego sensors available and how they work:

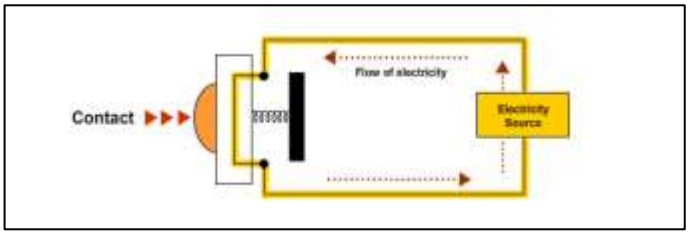




The Ultrasonic Sensor uses sound waves to measure distance. You can program the robot to do something when it reaches a certain distance, usually within about **15 centimeters** or closer works best, and on a flat upright surface. The sensor does not work well with corners or very thin or small objects.

What animals use similar methods for detecting distance? (Hint: echolocation)





Other sensors available: **Color sensor**-can detect several colors like blue, red, yellow, green, white, and black. **Light sensor**- can detect between light and dark. I**nfrared sensor**- that is what's used in remote controls like for TVs. **Gyroscopic sensor**- detects angle rotation that can be used for things like balancing the robot and helping it make turns more accurately. Gyros are used in smartphones and Ipods to keep the screens upright, and to balance things like the Segway. **Sound sensor**- can "hear" sounds. **Magnetic sensor**-can detect magnets, and a few more.

(Images from Carnegie Mellon Robot Academy 2.0 NXT Video Trainer preview)

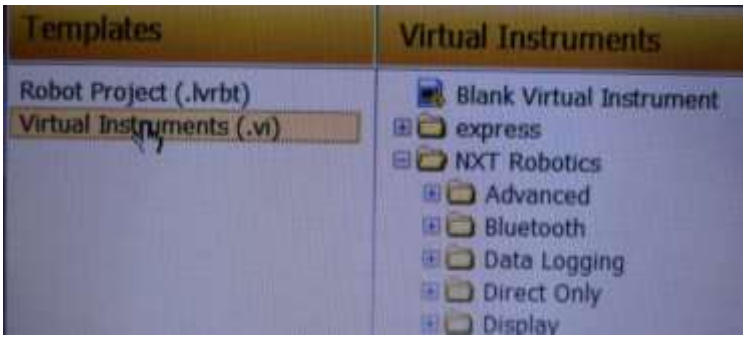
We will be using the Lego Mindstorms Labview software. It is an “object-oriented computer programming language” which uses icons and graphics instead of “scripting” like in Java. It is easier to get started programming with this object-oriented language, but a lot of the concepts are also used in the other languages, so when you start using one, the others get easier, also!

We will program the robot to dunk the basketball using touch sensors. Think of programming like following a recipe in cooking.

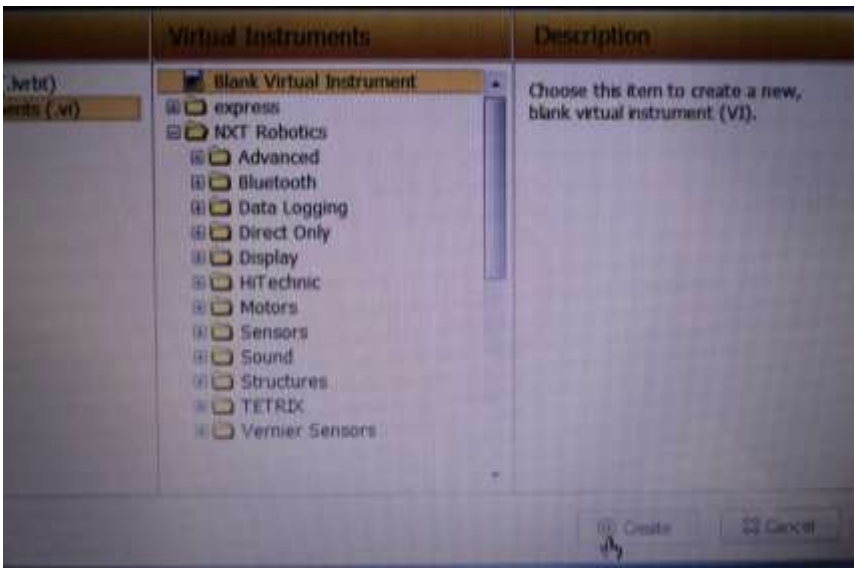
The steps will be:

1. The arm will get into position so a ball can be loaded.
2. Press one sensor to go forward.
3. Press the other sensor to stop.
4. The arm will dunk the ball, then the arm will go back down, and the robot will automatically start going backward.
5. Press the same Stop touch sensor to stop the robot.
6. This program will be in a Loop so it can be repeated without having to press “Run” on the brick.


LabVIEW for LEG
Create Program
Open Existing
Recent Files


Templates
Virtual Instruments
Robot Project (.lvrbt)
Virtual Instruments (.vi)
Blank Virtual Instrument
express
NXT Robotics
Advanced
Bluetooth
Data Logging
Direct Only
Display


Templates
Virtual Instruments
Robot Project (.lvrbt)
Virtual Instruments (.vi)
Blank Virtual Instrument
express
NXT Robotics
Advanced
Bluetooth
Data Logging
Direct Only
Display

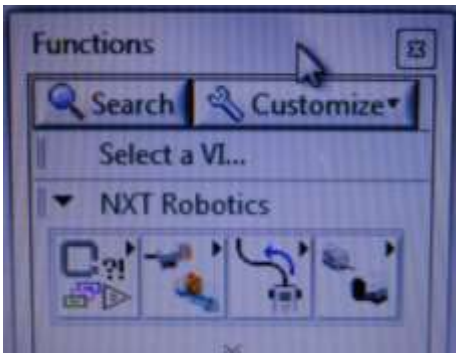

Virtual Instruments
Description
Blank Virtual Instrument
express
NXT Robotics
Advanced
Bluetooth
Data Logging
Direct Only
Display
HiTechnic
Motors
Sensors
Sound
Structures
TETRIX
Vernier Sensors
Choose this item to create a new, blank virtual instrument (VI).

Go to View: click on Functions Palette.

Go to View again: click on the Tools Palette.

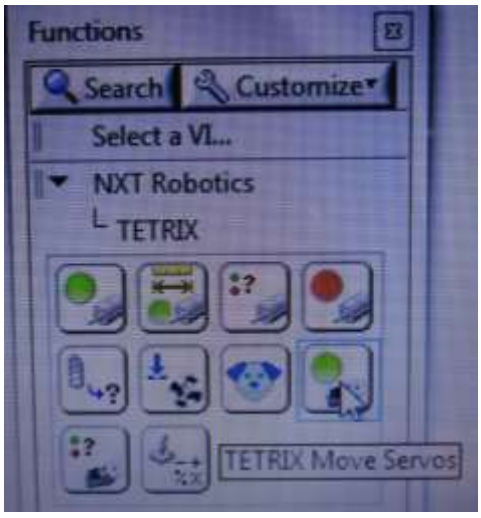
Tip: The Automatic Tool Selection Magic Wand is the best setting.
(It should be set to that as a default)

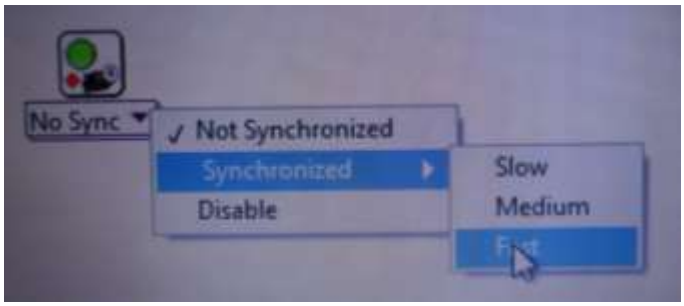
1.



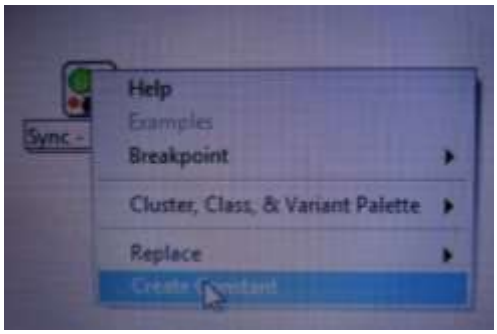
2.

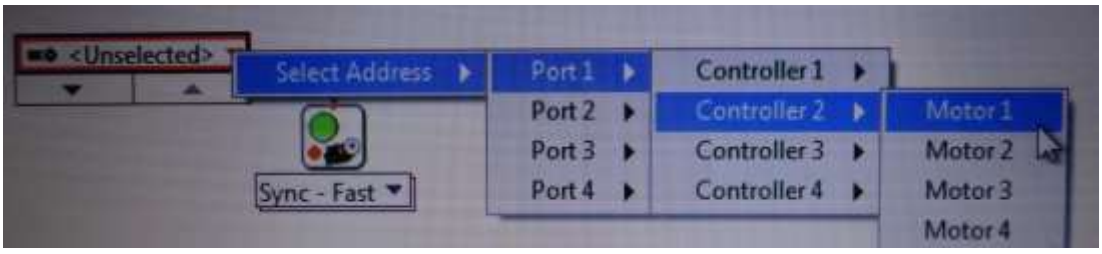
3.

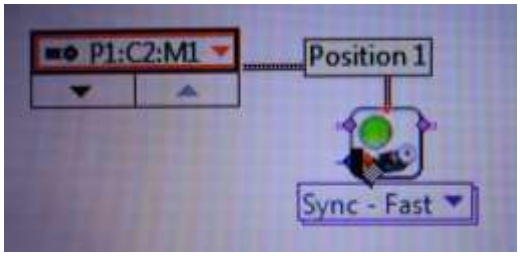


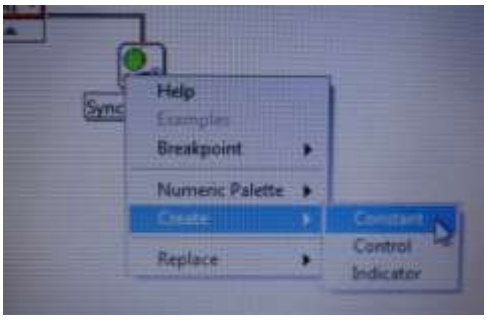
4. 
No Sync
✓ Not Synchronized
Synchronized
Disable
Slow
Medium
Fast

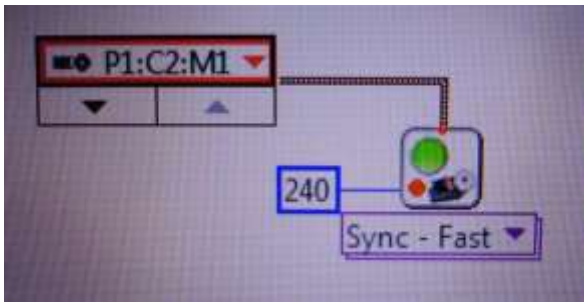
5. 
Sync - Fast

6. 
Sync -
Help
Examples
Breakpoint
Cluster, Class, & Variant Palette
Replace

7. 
<Unselected>
Select Address
Port 1
Port 2
Port 3
Port 4
Controller 1
Controller 2
Controller 3
Controller 4
Motor 1
Motor 2
Motor 3
Motor 4
Sync - Fast

8. 
P1:C2:M1
Position 1
Sync - Fast

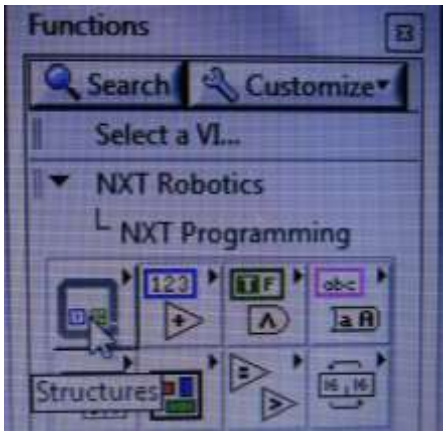
9. 
Help
Examples
Breakpoint
Numeric Palette
Create
Replace
Constant
Control
Indicator

10. 
P1:C2:M1
240
Sync - Fast

11.


