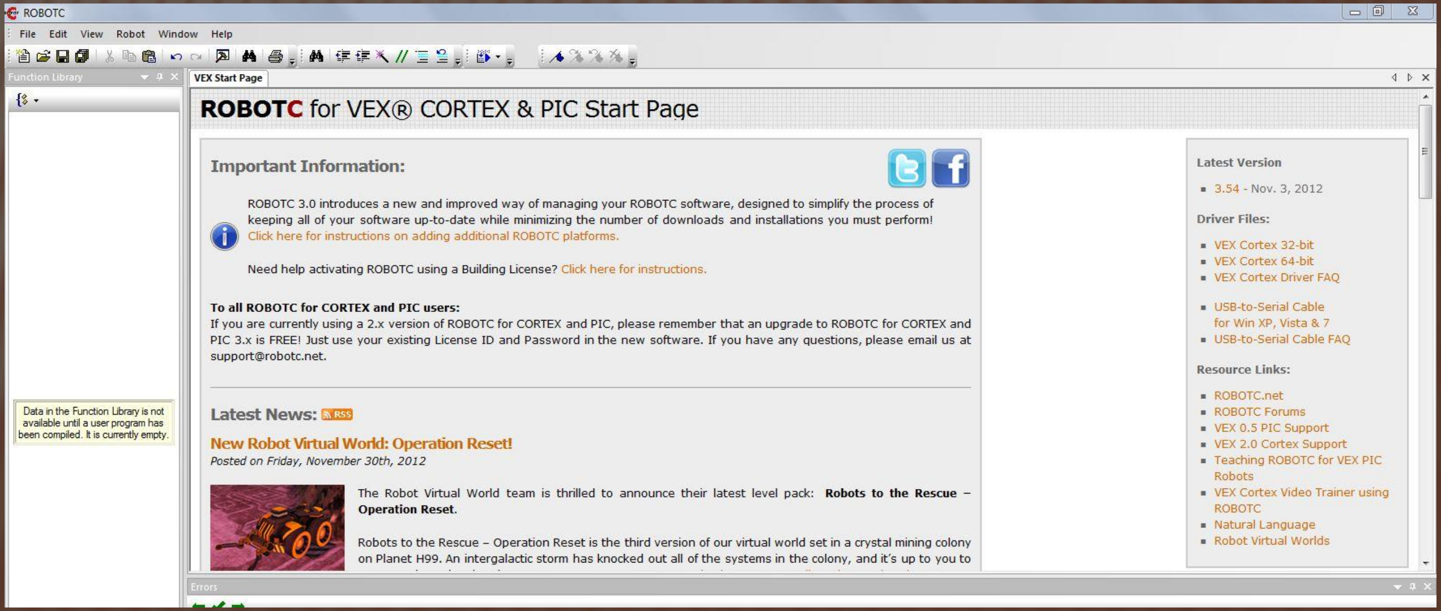
Automation and Robotics

# TESTBED PROGRAMING

# SET UP ROBOTC



Data in the Function Library is not available until a user program has been compiled. It is currently empty.

## ROBOTC for VEX® CORTEX & PIC Start Page

### Important Information:

ROBOTC 3.0 introduces a new and improved way of managing your ROBOTC software, designed to simplify the process of keeping all of your software up-to-date while minimizing the number of downloads and installations you must perform! Click here for instructions on adding additional ROBOTC platforms.

Need help activating ROBOTC using a Building License? Click here for instructions.

**To all ROBOTC for CORTEX and PIC users:**
If you are currently using a 2.x version of ROBOTC for CORTEX and PIC, please remember that an upgrade to ROBOTC for CORTEX and PIC 3.x is FREE! Just use your existing License ID and Password in the new software. If you have any questions, please email us at support@robotc.net.

### Latest News: RSS

New Robot Virtual World: Operation Reset!

*Posted on Friday, November 30th, 2012*

The Robot Virtual World team is thrilled to announce their latest level pack: **Robots to the Rescue – Operation Reset**.

Robots to the Rescue – Operation Reset is the third version of our virtual world set in a crystal mining colony on Planet H99. An intergalactic storm has knocked out all of the systems in the colony, and it's up to you to

**Latest Version**

- 3.54 - Nov. 3, 2012

**Driver Files:**

- VEX Cortex 32-bit
- VEX Cortex 64-bit
- VEX Cortex Driver FAQ

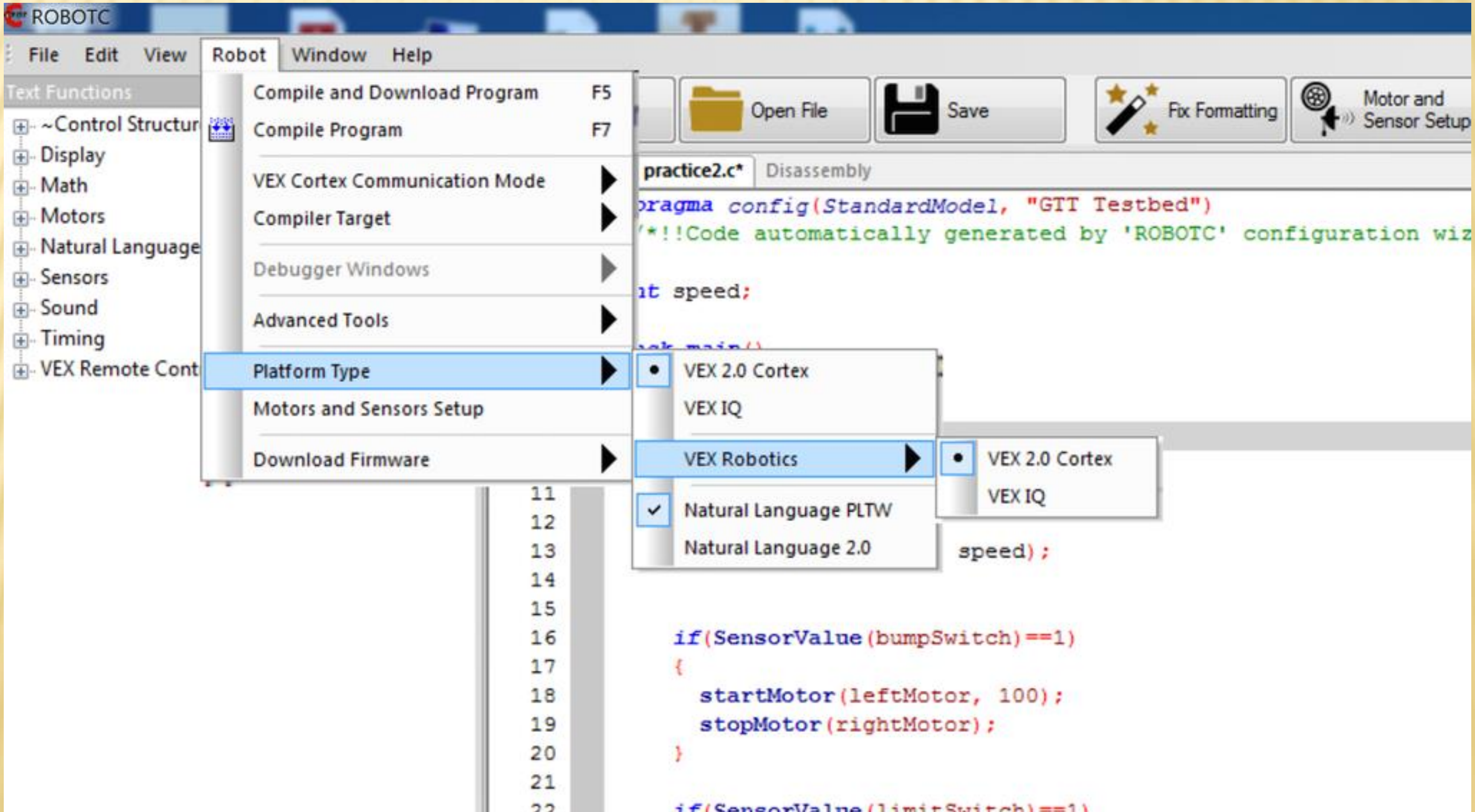
- USB-to-Serial Cable for Win XP, Vista & 7
- USB-to-Serial Cable FAQ

**Resource Links:**

- ROBOTC.net
- ROBOTC Forums
- VEX 0.5 PIC Support
- VEX 2.0 Cortex Support
- Teaching ROBOTC for VEX PIC Robots
- VEX Cortex Video Trainer using ROBOTC
- Natural Language
- Robot Virtual Worlds

# PLATFORM TYPE

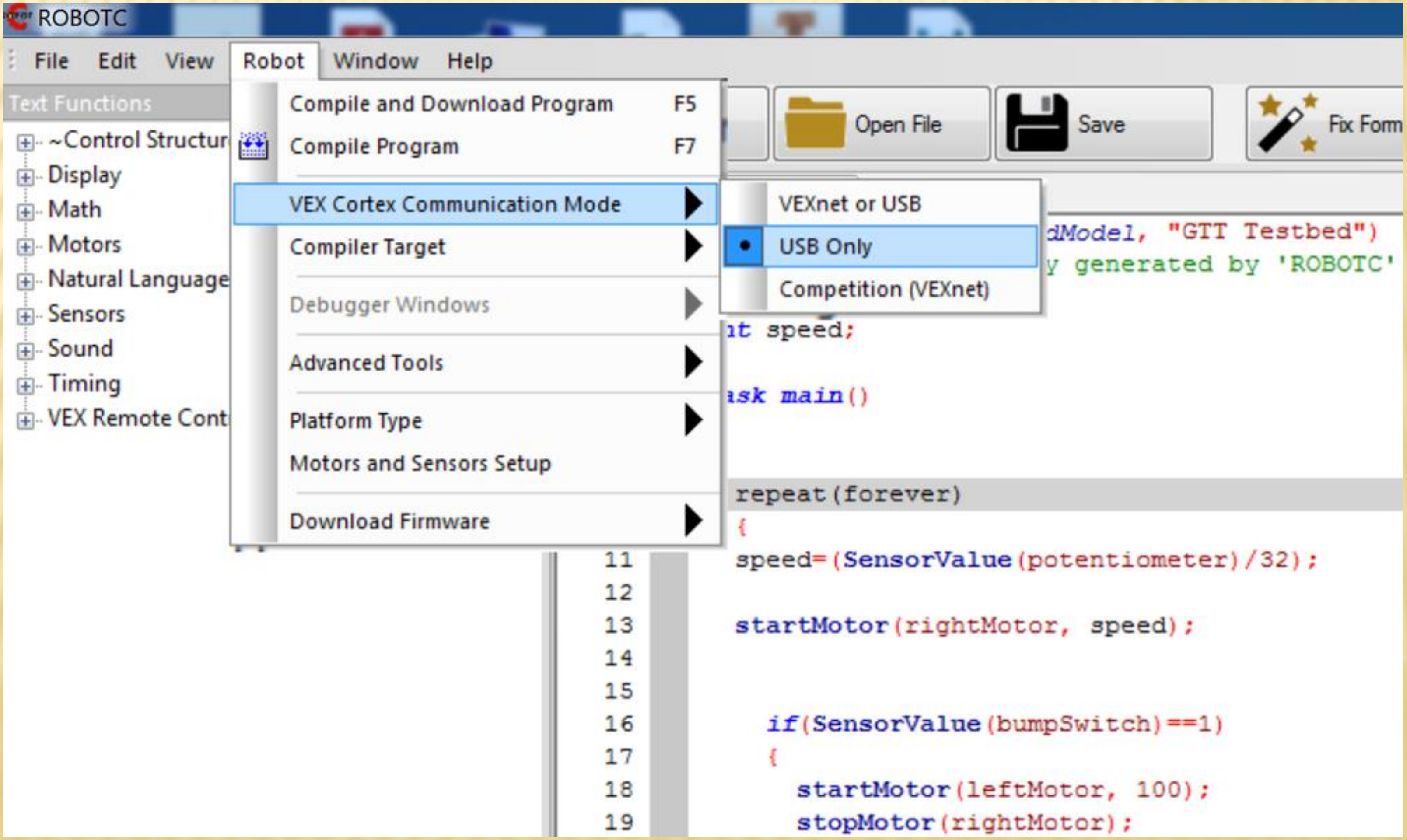
- First you select the platform type so that you can use Natural Language



```
pragma config(StandardModel, "GTT Testbed")
/*!!Code automatically generated by 'ROBOTC' configuration wiz

nt speed;

                                speed);

    if(SensorValue(bumpSwitch)==1)
    {
      startMotor(leftMotor, 100);
      stopMotor(rightMotor);
    }

    if(SensorValue(limitSwitch)==1)
```

# VEX CORTEX COMMUNICATION MODE

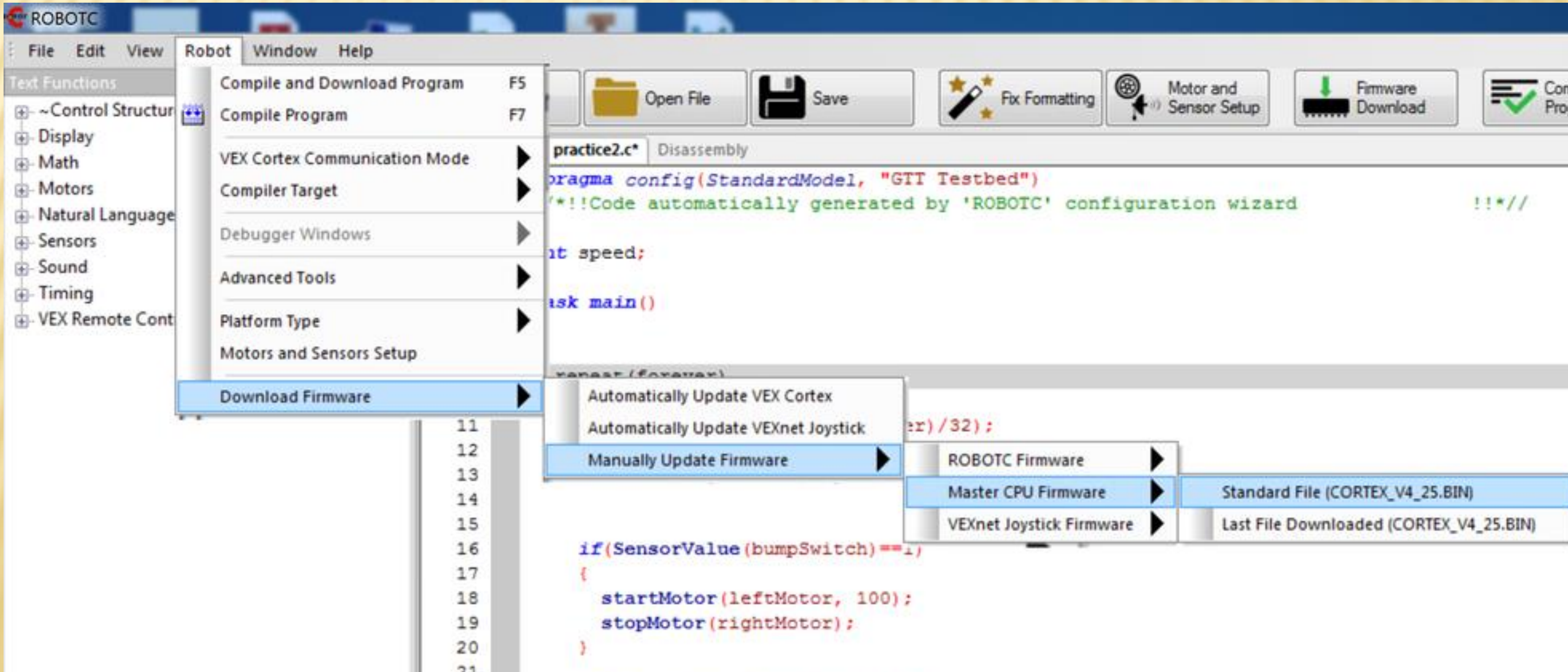
- Choose USB only



```
dModel, "GTT Testbed")
y generated by 'ROBOTC'

it speed;

ask main()


repeat(forever)
{
speed=(SensorValue(potentiometer)/32);

startMotor(rightMotor, speed);


  if(SensorValue(bumpSwitch)==1)
  {
    startMotor(leftMotor, 100);
    stopMotor(rightMotor);
```

# DOWNLOAD FIRMWARE

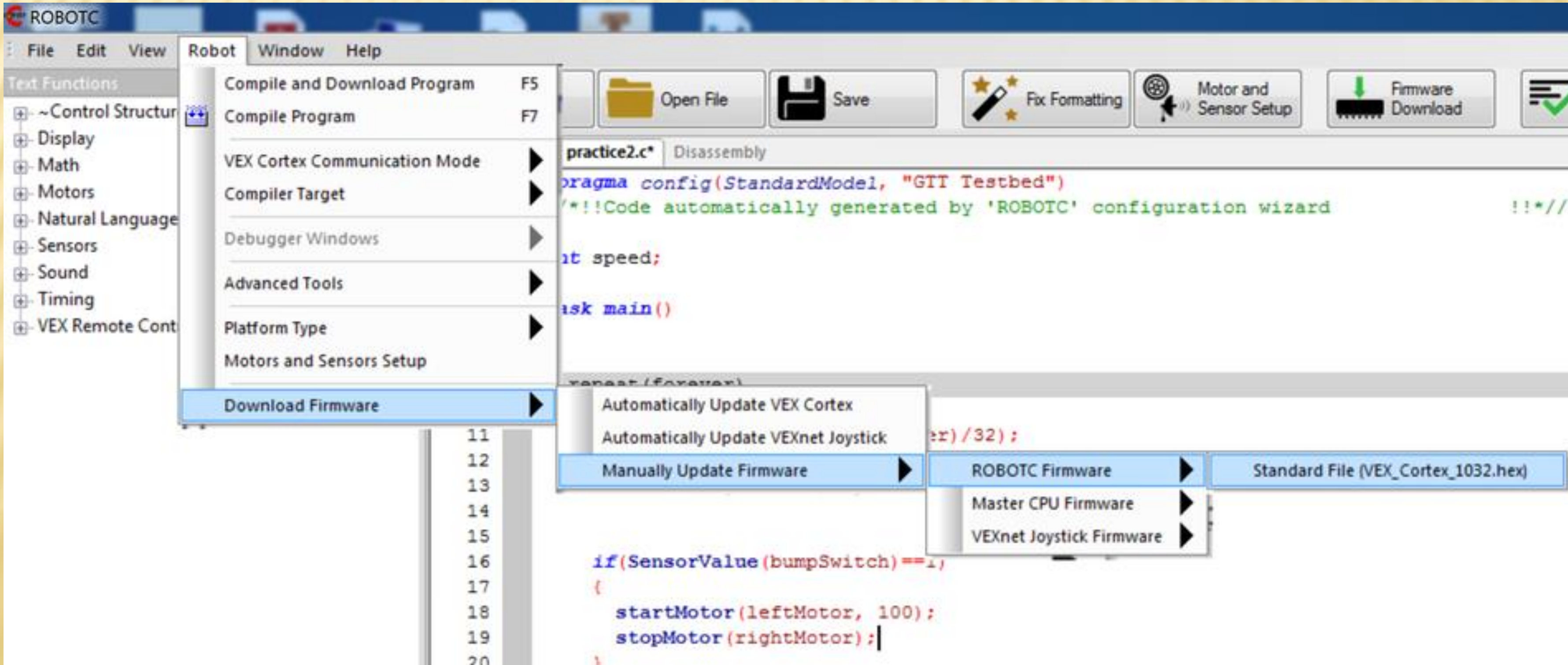
- The first time we connect to our cortex we need to make sure they have the updated firmware. This is a two step process. Step 1



```
pragma config(StandardModel, "GTT Testbed")
/*!!Code automatically generated by 'ROBOTC' configuration wizard               !!*//

nt speed;

ask main()

repeat(forever)

                                    er)/32);




    if(SensorValue(bumpSwitch)==1)
    {
      startMotor(leftMotor, 100);
      stopMotor(rightMotor);
    }
```

# DOWNLOAD FIRMWARE

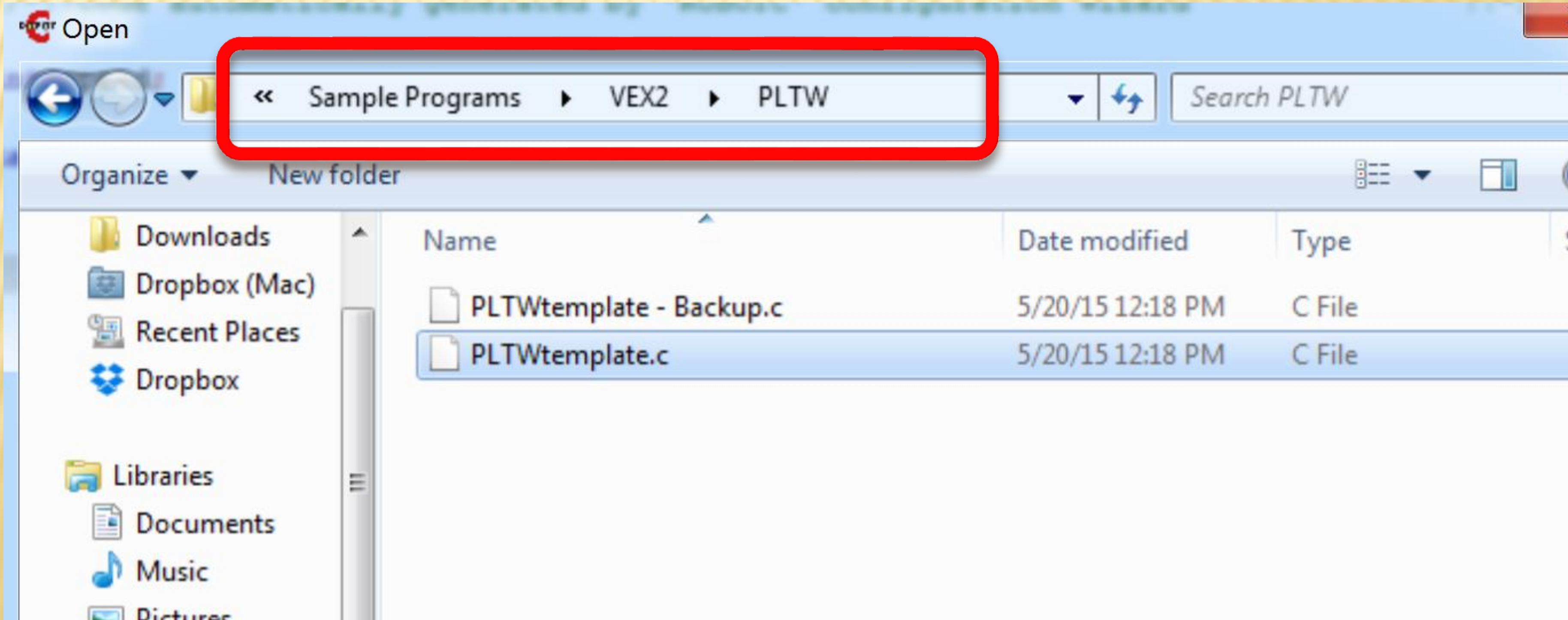
- The first time we connect to our cortex we need to make sure they have the updated firmware. This is a two step process. Step 2



```
pragma config(StandardModel, "GTT Testbed")
*!!Code automatically generated by 'ROBOTC' configuration wizard               !!*//

nt speed;

ask main()

  repeat(forever)

                                          er)/32);



    if(SensorValue(bumpSwitch)==1)
    {
      startMotor(leftMotor, 100);
      stopMotor(rightMotor);
```