Functions
Search
Customize
Select a VI...
NXT Robotics
NXT Programming

12.


Functions
Search
Customize
Select a VI...
NXT Robotics
NXT Programming
Structures

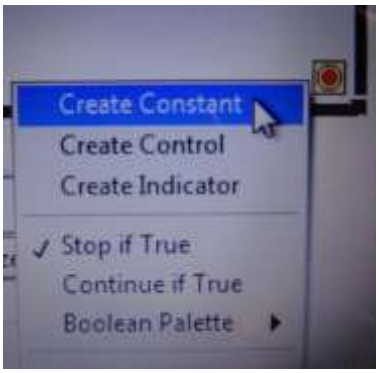
13.


Functions
Search
Customize
Select a VI...
NXT Robotics
NXT Programming
Structures
While Loop

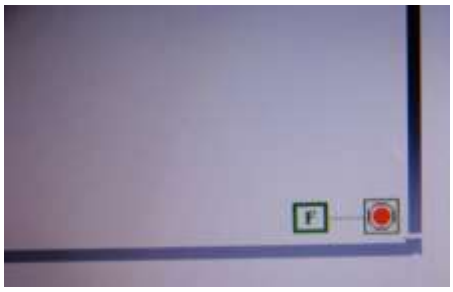
Make your Loop long enough to hold about 12 programming buttons.

14.

15.

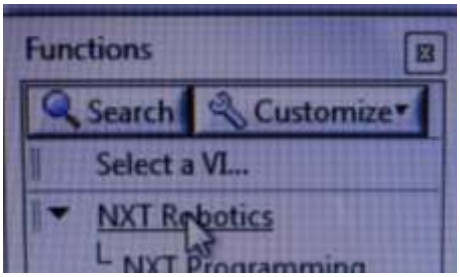


16.

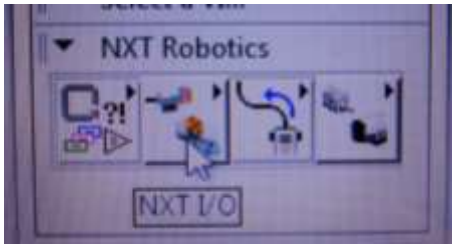


This Stop button is part of the instructions for how the Loop runs.

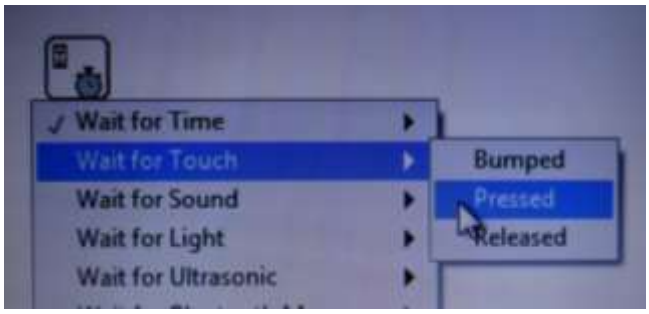
17.



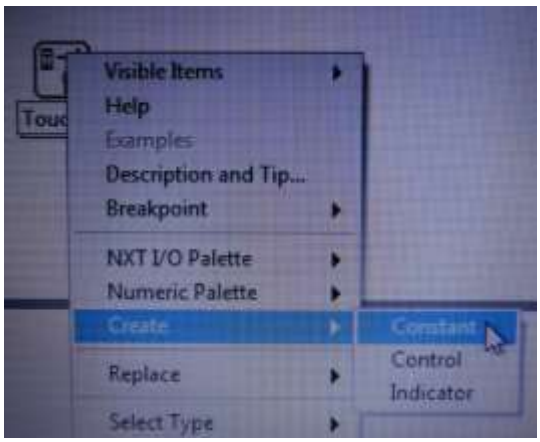
18.

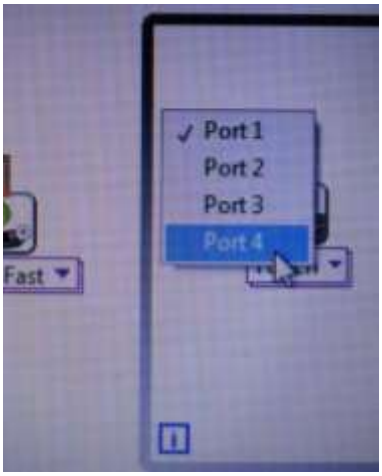


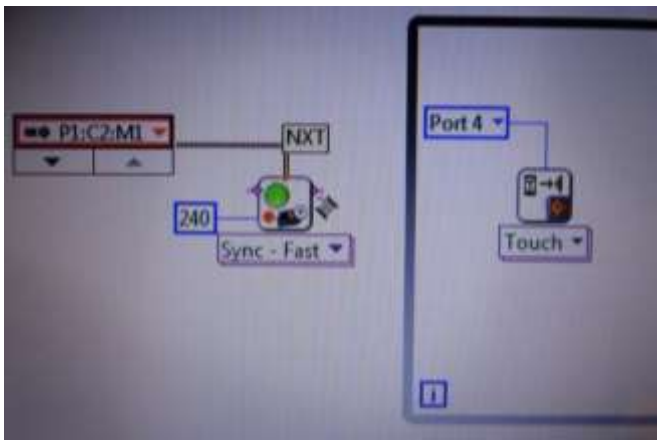
19.

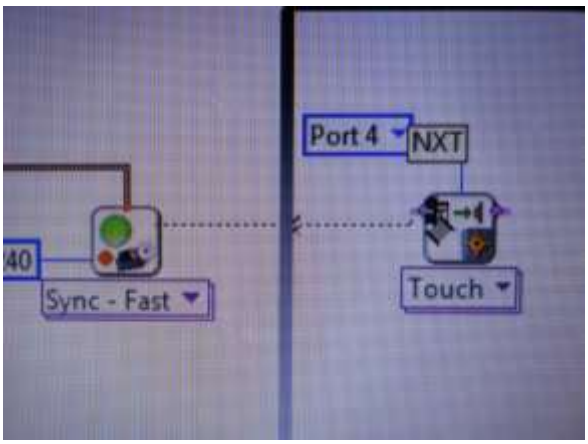
20. 
Wait for Time
Wait for Touch
Wait for Sound
Wait for Light
Wait for Ultrasonic
Bumped
Pressed
Released

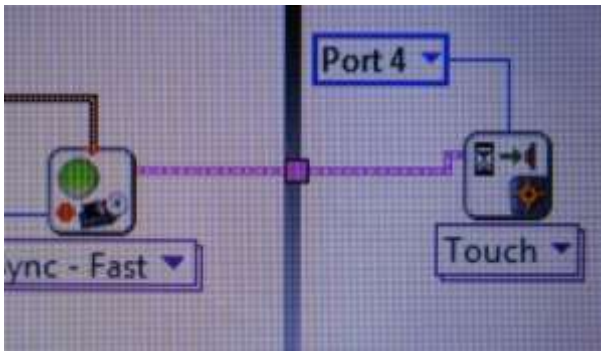
21. 
Touch

22. 
Visible Items
Help
Examples
Description and Tip...
Breakpoint
NXT I/O Palette
Numeric Palette
Create
Replace
Select Type
Constant
Control
Indicator

23. 
Port 1
Port 2
Port 3
Port 4
Fast

24. 

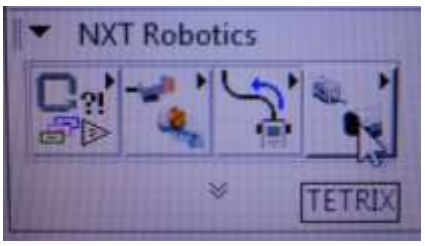
25. 

26. 

The wire is the order in which the buttons go.

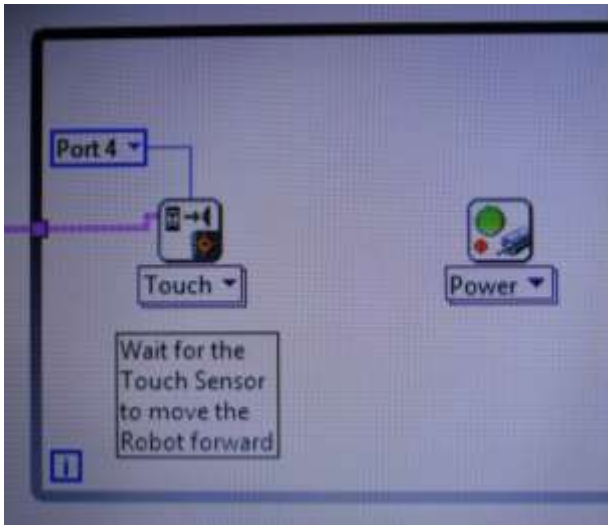
27.

28.



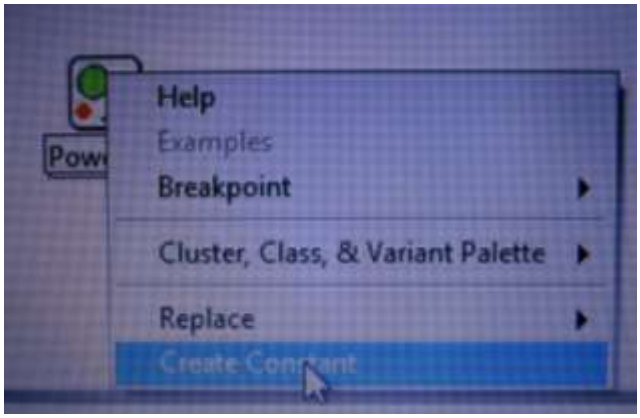
29.

30.

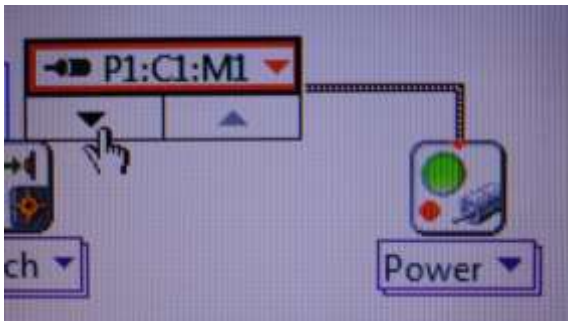


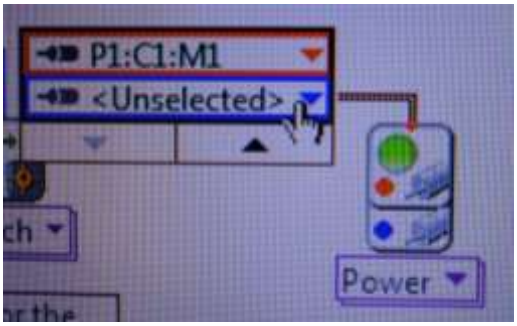
31.