# OPEN SAMPLE PROGRAM

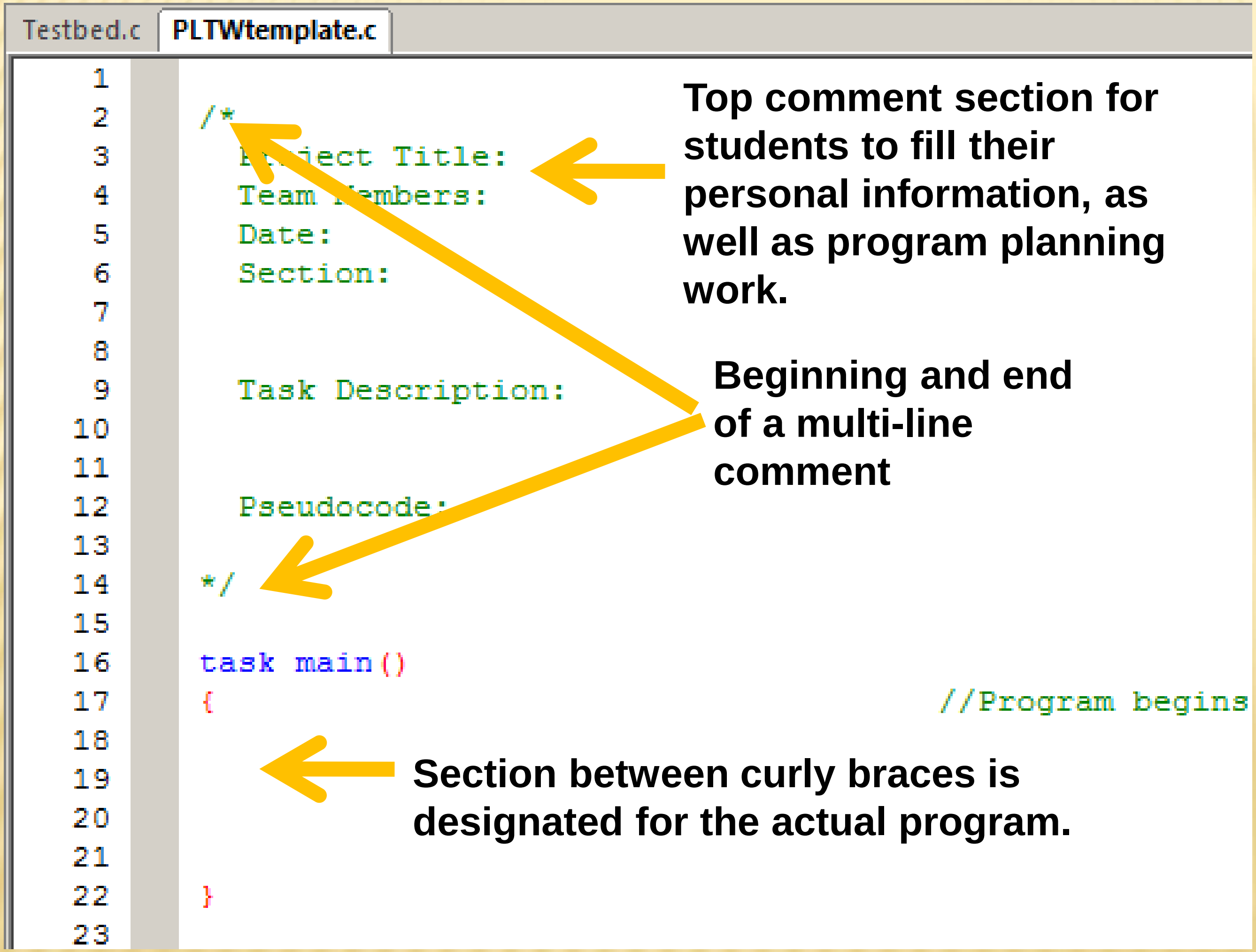
- You need to locate PLTWtemplate – go to open SAMPLE program.
- Immediately Save As “name” to your AR folder



« Sample Programs ▸ VEX2 ▸ PLTW

| Name | Date modified | Type |
|---|---|---|
| PLTWtemplate - Backup.c | 5/20/15 12:18 PM | C File |
| PLTWtemplate.c | 5/20/15 12:18 PM | C File |

# PLTW TEMPLATE



```

/*
   Project Title:
   Team Members:
   Date:
   Section:


   Task Description:


   Pseudocode:

*/

task main()
{                                       //Program begins




}

```

Top comment section for students to fill their personal information, as well as program planning work.

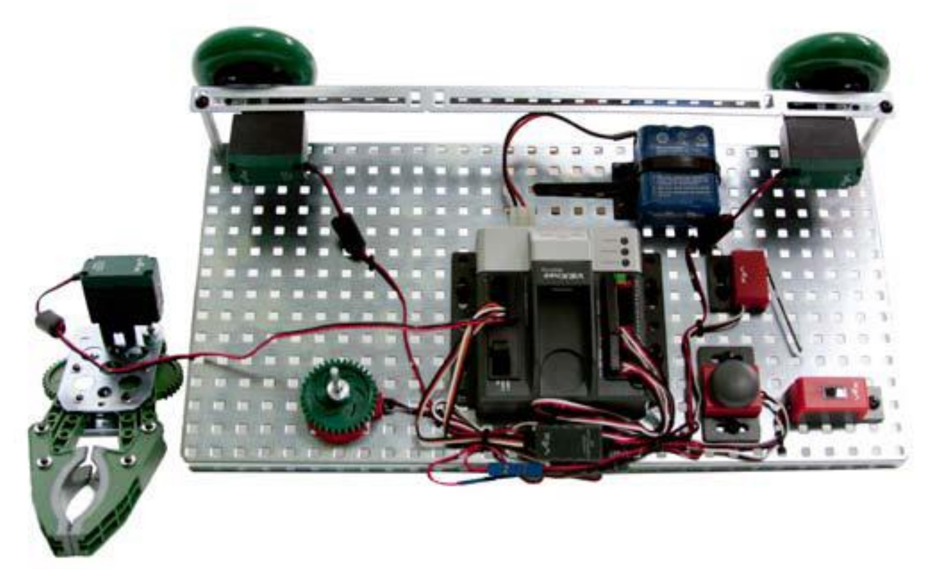
Beginning and end of a multi-line comment

Section between curly braces is designated for the actual program.

- Top comment section for student information
- After task main () is the code.

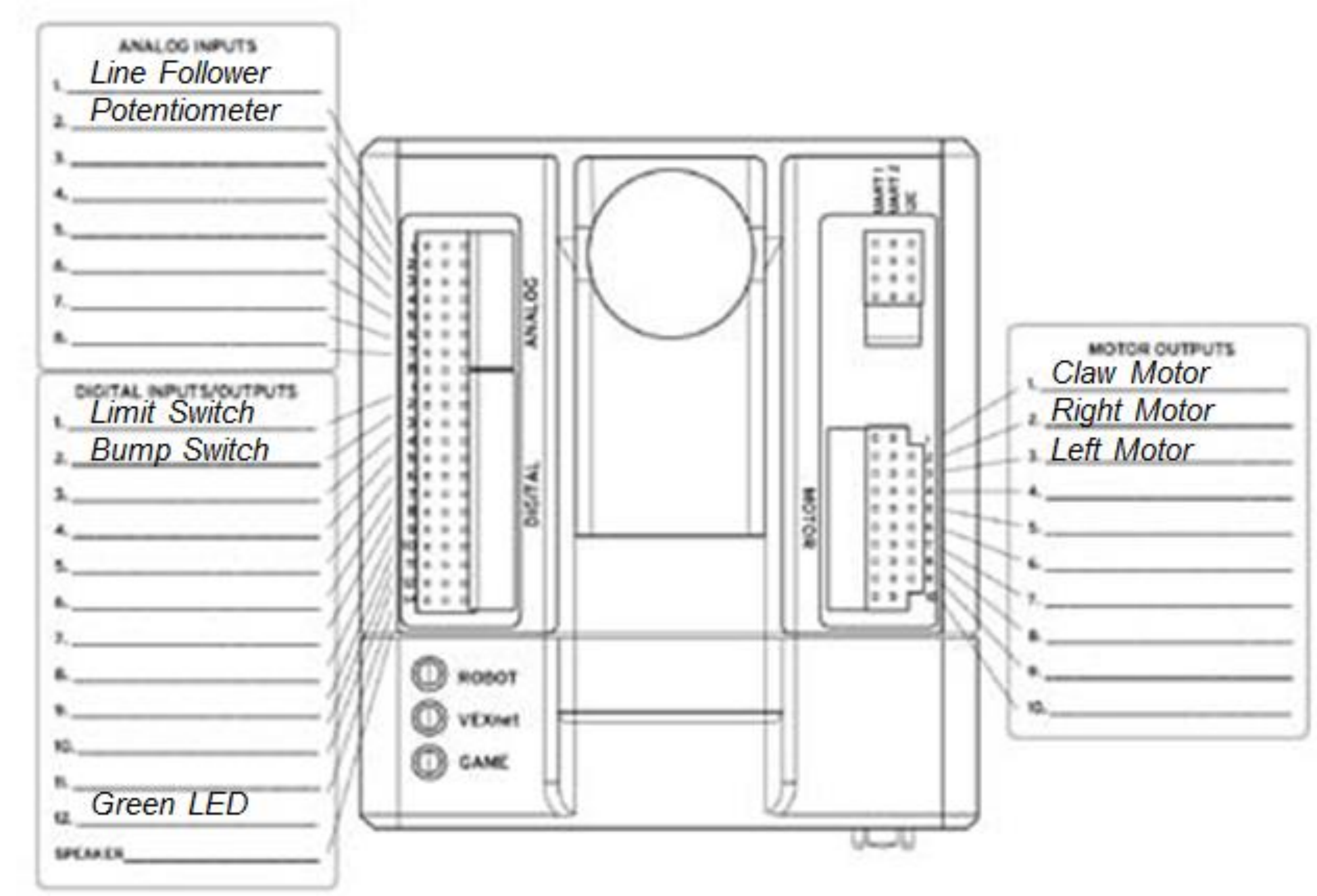
# CONNECT CORTEX

- Use orange USB cable to connect your cortex to the computer.
- Turn up the sound and make sure you get "the bonk" when you plug it in. Make sure it is off when you connect it.
- Then turn cortex on.



# CHECK THE WIRING GUIDE

- Check your wiring guide to make sure all your sensors are in the right places.



ANALOG INPUTS

1. Line Follower
2. Potentiometer
3. 
4. 
5. 
6. 
7. 
8.

DIGITAL INPUTS/OUTPUTS

1. Limit Switch
2. Bump Switch
3. 
4. 
5. 
6. 
7. 
8. 
9. 
10. 
11. 
12. Green LED

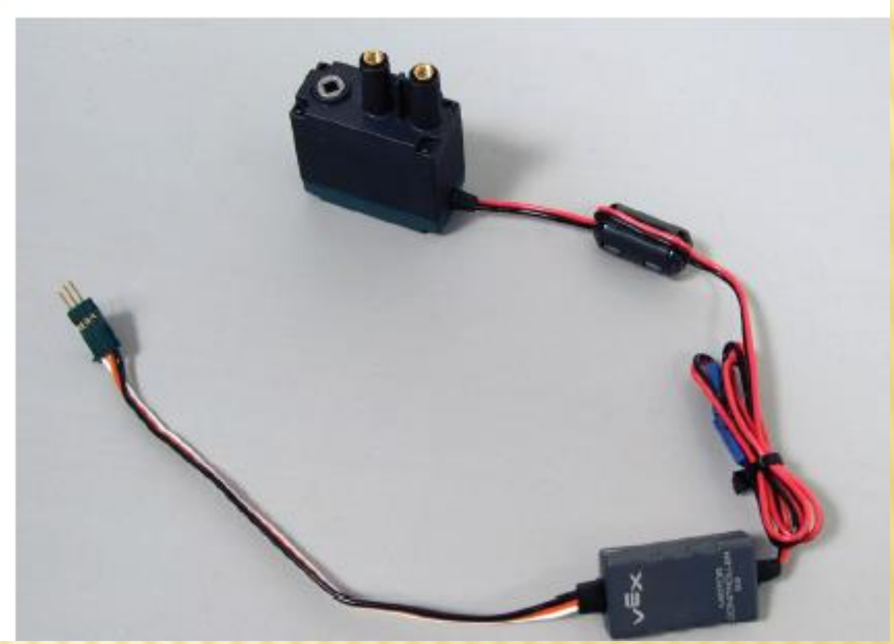
SPEAKER

MOTOR OUTPUTS

1. Claw Motor
2. Right Motor
3. Left Motor
4. 
5. 
6. 
7. 
8. 
9. 
10.

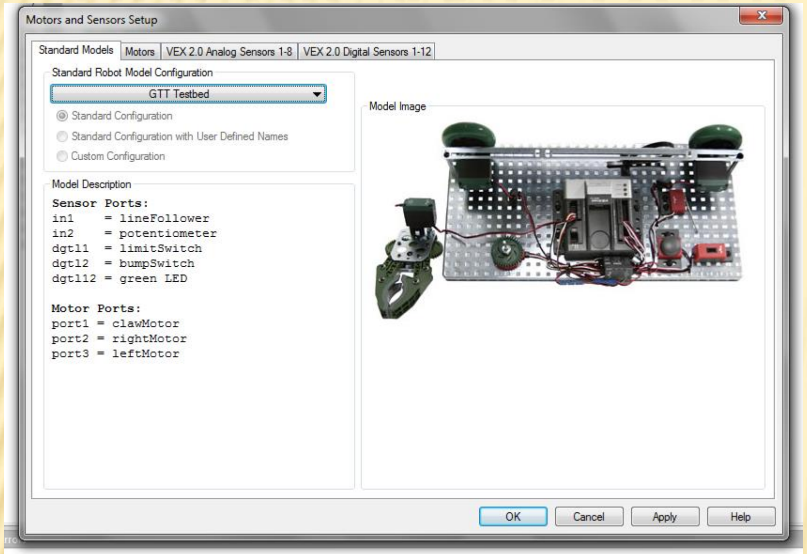
# MOTORS

- All our motors are VEX 393 two-wire motors
- Two-wire motors can be plugged directly into MOTOR ports 1 or 10 on the Cortex
- 2-9 need a Motor Controller wire
- 126 is full speed – 63 is half speed



# CHECK AND DOUBLE CHECK…

- Go to - Robot; Motors and Sensors Set Up; Standard Modules; select GTT Testbed



Standard Robot Model Configuration

GTT Testbed

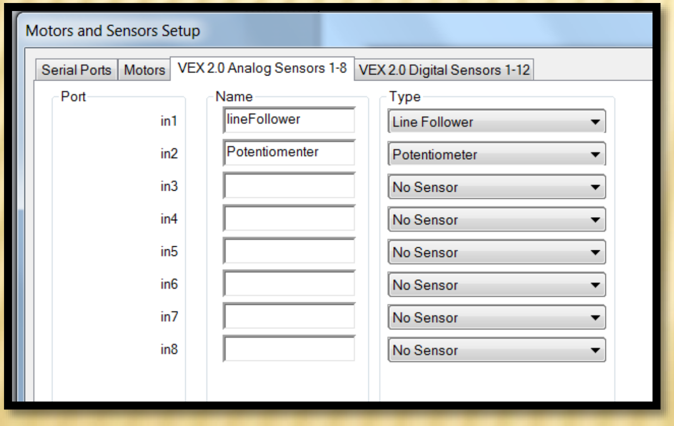
● Standard Configuration

○ Standard Configuration with User Defined Names

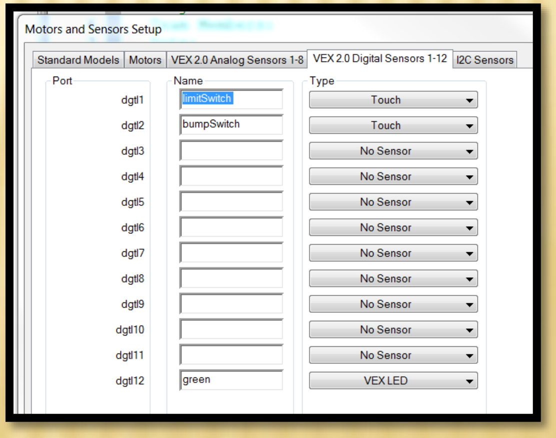
○ Custom Configuration

Model Description

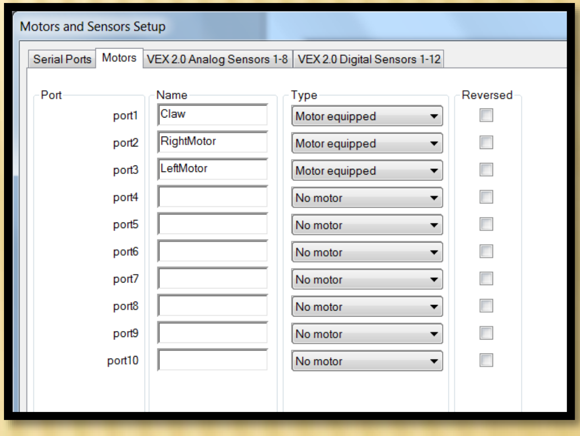
```
Sensor Ports:
in1     = lineFollower
in2     = potentiometer
dgtl1   = limitSwitch
dgtl2   = bumpSwitch
dgtl12  = green LED

Motor Ports:
port1 = clawMotor
port2 = rightMotor
port3 = leftMotor
```



| Port | Name | Type |
|---|---|---|
| in1 | lineFollower | Line Follower |
| in2 | Potentiomenter | Potentiometer |
| in3 | | No Sensor |
| in4 | | No Sensor |
| in5 | | No Sensor |
| in6 | | No Sensor |
| in7 | | No Sensor |
| in8 | | No Sensor |



| Port | Name | Type |
|---|---|---|
| dgtl1 | limitSwitch | Touch |
| dgtl2 | bumpSwitch | Touch |
| dgtl3 | | No Sensor |
| dgtl4 | | No Sensor |
| dgtl5 | | No Sensor |
| dgtl6 | | No Sensor |
| dgtl7 | | No Sensor |
| dgtl8 | | No Sensor |
| dgtl9 | | No Sensor |
| dgtl10 | | No Sensor |
| dgtl11 | | No Sensor |
| dgtl12 | green | VEX LED |



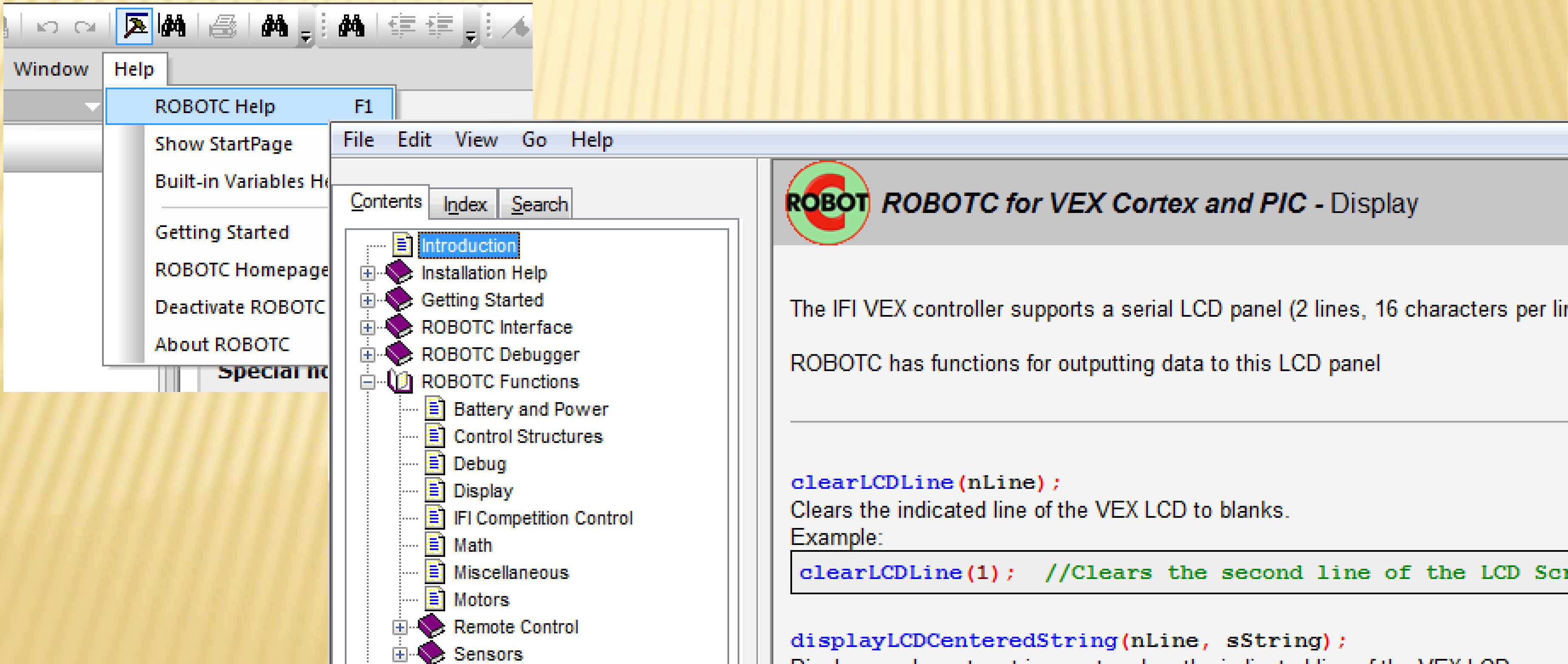
| Port | Name | Type | Reversed |
|---|---|---|---|
| port1 | Claw | Motor equipped | □ |
| port2 | RightMotor | Motor equipped | □ |
| port3 | LeftMotor | Motor equipped | □ |
| port4 | | No motor | □ |
| port5 | | No motor | □ |
| port6 | | No motor | □ |
| port7 | | No motor | □ |
| port8 | | No motor | □ |
| port9 | | No motor | □ |
| port10 | | No motor | □ |

# NAMING CONVENTIONS…

- The names of your motors and sensors follow some basic rules
- Must be all one word (leftMotor, frontLight, etc.)
- Cannot contain any special characters (%, ^, #, etc.)
- Cannot already be a ROBOTC “Reserved Word (while, motor, task, left, right, etc.)
- Check all your motor and sensor names to make sure they are OK.

# ROBOTC HELP

- Help is extremely useful if you get stuck!
- Search by topic or command – faster than waiting for your teacher to get to you!



***ROBOTC for VEX Cortex and PIC* - Display**

The IFI VEX controller supports a serial LCD panel (2 lines, 16 characters per li

ROBOTC has functions for outputting data to this LCD panel

```
clearLCDLine(nLine);
```

Clears the indicated line of the VEX LCD to blanks.

Example:

```
clearLCDLine(1);   //Clears the second line of the LCD Scr
```

```
displayLCDCenteredString(nLine, sString);
```

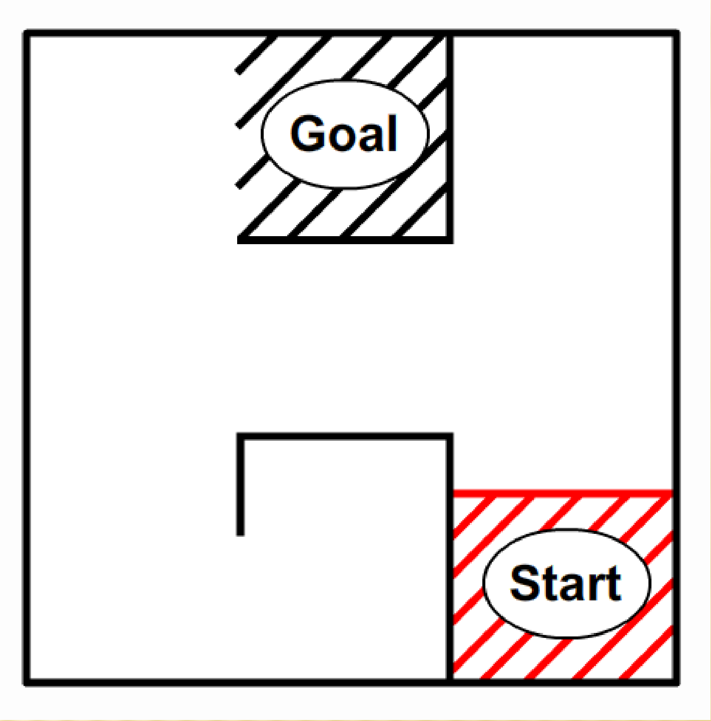
# STOP HERE AND DO THE FIRST SET OF STEPS!