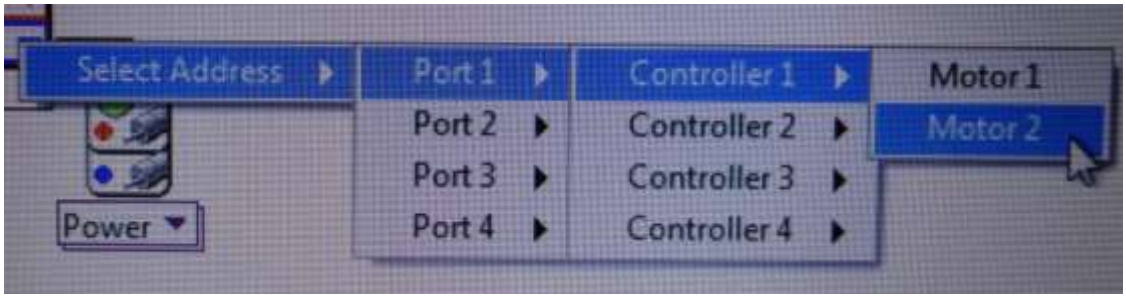
32.

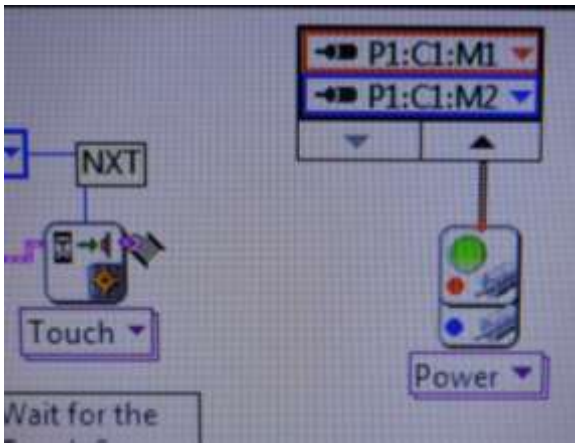


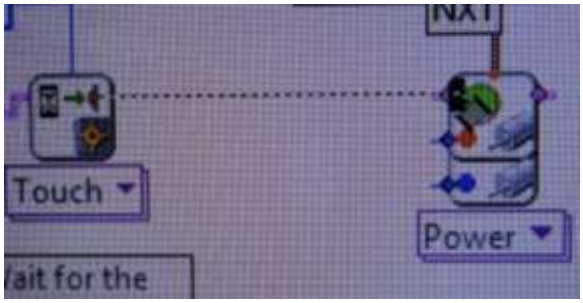
33. 
Select Address
Port 1
Port 2
Port 3
Port 4
Controller 1
Controller 2
Controller 3
Controller 4
Motor 1
Motor 2
Power

34. 
P1:C1:M1
Power

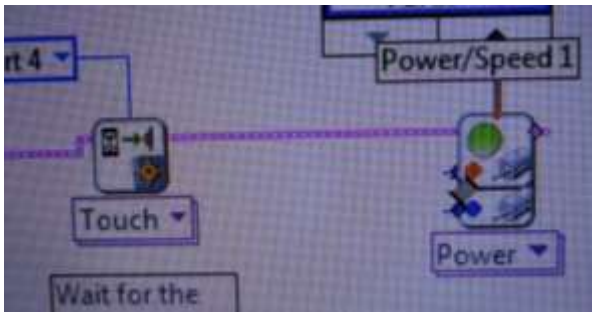
35. 
P1:C1:M1
<Unselected>
Power

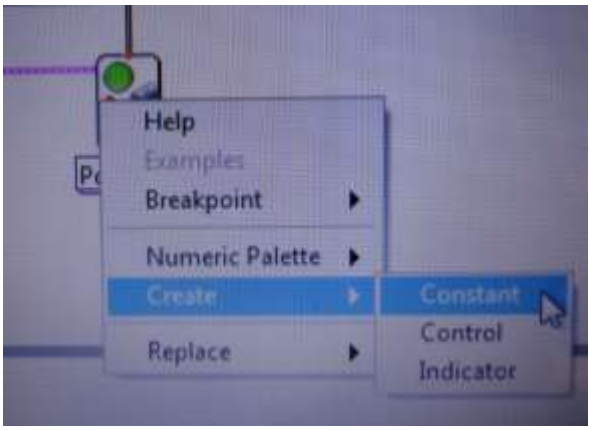
36. 
Select Address
Port 1
Port 2
Port 3
Port 4
Controller 1
Controller 2
Controller 3
Controller 4
Motor 1
Motor 2
Power

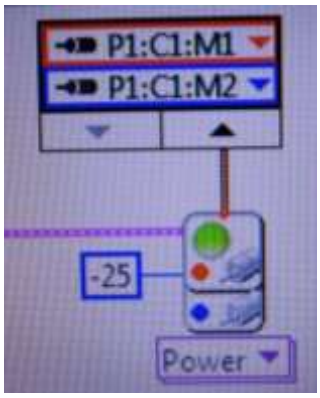
37. 

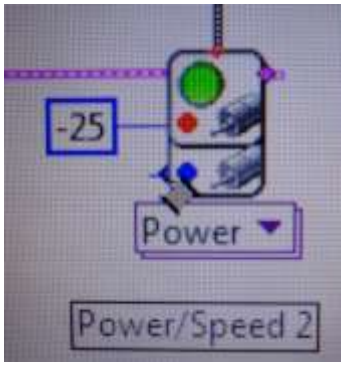
38. 

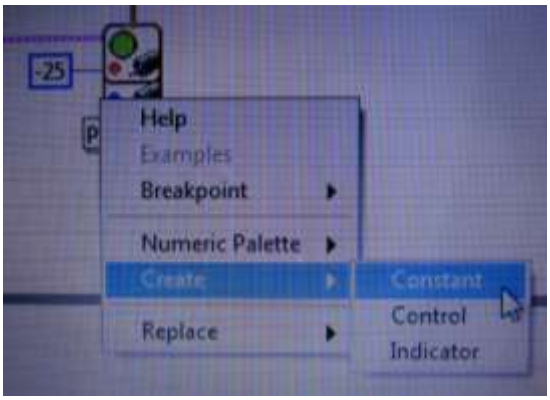
Wire them up

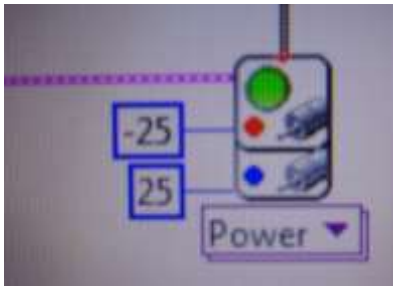
39. 

40. 

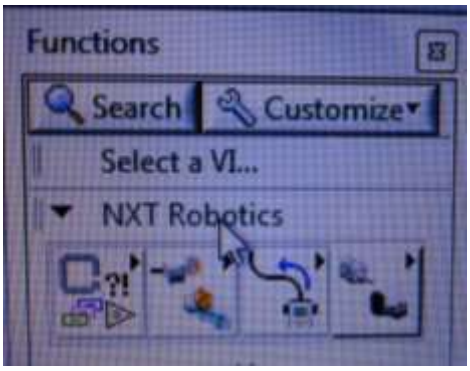
41. 
P1:C1:M1
P1:C1:M2
-25
Power

42. 
-25
Power
Power/Speed 2

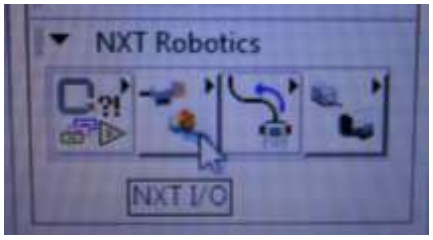
43. 
-25
Help
Examples
Breakpoint
Numeric Palette
Create
Replace
Constant
Control
Indicator

44. 
-25
25
Power

45.


Functions
Search
Customize
Select a VI...
NXT Robotics

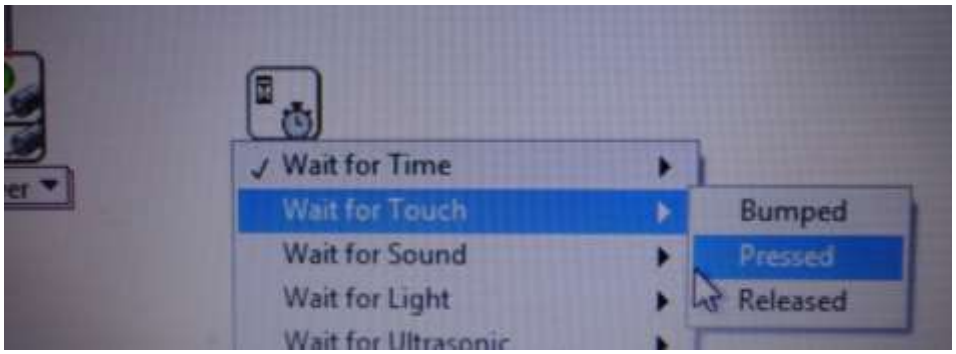
46.


NXT Robotics
NXT I/O

47.

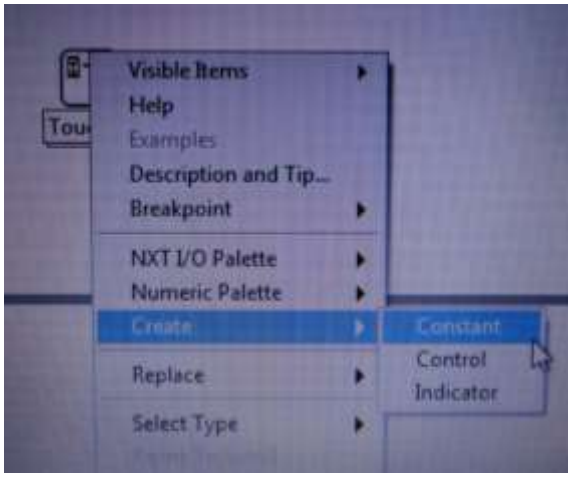

NXT Robotics
NXT I/O
Wait For

48.

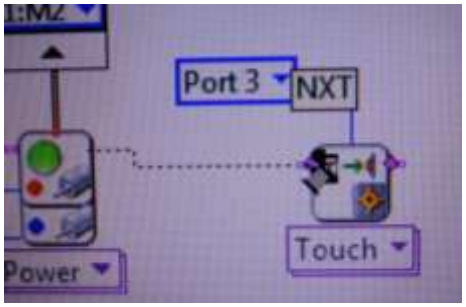

Wait for Time
Wait for Touch
Wait for Sound
Wait for Light
Bumped
Pressed
Released

49. 

The top

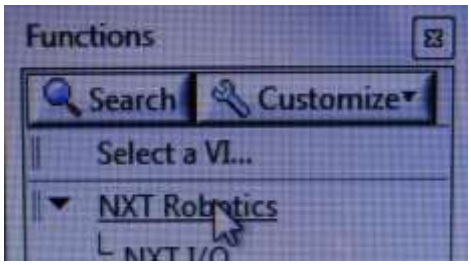
50. 

51. 

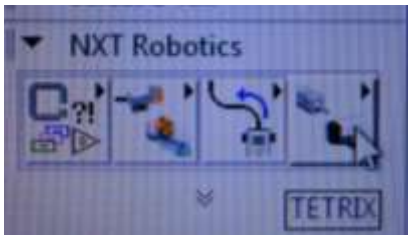
52. 

Wire them up.

53.