# BEHAVIOR BASED PROGRAMING

- A **behavior** is anything your robot does:
  - turning on a single motor, moving forward, tracking a, navigating a maze
- Three main types of behaviors:
  - basic behaviors – single commands to the robot (turn on a motor)
  - simple behaviors – simple task performed by the robot (move forward, track a line)
  - and complex behaviors – robot performs a complex task (solve the maze)
- Complex behaviors can always be broken down into simple behaviors, which are then broken down into basic behaviors

# BEHAVIORS CONT.

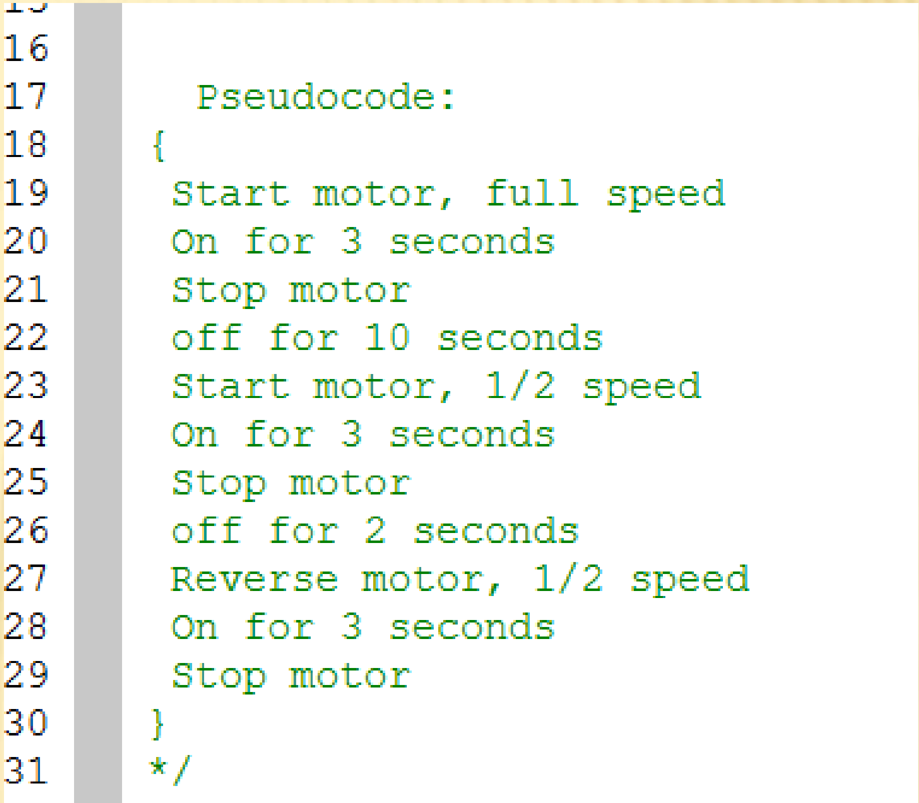
- If I want my robot to run this labyrinth I need to identify the different behaviors.
- Complex – go from start to the goal
- Simple – forward, turn left, forward turn right, forward, turn right



- Basic – Start motor at 63 for 2 seconds, Stop motor, start motor, point turn left, stop motor…

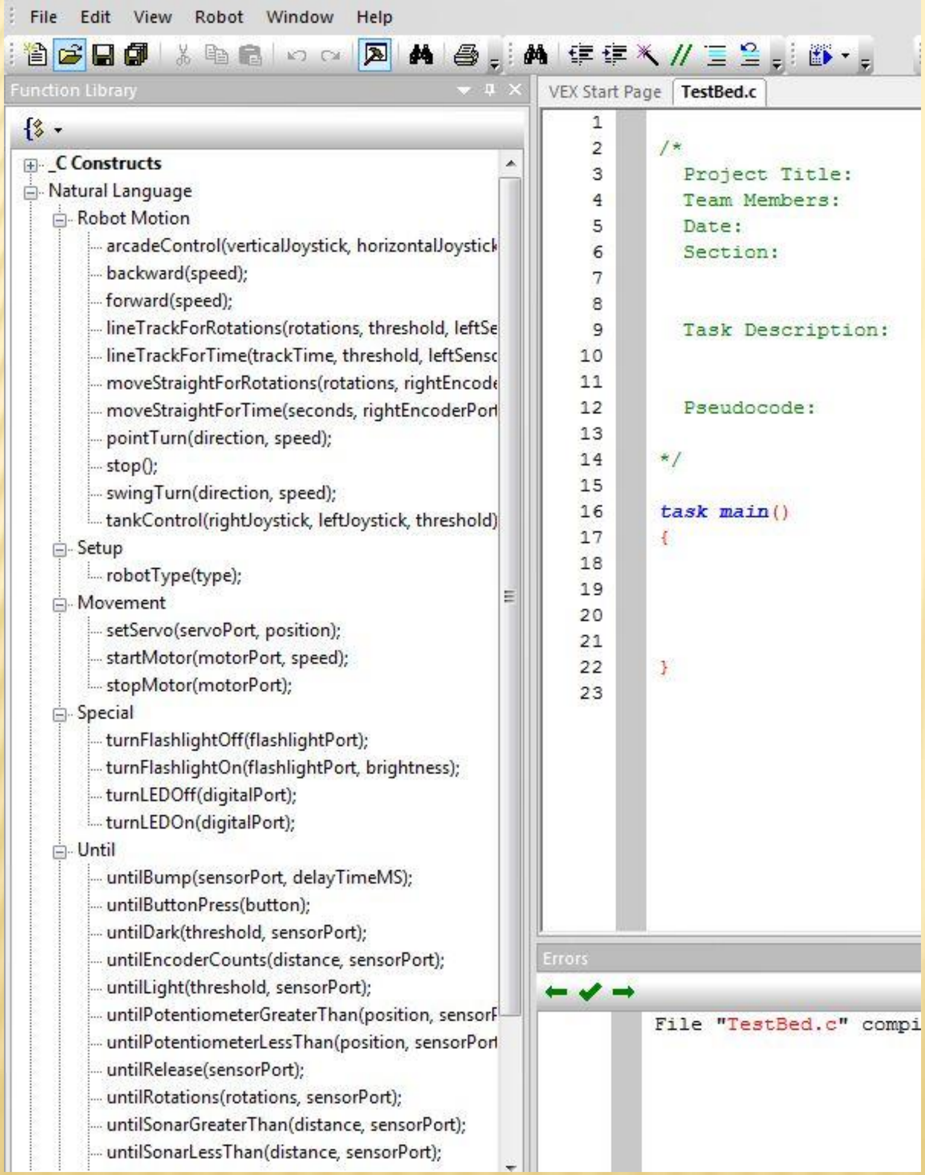
# PSEUDOCODE

- Pseudocode is a regular language of what you plan to have the robot do.
- Almost code, but not quite…
- Your lines of Pseudocode should be listed in the same order as they will appear in the Program



```
  Pseudocode:
{
 Start motor, full speed
 On for 3 seconds
 Stop motor
 off for 10 seconds
 Start motor, 1/2 speed
 On for 3 seconds
 Stop motor
 off for 2 seconds
 Reverse motor, 1/2 speed
 On for 3 seconds
 Stop motor
}
*/
```

# NATURAL LANGUAGE



- _C Constructs
- Natural Language
  - Robot Motion
    - arcadeControl(verticalJoystick, horizontalJoystick
    - backward(speed);
    - forward(speed);
    - lineTrackForRotations(rotations, threshold, leftSe
    - lineTrackForTime(trackTime, threshold, leftSensc
    - moveStraightForRotations(rotations, rightEncode
    - moveStraightForTime(seconds, rightEncoderPort
    - pointTurn(direction, speed);
    - stop();
    - swingTurn(direction, speed);
    - tankControl(rightJoystick, leftJoystick, threshold)
  - Setup
    - robotType(type);
  - Movement
    - setServo(servoPort, position);
    - startMotor(motorPort, speed);
    - stopMotor(motorPort);
  - Special
    - turnFlashlightOff(flashlightPort);
    - turnFlashlightOn(flashlightPort, brightness);
    - turnLEDOff(digitalPort);
    - turnLEDOn(digitalPort);
  - Until
    - untilBump(sensorPort, delayTimeMS);
    - untilButtonPress(button);
    - untilDark(threshold, sensorPort);
    - untilEncoderCounts(distance, sensorPort);
    - untilLight(threshold, sensorPort);
    - untilPotentiometerGreaterThan(position, sensorP
    - untilPotentiometerLessThan(position, sensorPort
    - untilRelease(sensorPort);
    - untilRotations(rotations, sensorPort);
    - untilSonarGreaterThan(distance, sensorPort);
    - untilSonarLessThan(distance, sensorPort);

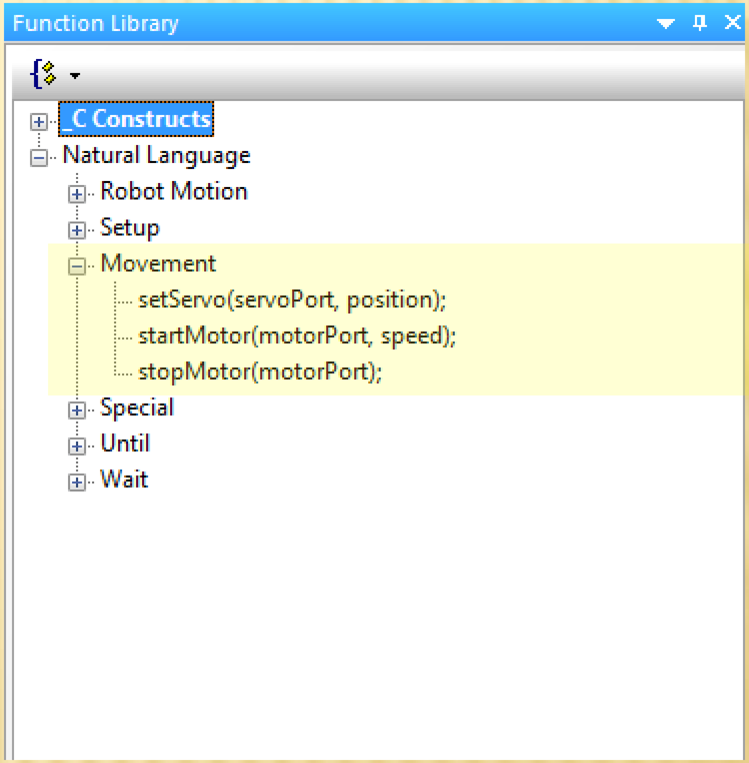
```

/*
  Project Title:
  Team Members:
  Date:
  Section:


  Task Description:


  Pseudocode:

*/

task main()
{




}

```

```
File "TestBed.c" compi
```

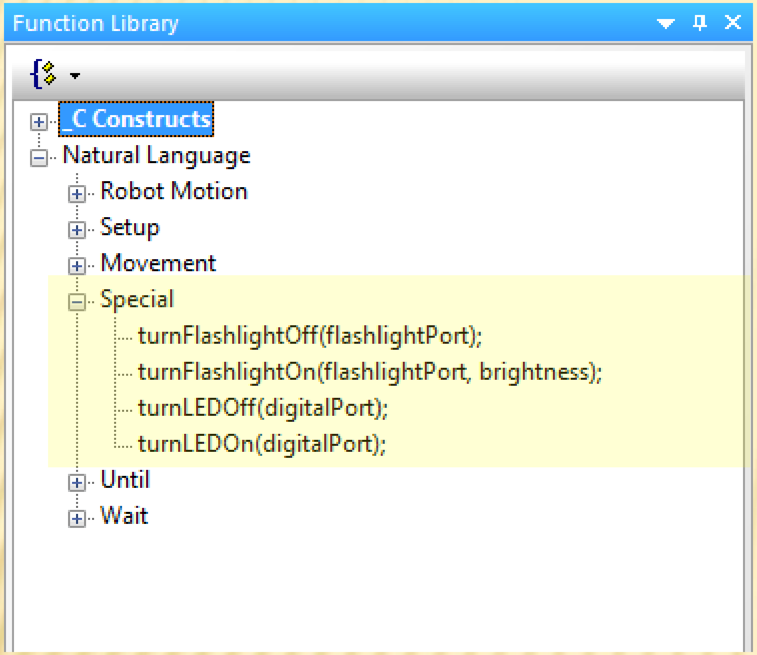
- Allows you to drag and drop code, rather than typing it all yourself.
- Common commands stored in Function Library
- Saves time, and is a lot easier than remembering all the rules for writing code.