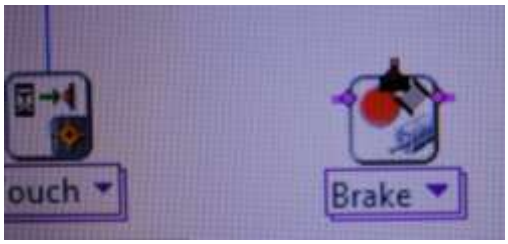


54.

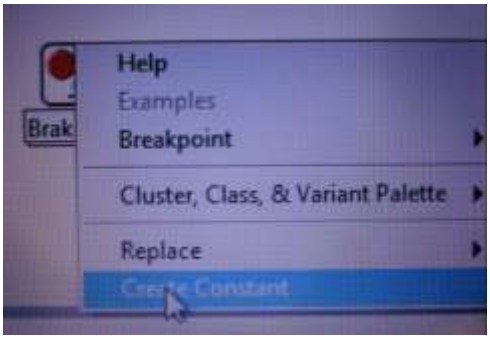


55.

56.

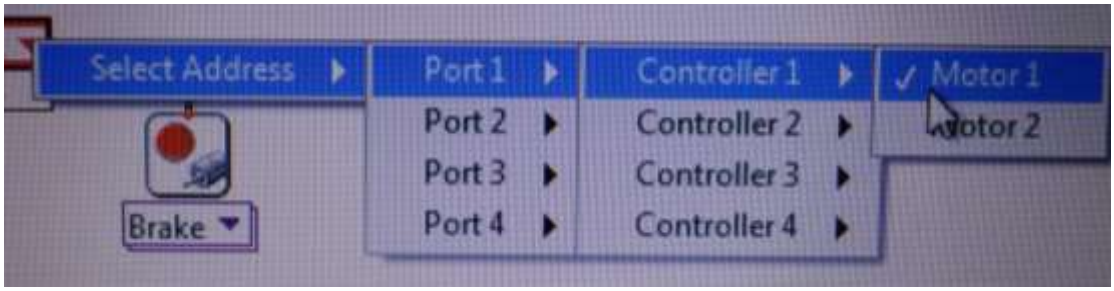


57.



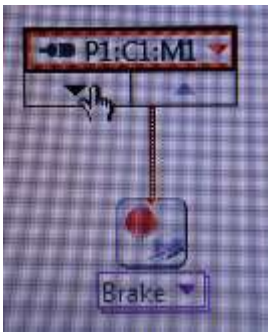
We have to pick which motors.

58.

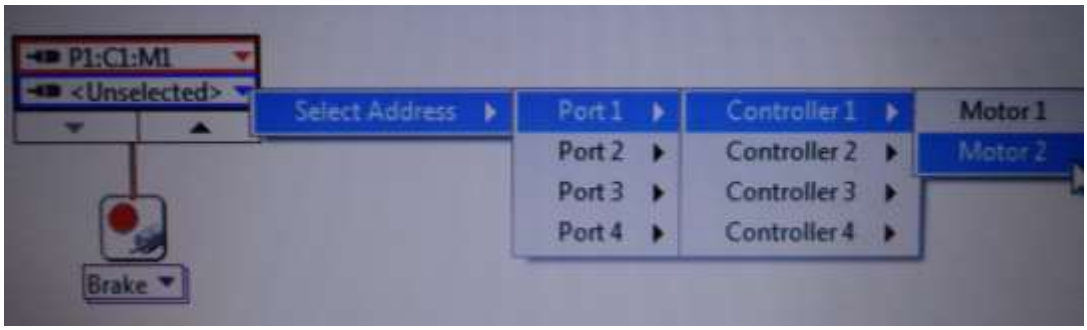


The other wheel motor: (if you look at the robot, you can see these ports and controllers labeled)

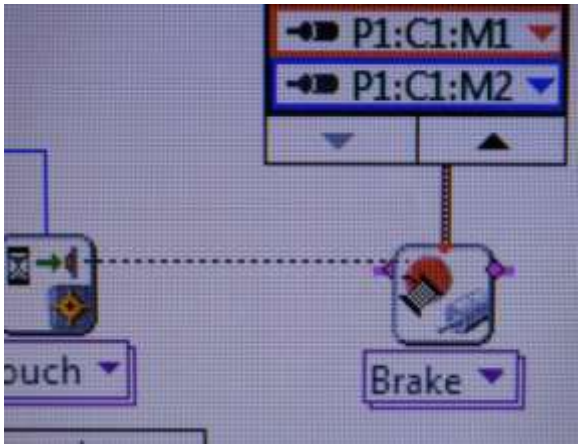
59.



60.



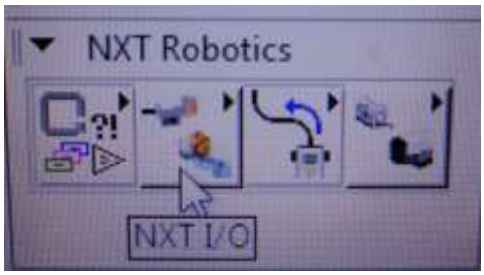
61.



Wire everything up in order.

62.

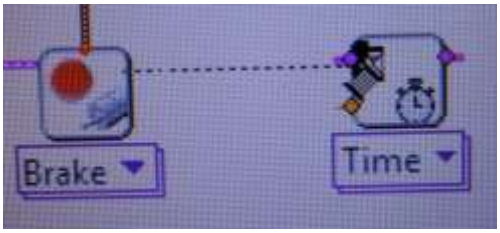
63.



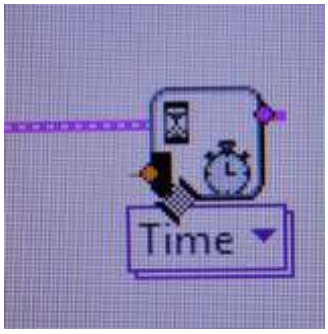
64.

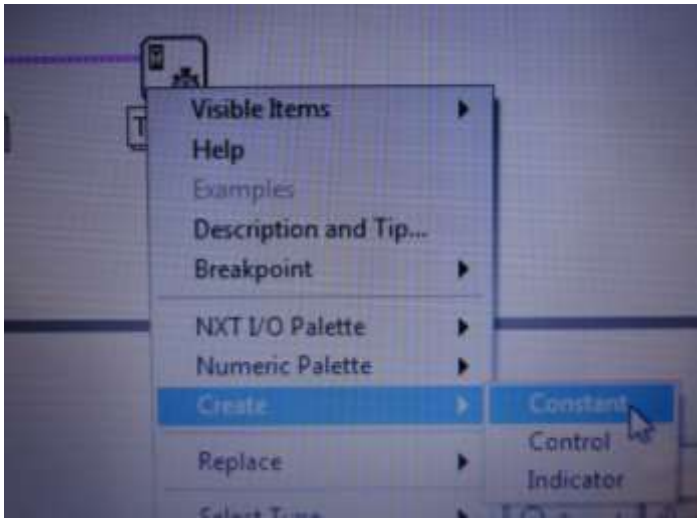
65.

66.



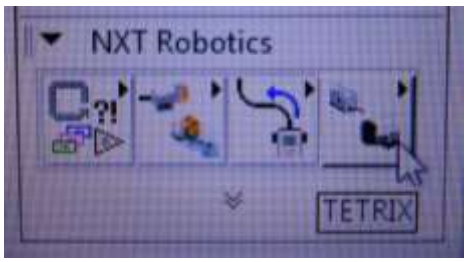
Wire them up.

67. 

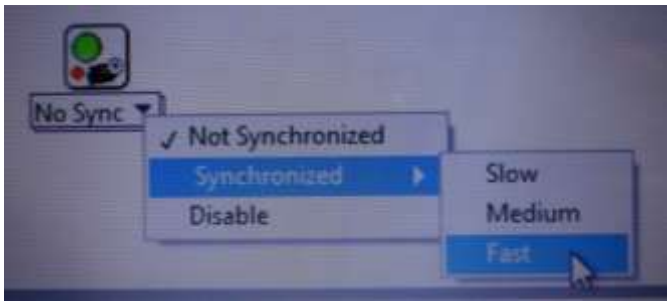
68. 

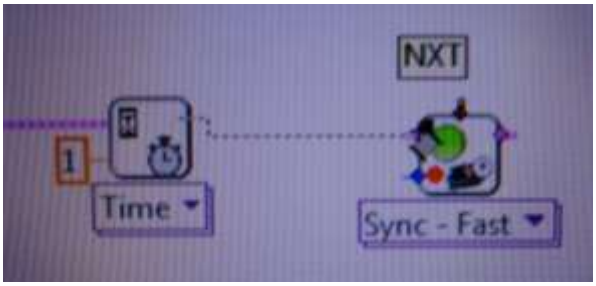
69. 

70. 

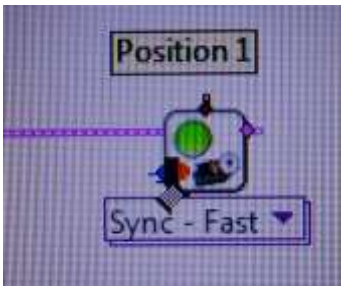
71. 

72. 

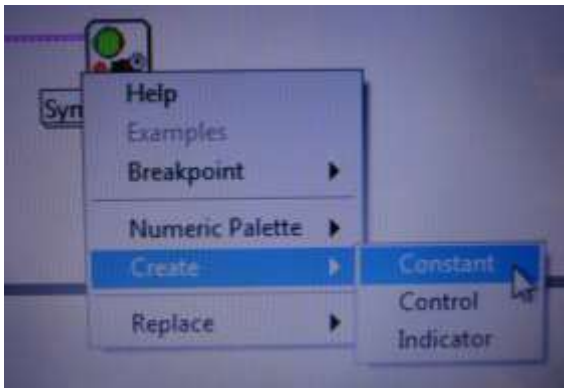
73. 
No Sync
Not Synchronized
Synchronized
Disable
Slow
Medium
Fast

74. 
NXT
1
Time
Sync - Fast

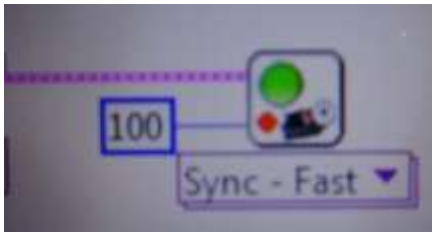
75.



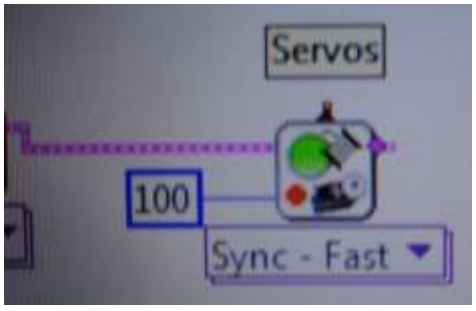
76.



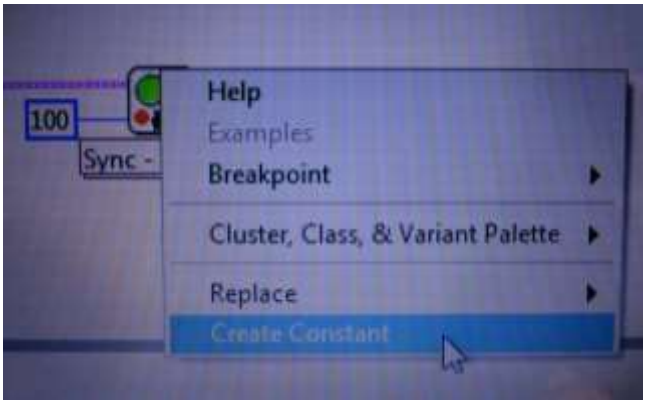
77.