# MOVEMENT

- Commands that allow you to control individual motors



# SPECIAL



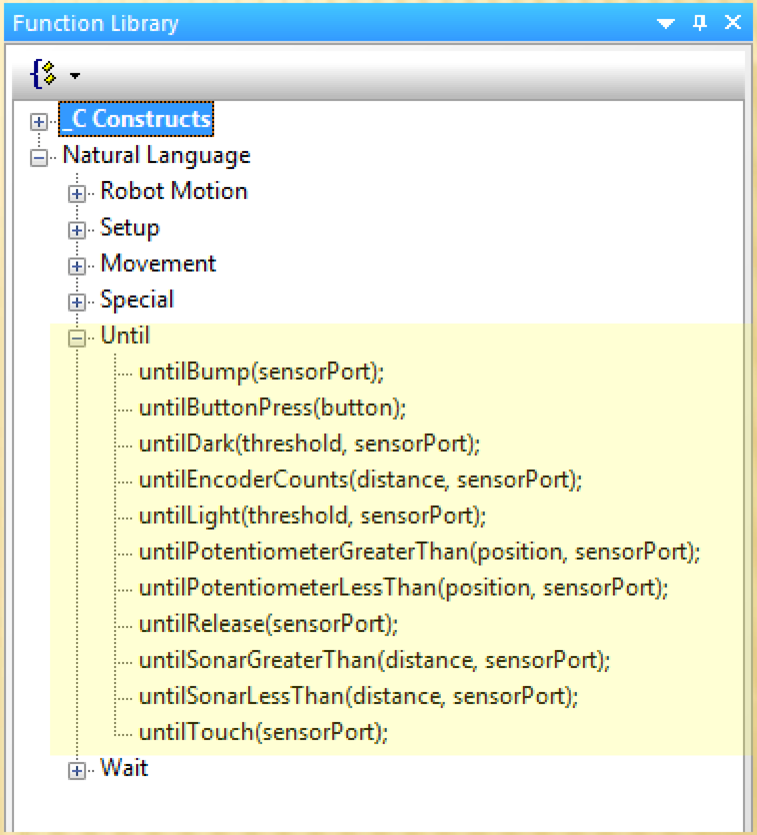
Function Library

- _C Constructs
- Natural Language
  - Robot Motion
  - Setup
  - Movement
  - Special
    - turnFlashlightOff(flashlightPort);
    - turnFlashlightOn(flashlightPort, brightness);
    - turnLEDOff(digitalPort);
    - turnLEDOn(digitalPort);
  - Until
  - Wait

- Commands that control the more unique VEX Hardware – LED’s

# UNTIL

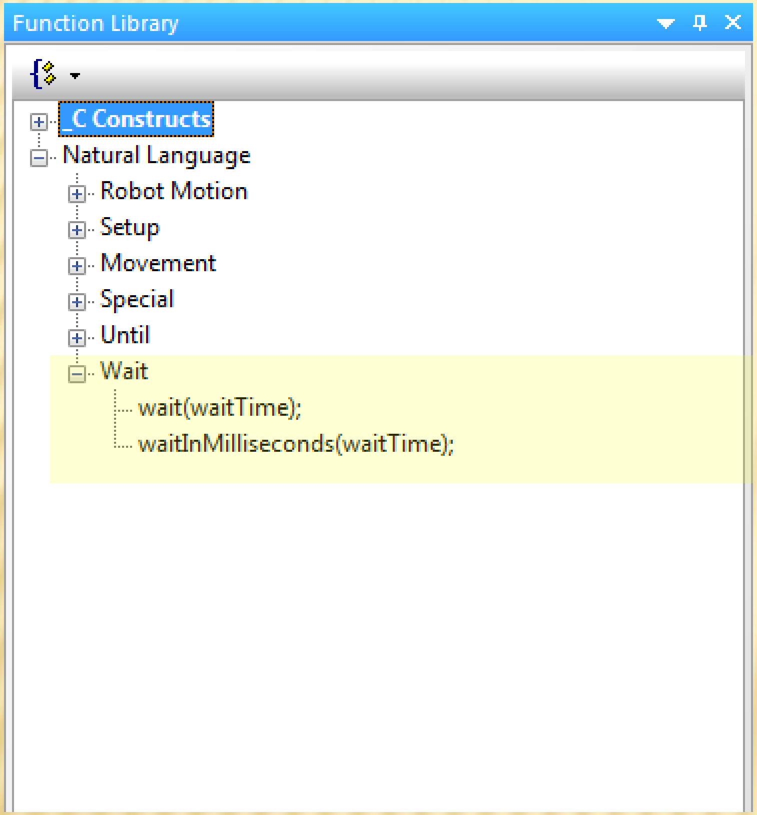
- Commands that allow you to create behaviors where the robot acts “until” a certain event
- **DON’T** use **Button Press**
- UNTIL touch-sends a 1 when sensor pressed in
- UNTIL bump-sends a 1 when sensor is pressed in AND released.



Function Library

```
_C Constructs
Natural Language
    Robot Motion
    Setup
    Movement
    Special
    Until
        untilBump(sensorPort);
        untilButtonPress(button);
        untilDark(threshold, sensorPort);
        untilEncoderCounts(distance, sensorPort);
        untilLight(threshold, sensorPort);
        untilPotentiometerGreaterThan(position, sensorPort);
        untilPotentiometerLessThan(position, sensorPort);
        untilRelease(sensorPort);
        untilSonarGreaterThan(distance, sensorPort);
        untilSonarLessThan(distance, sensorPort);
        untilTouch(sensorPort);
    Wait
```

# WAIT



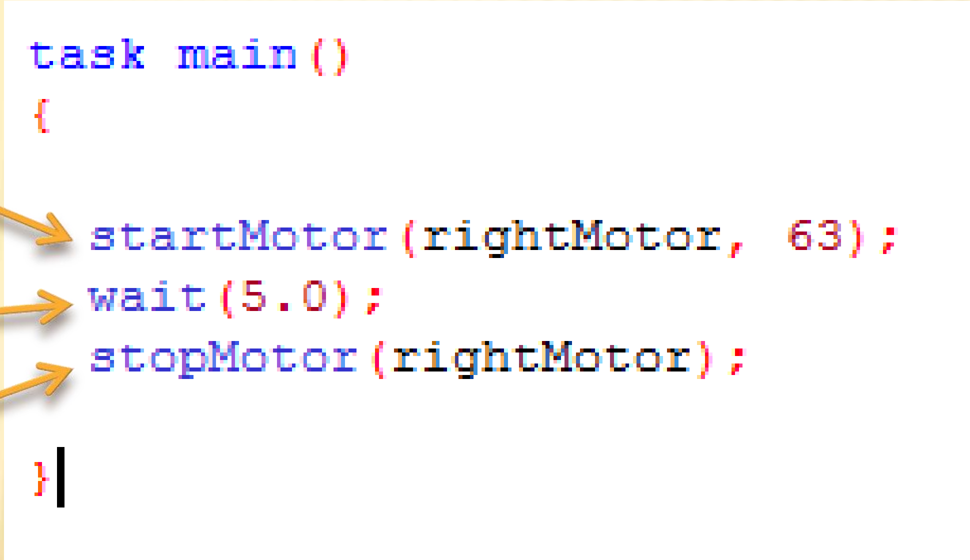
Function Library

- _C Constructs
- Natural Language
  - Robot Motion
  - Setup
  - Movement
  - Special
  - Until
  - Wait
    - wait(waitTime);
    - waitInMilliseconds(waitTime);

- Commands that wait for an elapsed amount of time in seconds or milliseconds
- Start motor at speed 63 then put in a wait for 3 seconds to run the motor for 3 seconds

# RIGHT MOTOR FOR 5 SECONDS

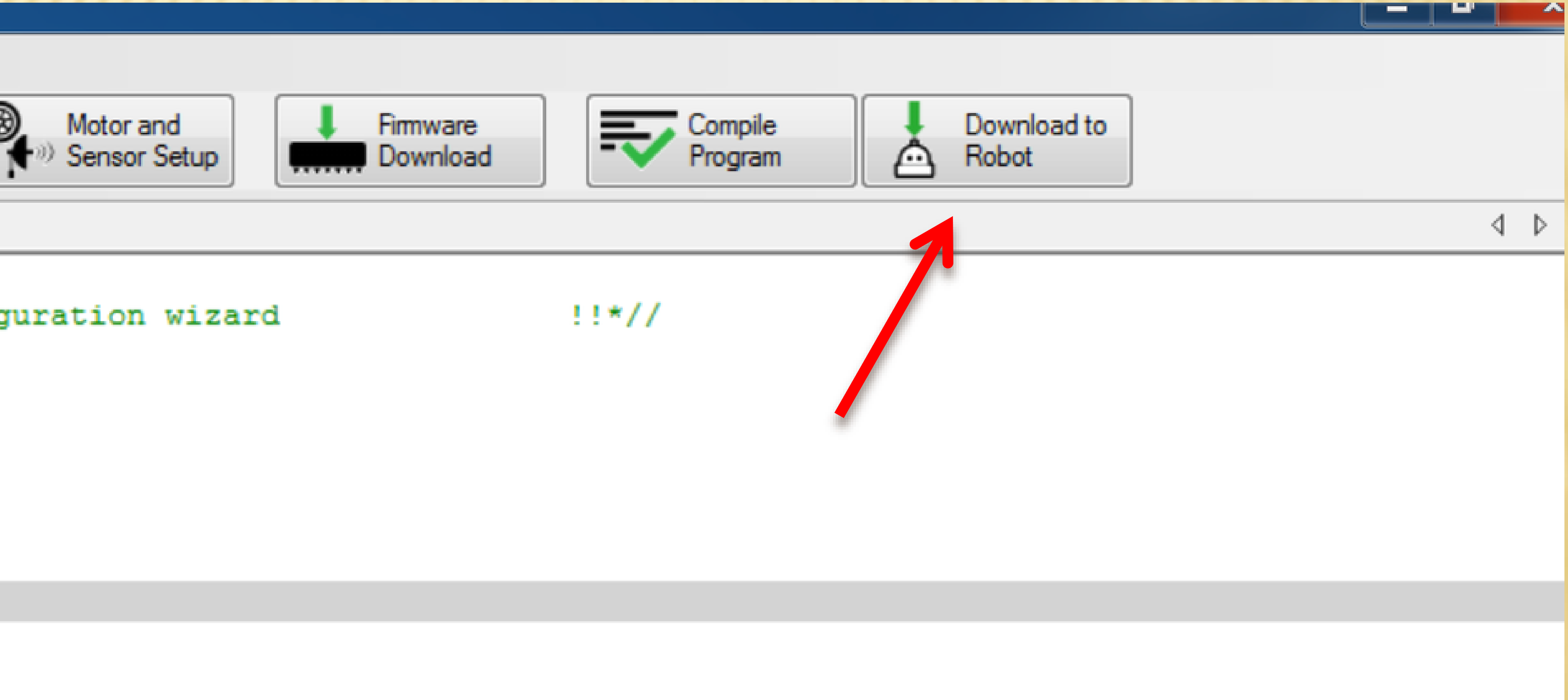
- Starts right motor and runs it at ½ speed
- Motor on for 5 seconds
- Stops right motor
- Task main() says “I’m Programing now”
- Code between{ and }
- Everything goes in order top down.
- Drag and drop – customize - run



```
task main()
{

  startMotor(rightMotor, 63);
  wait(5.0);
  stopMotor(rightMotor);

}
```

# DOWNLOAD TO ROBOT

- Go to Robot; Compile and Download Program
- Your code is now on your robot.