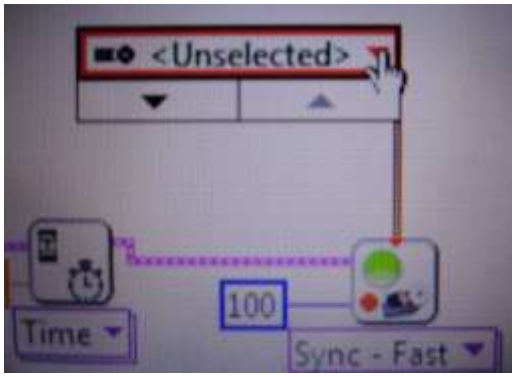
78.

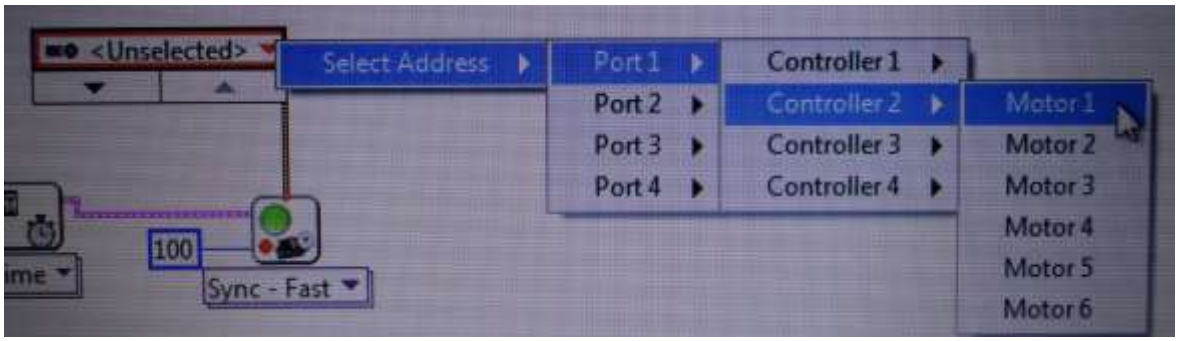


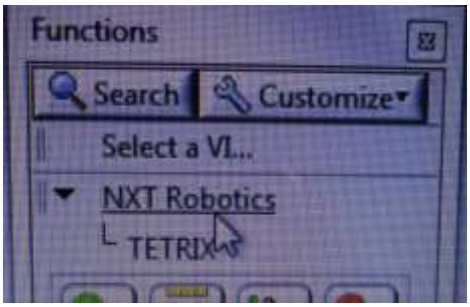
79.

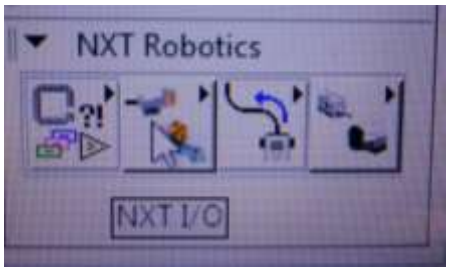


80.

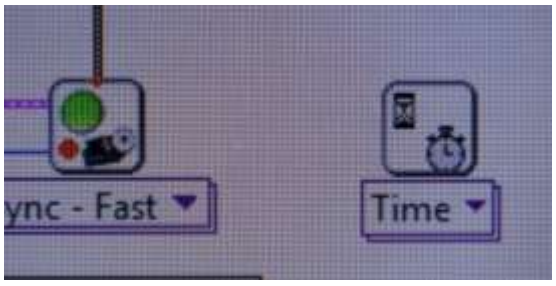


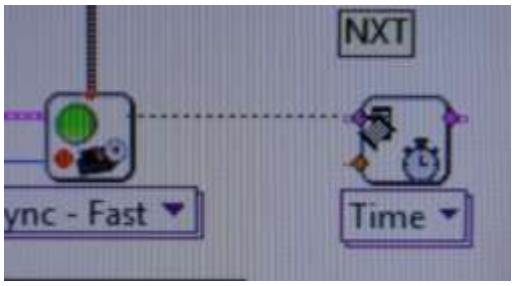
81. 

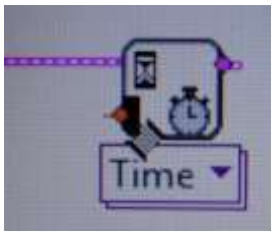
82. 

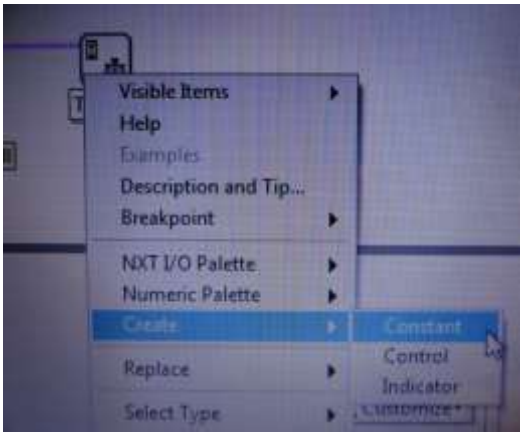
83. 

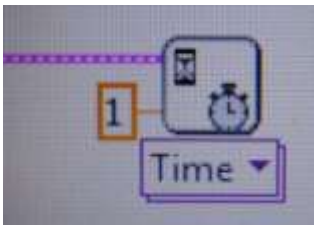
84. 

85. 

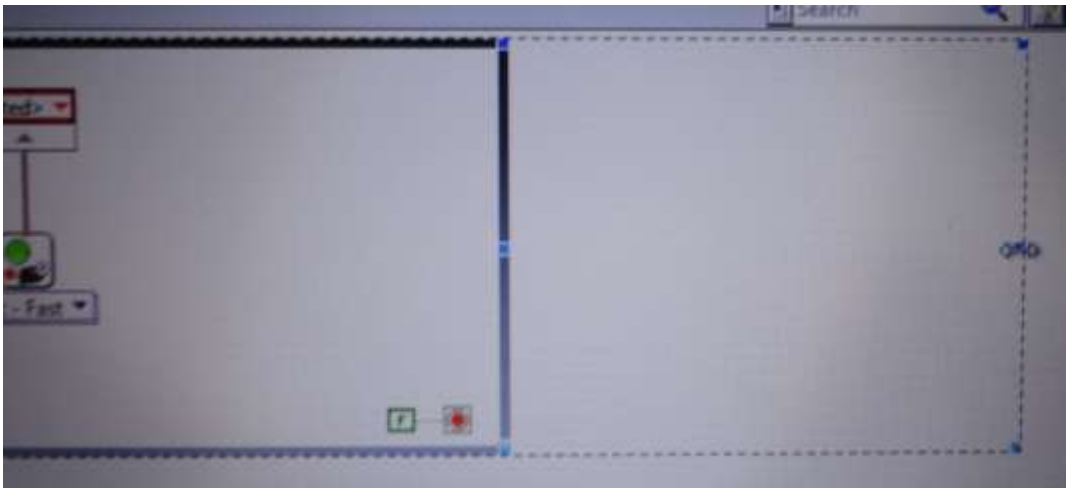
86. 

87. 

88. 

89. 

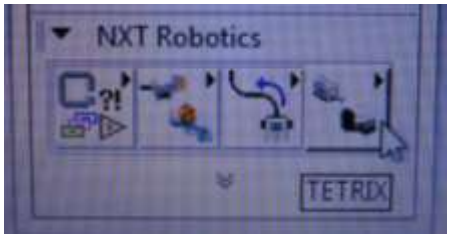
(If you don't set these constants, the robot will sometimes go crazy.)



Extend the Loop as needed.

90.

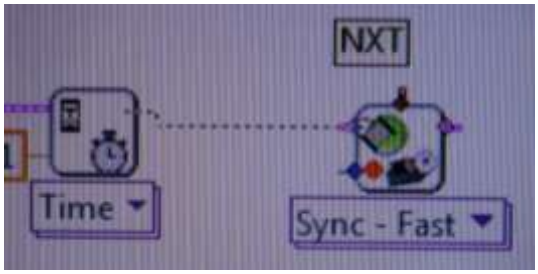
91.



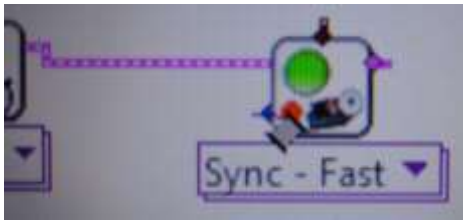
92.

93.

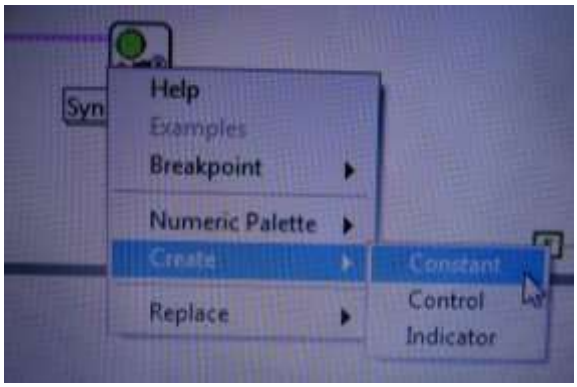
94.

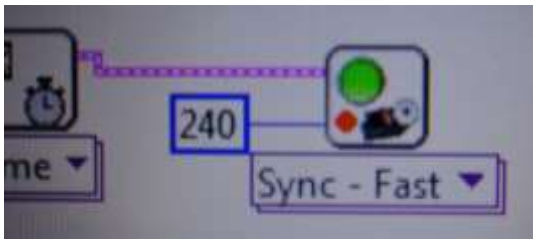


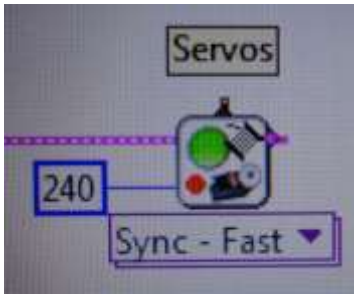
95.

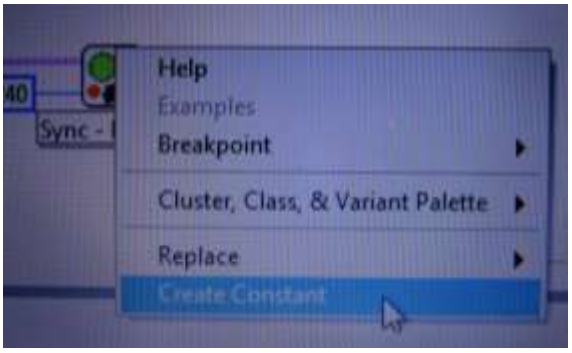


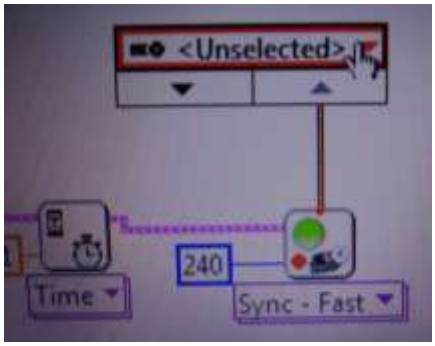
96.

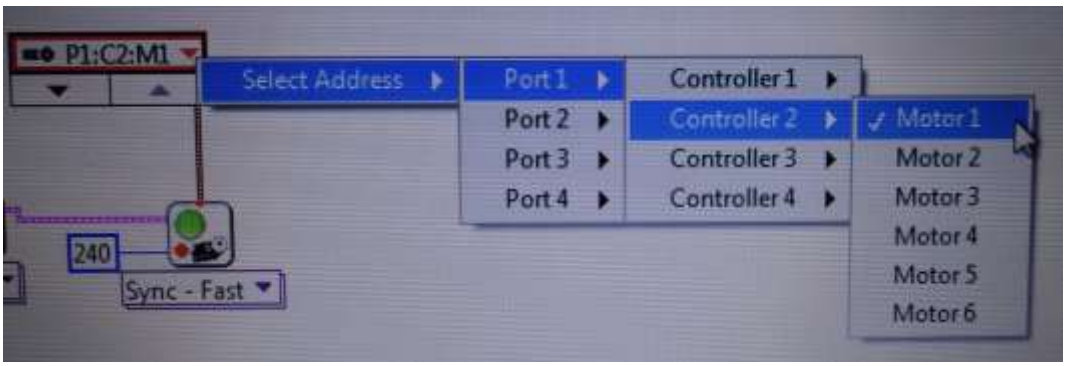


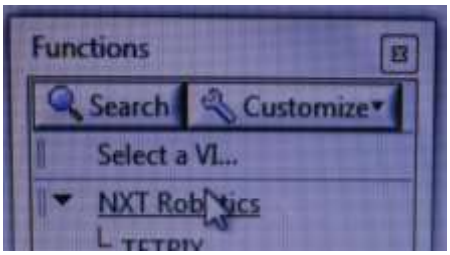
97. 
240
Sync - Fast

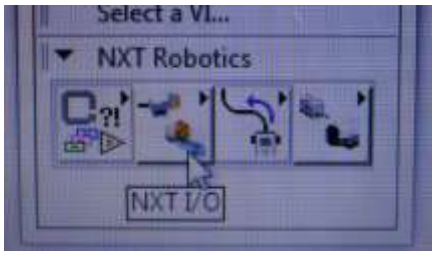
98. 
Servos
240
Sync - Fast

99. 
Help
Examples
Breakpoint
Cluster, Class, & Variant Palette
Replace
Create Constant

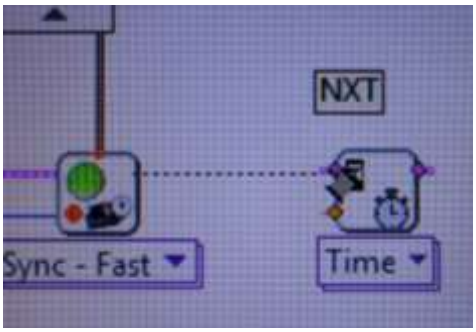
100. 
<Unselected>
240
Time
Sync - Fast

1-01. 

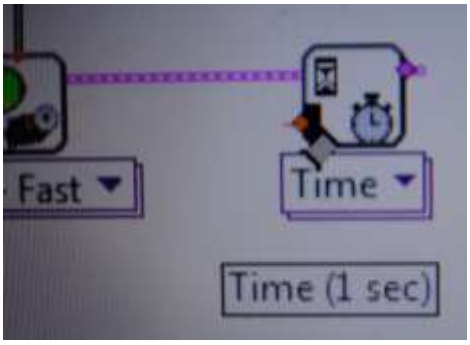
1-02. 

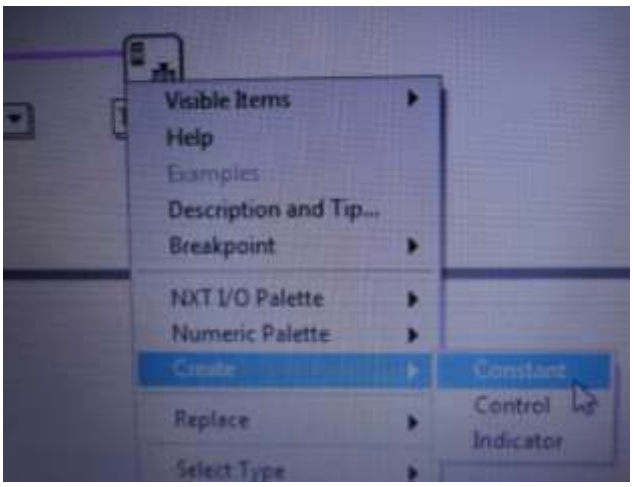
1-03. 

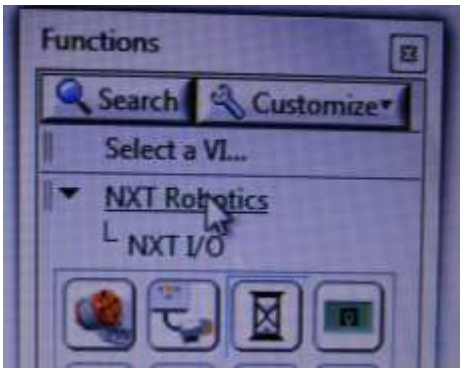
1-04. 

1-05. 

Wire them together.

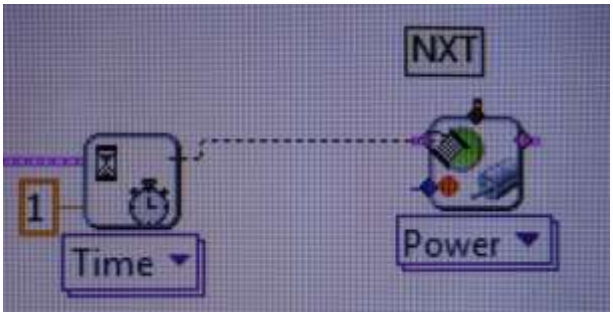
1-06. 

1-07. 

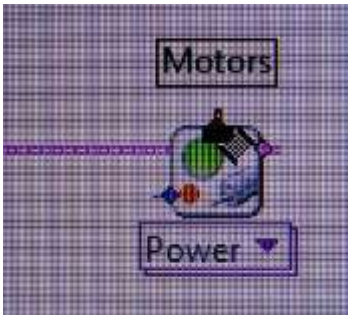
1-09. 

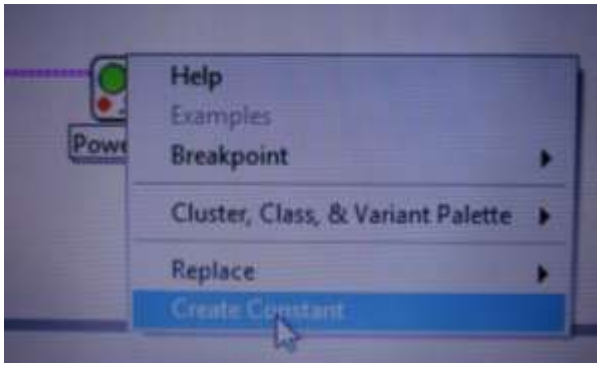
1-10. 

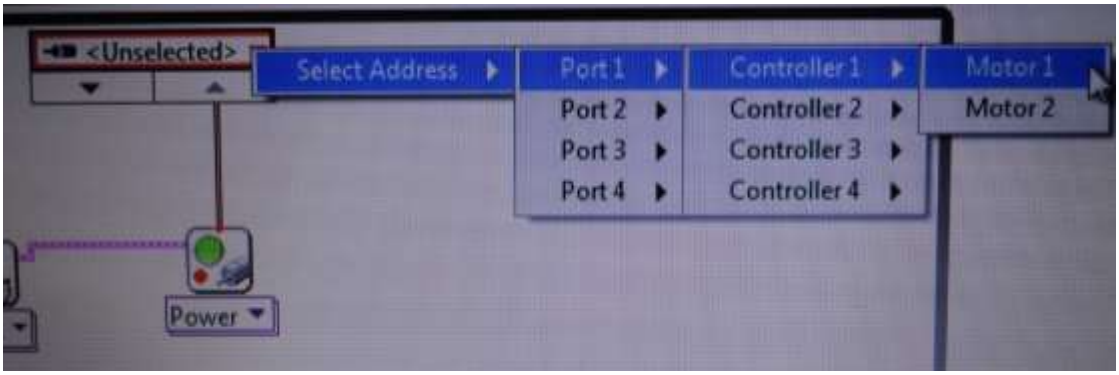
1-11. 

1-12. 

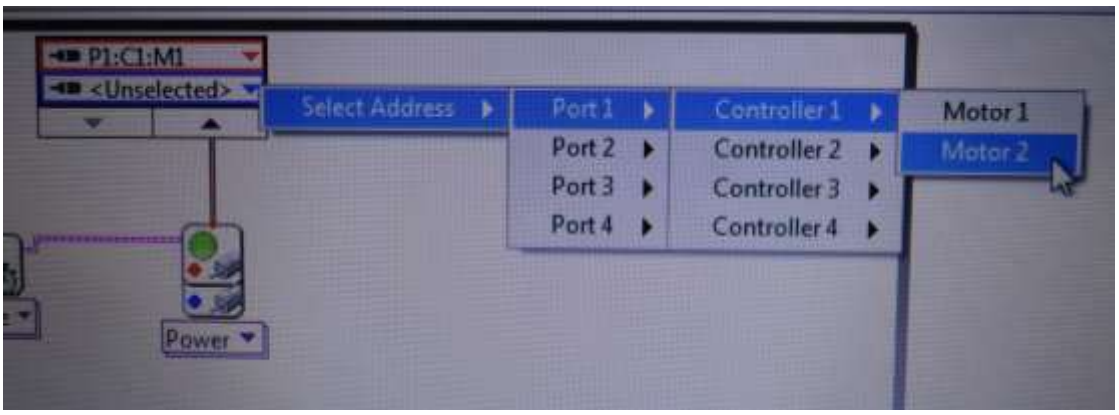
Wire them together.

1-13. 

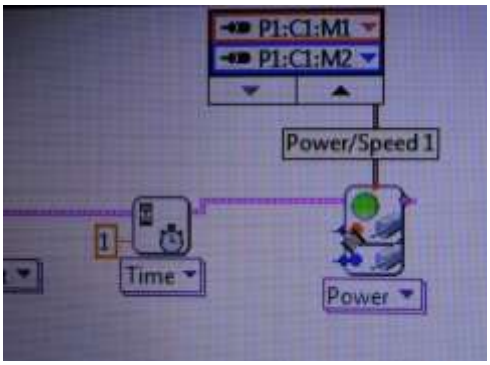
1-14. 

1-15. 

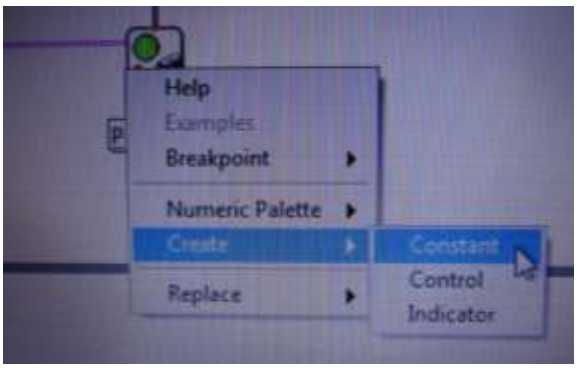
1-16.