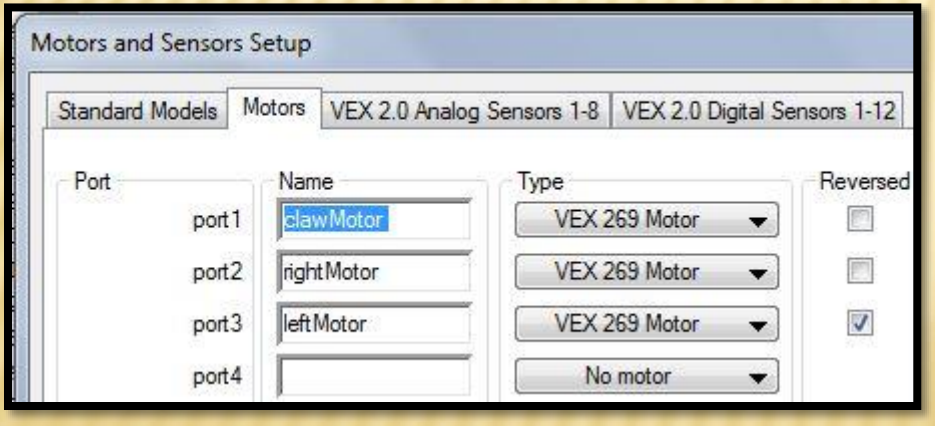
```
guration wizard              !!*//
```

# STOP HERE
# AND DO YOUR FIRST PROGRAM
# TEST BED 1

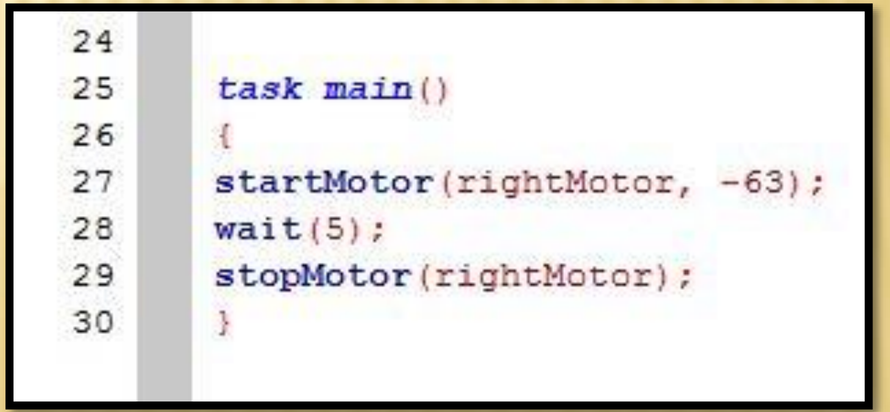
- Turn on the right motor and run it for 5 seconds at half speed (63) then turn it off.

# DIRECTION OF MOTORS

- You can make motors go in reverse by going to Robot; Motors and Sensors Set Up; then selecting reverse for one motor.
- Or you can simply type the speed as a negative number…



| Port | Name | Type | Reversed |
|---|---|---|---|
| port1 | clawMotor | VEX 269 Motor | □ |
| port2 | rightMotor | VEX 269 Motor | □ |
| port3 | leftMotor | VEX 269 Motor | ☑ |
| port4 | | No motor | |



```
task main()
{
startMotor(rightMotor, -63);
wait(5);
stopMotor(rightMotor);
}
```

# STOP HERE
# SAVE AS TEST BED 2

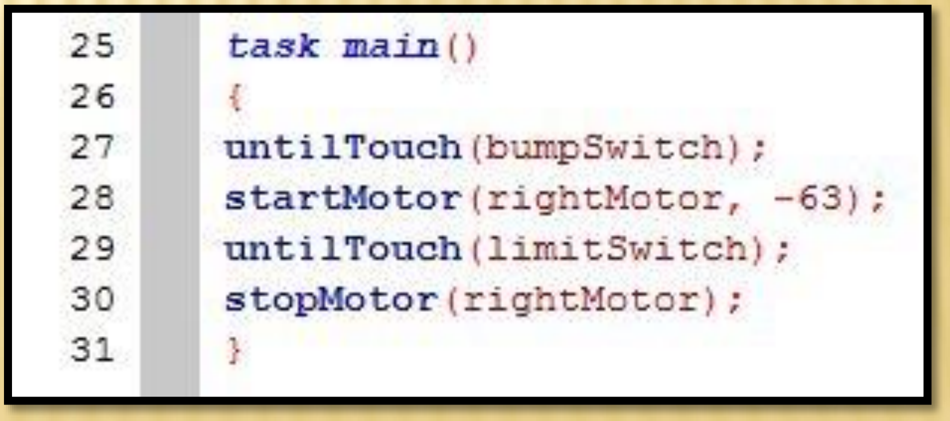
Turn on the right motor and run it forward for 5 seconds at ½ speed (63) then turn it off.
Turn on the left motor and run it in reverse at ¾ speed (94.5) for 2.5 seconds then turn it off.
Turn on both motors and run at full power (126), in the same direction, for 7.25 seconds then turn them off.

# TOUCH SENSORS

- Plugged into Digital ports only
- Pressed = 1(on)  Released = 0(off)
- Limit Switches
- Bump Switches

# SWITCH PROGRAMING

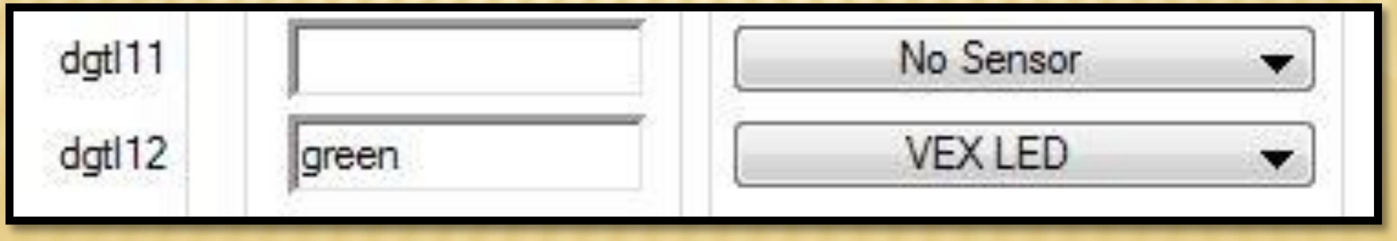
- You can add an UntilTouch to make the testbed wait to start until you press the bump switch.
- UntilBump will do this too, but not UntilButtonPress
- You can also add an UntilTouch to make the testbed run until you press the limit switch



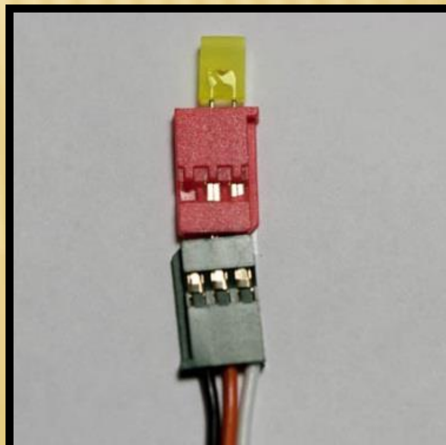
```
task main()
{
untilTouch(bumpSwitch);
startMotor(rightMotor, -63);
untilTouch(limitSwitch);
stopMotor(rightMotor);
}
```

# VEX LED

- The VEX LED’s all work the same, no matter the color.
- You may name them as you like in the Digital section of your set up
- Make sure they are plugged into the extender correctly (metal to metal) or you will short them out



| | | |
|---|---|---|
| dgtl11 | | No Sensor |
| dgtl12 | green | VEX LED |



# STOP HERE AND DO TEST BED 3

Add an UntilTouch for the bump switch to turn on the right motor forward at ½ speed and the LED on

Then add an UntilTouch for the limit switch to turn off the motor and LED

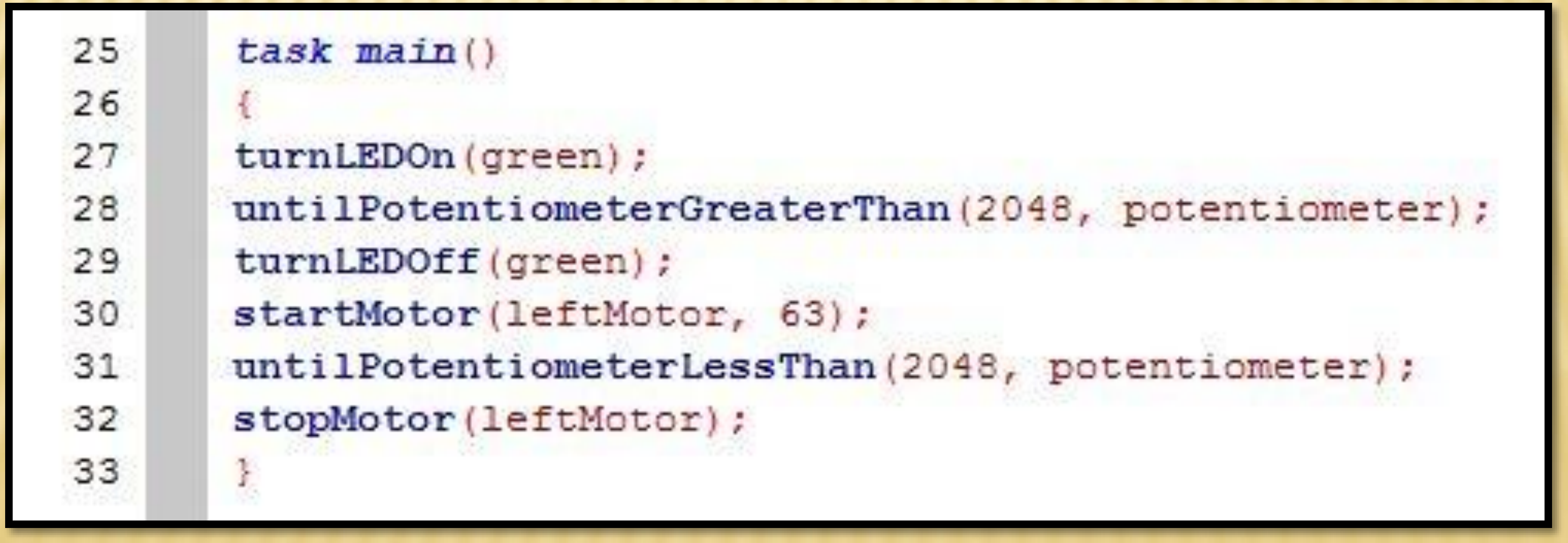
# POTENTIOMETER

- Potentiometers are analog sensors
- They measure rotation of a shaft between 0 and ~4095
- Internal mechanical stops prevent the potentiometer from turning a full revolution.

- **Caution:** Excess torque against the internal mechanical stops (can be caused by hand or by a VEX motor) will cause them to wear away. The potentiometer will continue to function, but will have a "dead zone" where the mechanical stops were, where no new values are sent.
- Switching the direction the potentiometer is facing will also switch the direction it "counts". **For example:** counter-clockwise turns will count 0 to 4095 on one side; on the other counter-clockwise turns will count 4095 – 0.

# PROGRAMING A POTENTIOMETER…

- Use UntilPotentiometerGreaterThan to set the positive value you want
- Use UntilPotentiometerLessThan to set the negative value you want



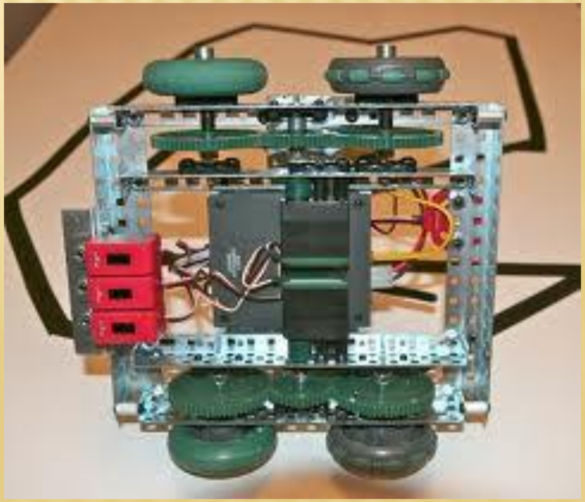
```
task main()
{
turnLEDOn(green);
untilPotentiometerGreaterThan(2048, potentiometer);
turnLEDOff(green);
startMotor(leftMotor, 63);
untilPotentiometerLessThan(2048, potentiometer);
stopMotor(leftMotor);
}
```

# STOP HERE AND DO TEST BED 4

- ❑ Turn on the green LED until the potentiometer value is greater than 2048. Then the green LED should turn off, and the left Motor should turn on until the potentiometer is less than 2048.