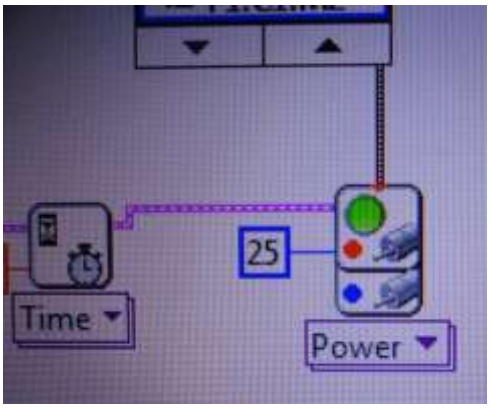

P1:C1:M1
<Unselected>
Select Address
Port 1
Port 2
Port 3
Port 4
Controller 1
Controller 2
Controller 3
Controller 4
Motor 1
Motor 2
Power

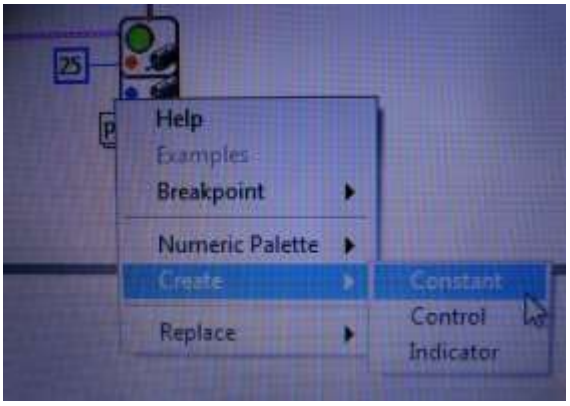
1-17.

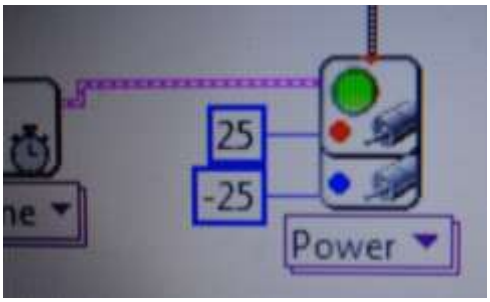

P1:C1:M1
P1:C1:M2
Power/Speed 1
1
Time
Power

1-18.


Help
Examples
Breakpoint
Numeric Palette
Create
Replace
Constant
Control
Indicator

1-19. 
25
Time
Power

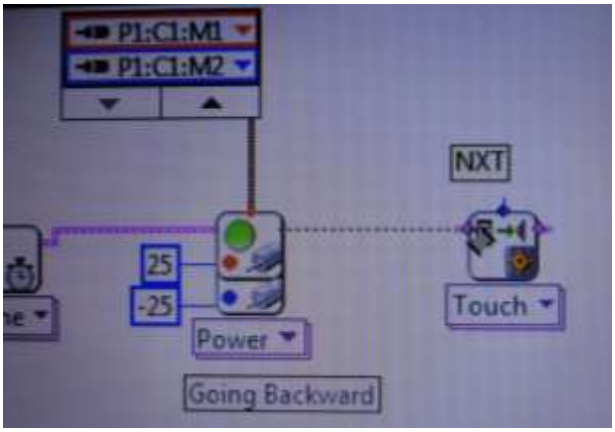
1-20. 
25
Help
Examples
Breakpoint
Numeric Palette
Create
Replace
Constant
Control
Indicator

1-21. 
25
-25
Power

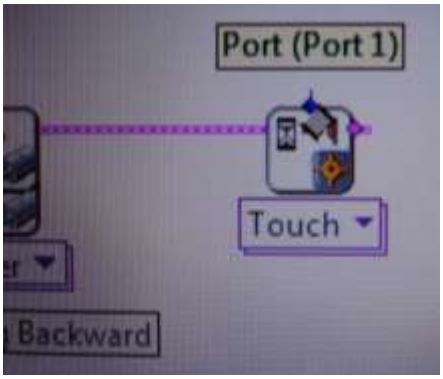
1-22. 

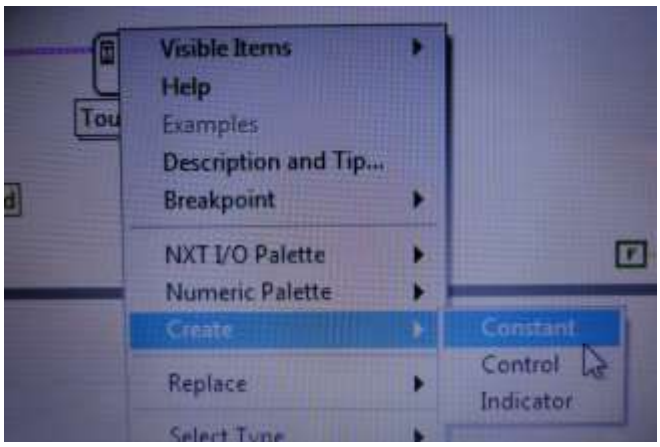
1-23. 

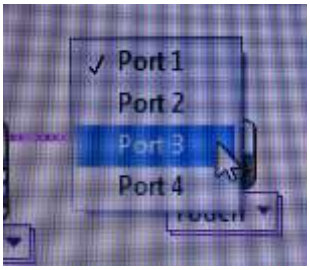
1-24. 

1-25. 

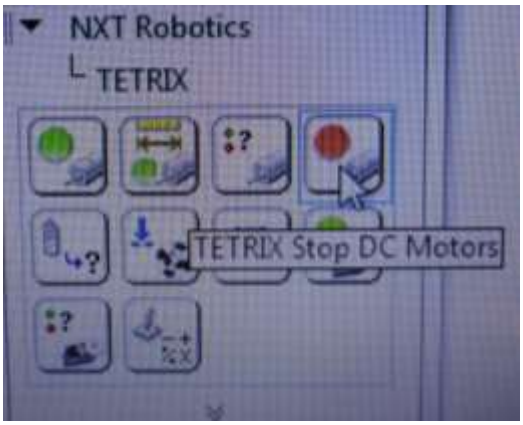
Wire them together.

1-26. 
Port (Port 1)
Touch
Backward

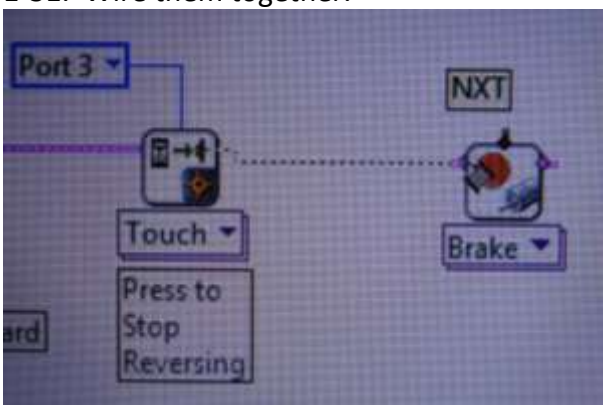
1-27. 
Visible Items
Help
Examples
Description and Tip...
Breakpoint
NXT I/O Palette
Numeric Palette
Create
Replace
Constant
Control
Indicator

1-28. 
Port 1
Port 2
Port 3
Port 4

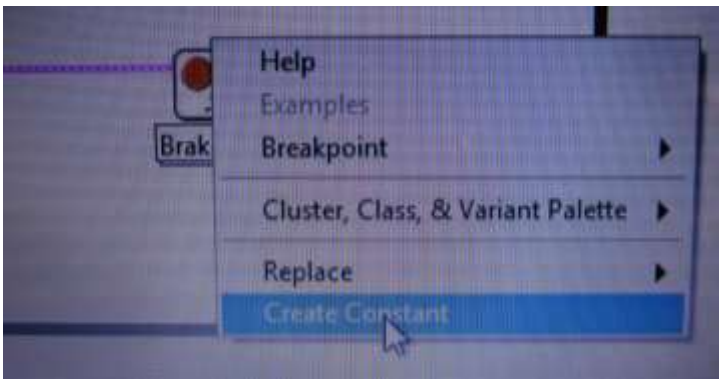
1-29. 

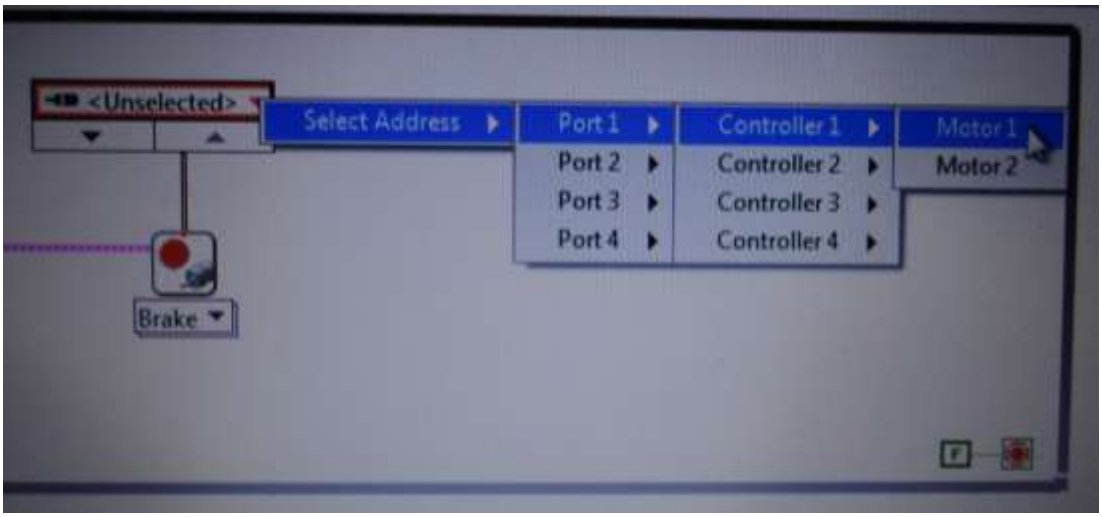
1-30. 

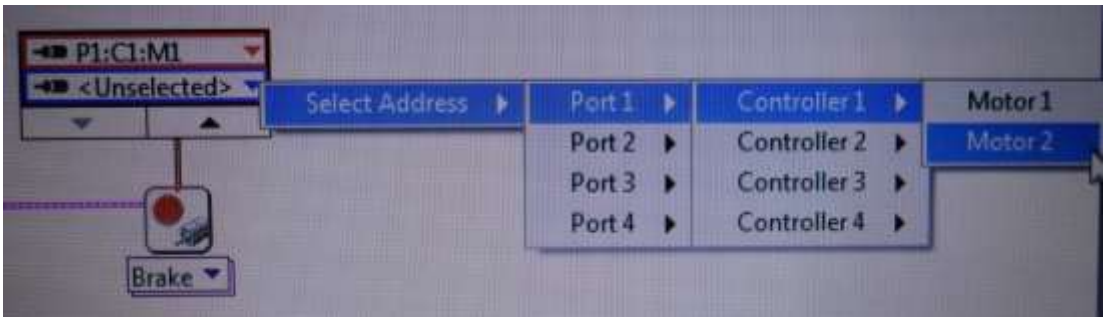
1-31. Wire them together.



1-32.

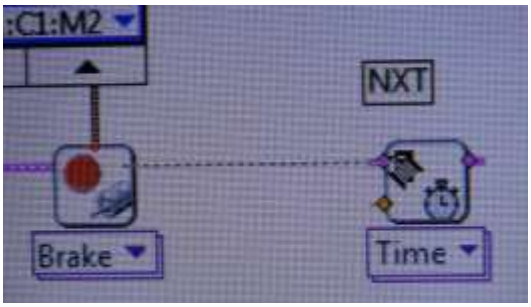


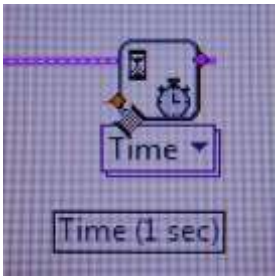
1-33. 

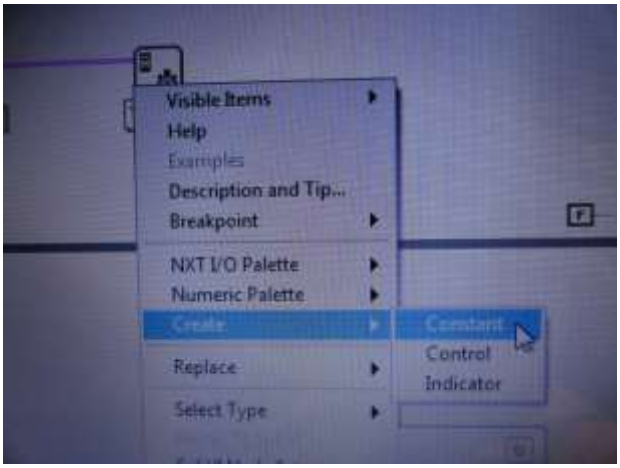
1-34. 

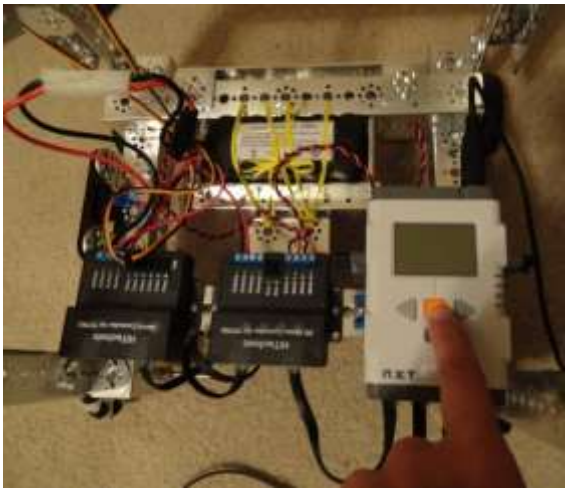
1-35. 

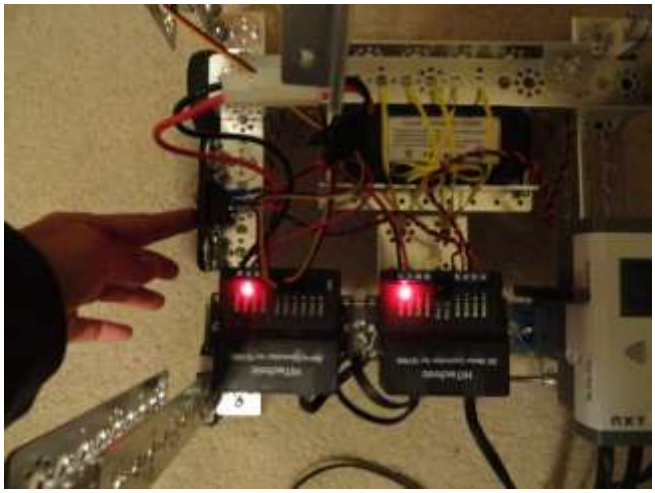
1-36. 

1-37. 
:C1:M2
NXT
Brake
Time

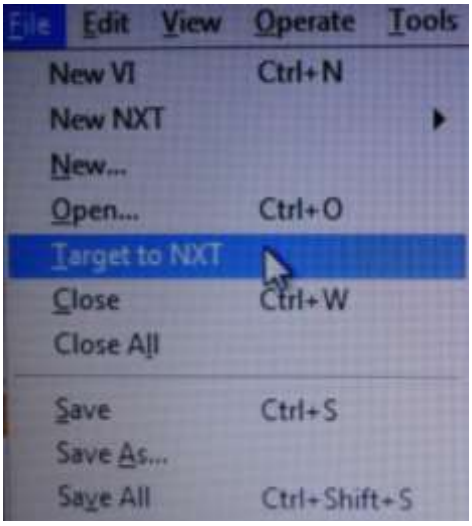
1-38. 
Time
Time (1 sec)

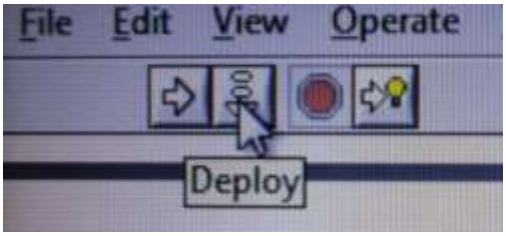
1-39. 
Visible Items
Help
Examples
Description and Tip...
Breakpoint
NXT I/O Palette
Numeric Palette
Create
Replace
Select Type
Constant
Control
Indicator





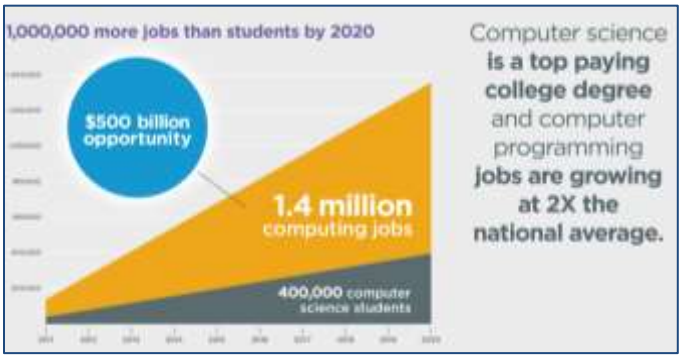
Connect to the robot with a USB cable, turn on both the NXT brick and the Tetrix motors.

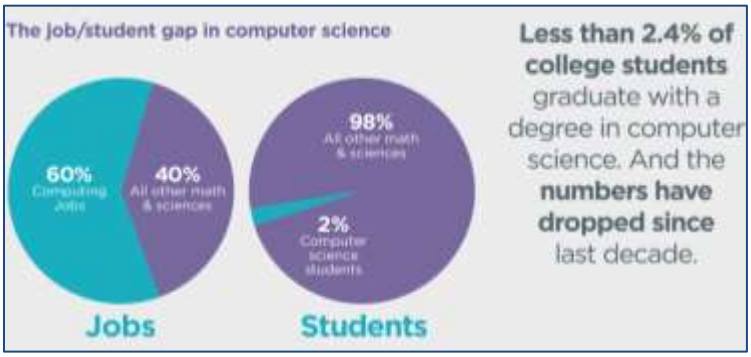




(To save: “Save Project As” to your flash drive, and then “Save All” before exiting to save your programs.)
Good job on all your hard work!

www.code.org





www.SCRATCH.mit.edu

Check out this website (get your parents' permission!) for a programming environment to make your own animations, games, stories and more, and share them with others! This is very similar to the Lego Mindstorms programming and will help you learn more about computer programming in a fun way.

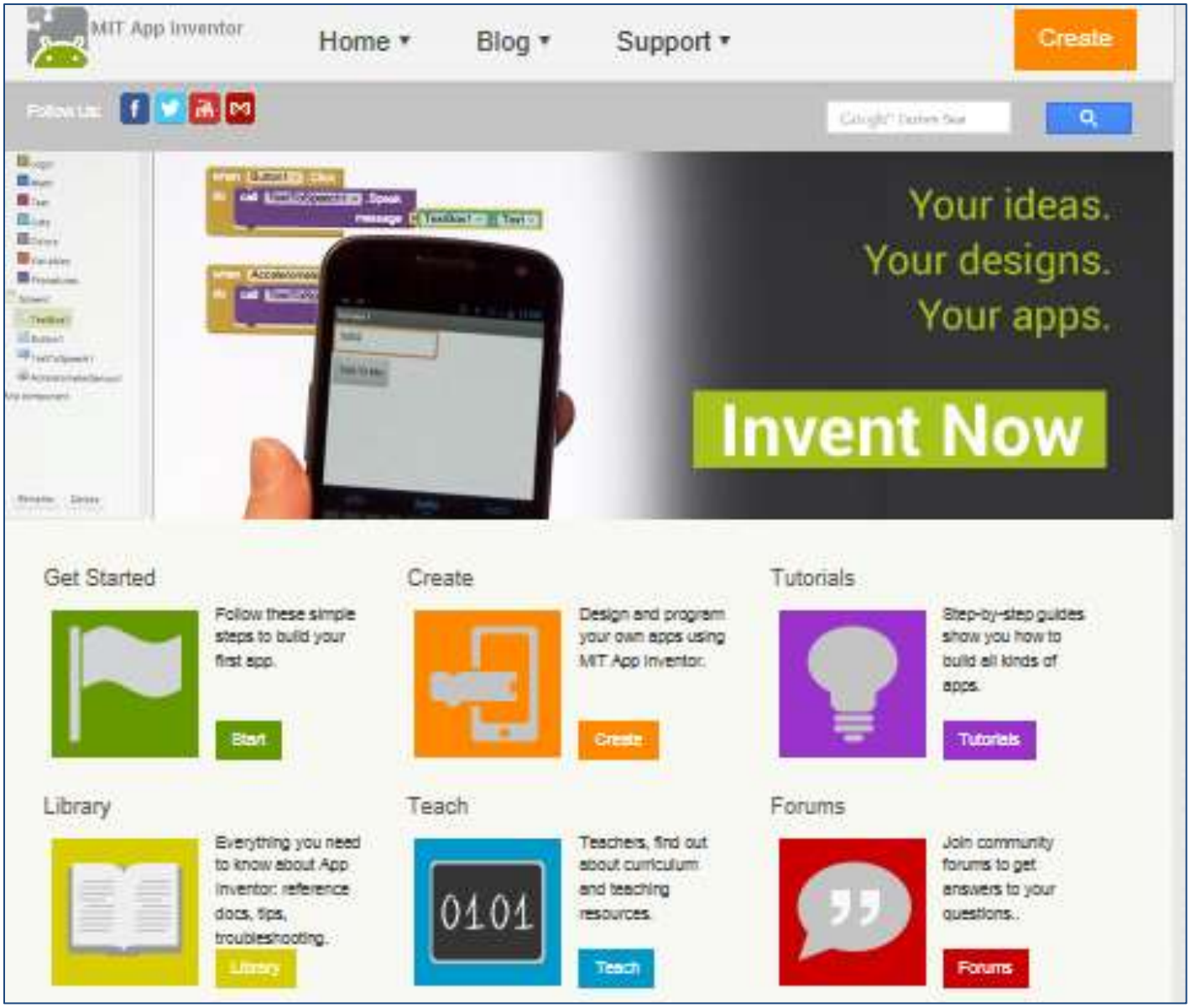
From their website:

About Scratch

Scratch is a programming language that makes it easy to create your own interactive stories, animations, games, music, and art -- and share your creations on the web.
As young people create and share Scratch projects, they learn important mathematical and computational ideas, while also learning to think creatively, reason systematically, and work collaboratively.

Scratch is developed by the Lifelong Kindergarten Group at the MIT Media Lab, with financial support from the National Science Foundation, Microsoft, Intel Foundation, MacArthur Foundation, Google, Iomega and MIT Media Lab research consortia.

imagine • program • share



Learn to make your own apps:
www.appinventor.mit.edu
programming is similar to Scratch!

MIT App Inventor