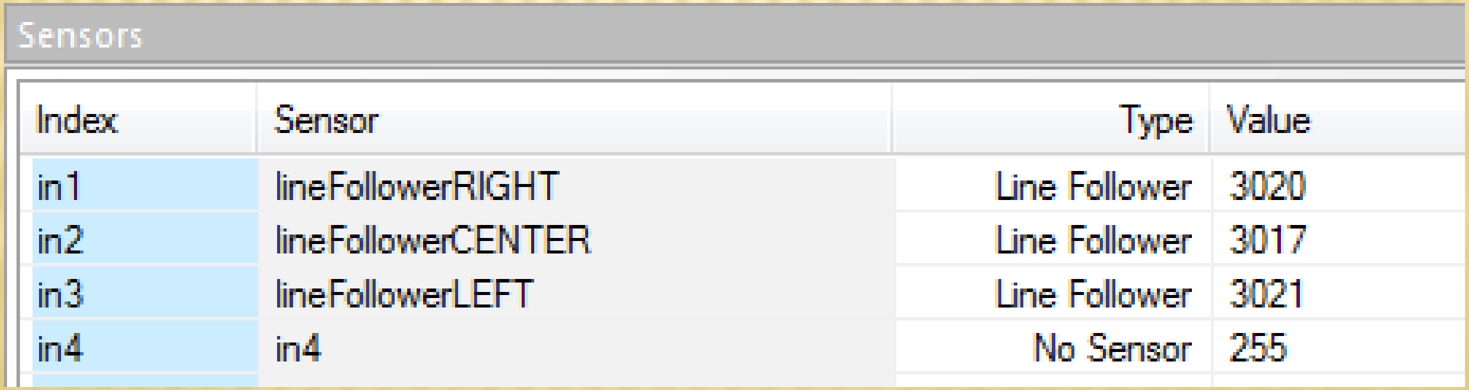
# LINE TRACKING

- “Active” Analog Light Sensor
- Sends out a IR beam, and measure how much light is reflected back
- Each reads values between 0 and 4095
- Usually mounted as a set of 3 ¼ to 1/8 inches off what it is measuring
- You have to calculate a threshold that allows it to distinguish light from dark.



# THRESHOLDS

- A threshold is a value (usually halfway) between two extremes (light/dark)
- Open Sensor Debug Window – make sure that the refresh rate is set to Once
- Place a white surface above the line tracker and record the value displayed in the window.

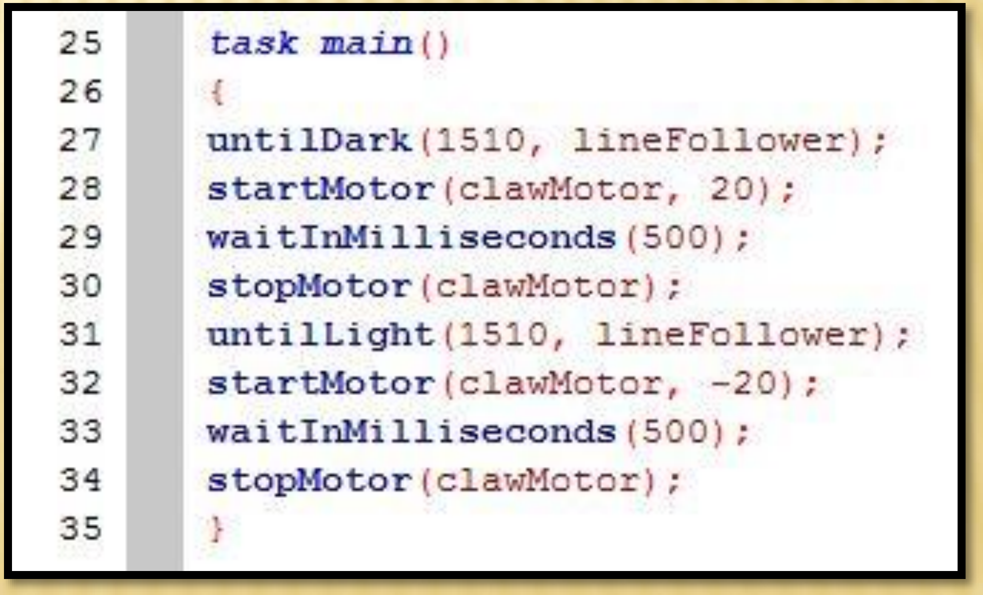


Sensors

| Index | Sensor | Type | Value |
|---|---|---|---|
| in1 | lineFollowerRIGHT | Line Follower | 3020 |
| in2 | lineFollowerCENTER | Line Follower | 3017 |
| in3 | lineFollowerLEFT | Line Follower | 3021 |
| in4 | in4 | No Sensor | 255 |

# THRESHOLDS CONT…

- Place a black surface above the line tracker and record the value displayed in the window.
- Add these two values and divide by 2
  $(Light\ value + Dark\ value) \div 2 = treshold$
- Use UntilDark for no light and UntilLight for light
  - Note that your threshold will be different than the example!



```
task main()
{
untilDark(1510, lineFollower);
startMotor(clawMotor, 20);
waitInMilliseconds(500);
stopMotor(clawMotor);
untilLight(1510, lineFollower);
startMotor(clawMotor, -20);
waitInMilliseconds(500);
stopMotor(clawMotor);
}
```

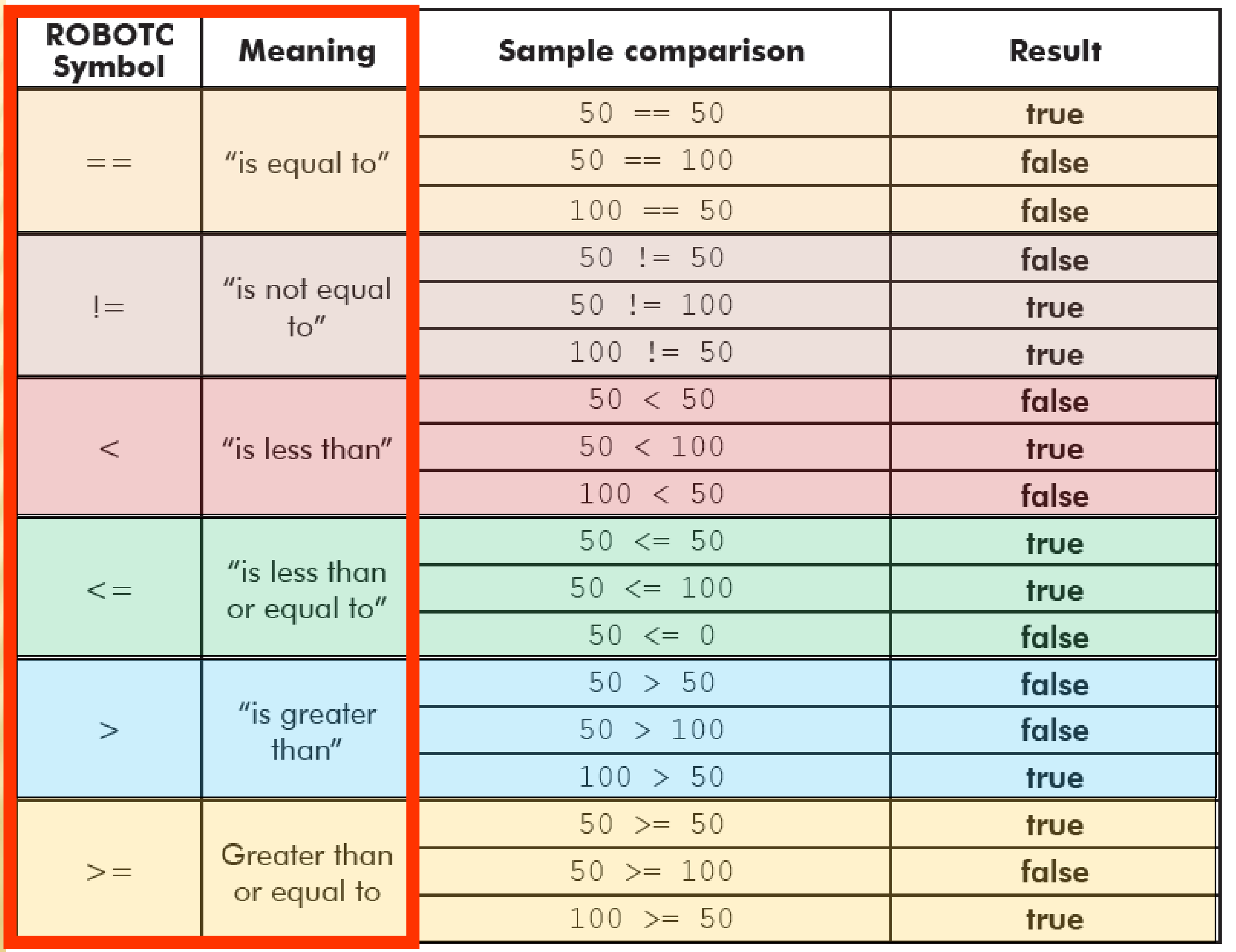
# STOP HERE AND DO TEST BED 5

- ❑ Open and close the claw by covering and uncovering the line follower.

# WHILE LOOPS

- A while loop is a structure that allows a section of code to be repeated while a condition is true or not true.
- While loops check to see if the “condition” is true. If it is it repeats the loop. When the condition is not true it goes to the next step after the loop.
- A loop that would last forever would be while(1==1) since 1 is always equal to 1.

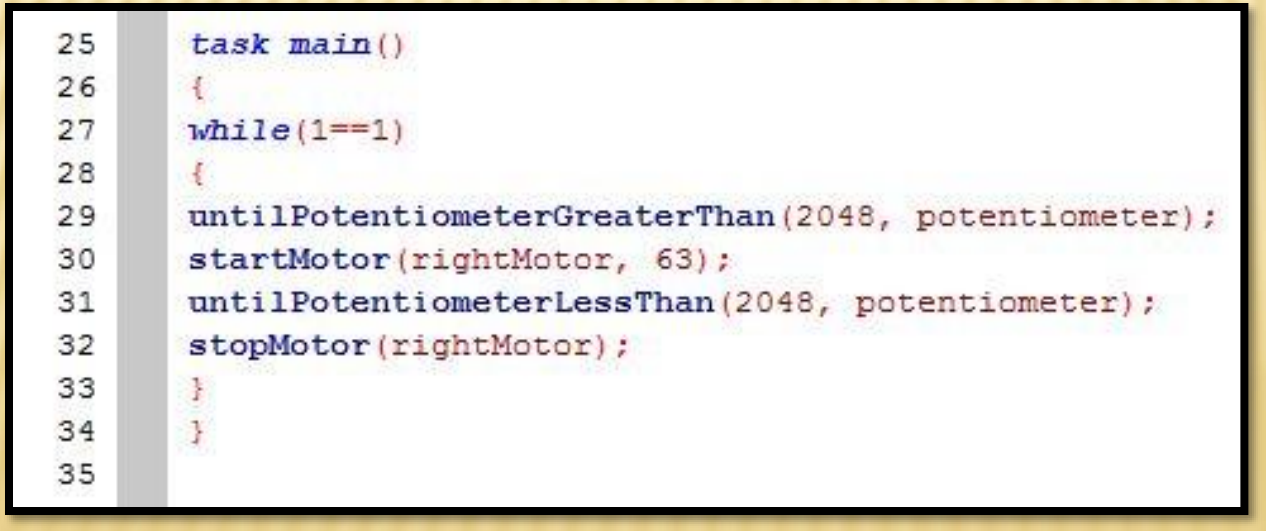
# CONDITIONS



| ROBOTC Symbol | Meaning | Sample comparison | Result |
|---|---|---|---|
| == | "is equal to" | `50 == 50` | true |
| | | `50 == 100` | false |
| | | `100 == 50` | false |
| != | "is not equal to" | `50 != 50` | false |
| | | `50 != 100` | true |
| | | `100 != 50` | true |
| < | "is less than" | `50 < 50` | false |
| | | `50 < 100` | true |
| | | `100 < 50` | false |
| <= | "is less than or equal to" | `50 <= 50` | true |
| | | `50 <= 100` | true |
| | | `50 <= 0` | false |
| > | "is greater than" | `50 > 50` | false |
| | | `50 > 100` | false |
| | | `100 > 50` | true |
| >= | Greater than or equal to | `50 >= 50` | true |
| | | `50 >= 100` | false |
| | | `100 >= 50` | true |

# PROGRAMING A WHILE LOOP

- Put the while loop after the task main() command
- Make sure you make an { after the while then a } at the end
- Two opens = two closes



```
task main()
{
while(1==1)
{
untilPotentiometerGreaterThan(2048, potentiometer);
startMotor(rightMotor, 63);
untilPotentiometerLessThan(2048, potentiometer);
stopMotor(rightMotor);
}
}
```

# STOP HERE AND DO TEST BED 6

- ❑ Add a continuous while loop (1==1) to
- ❑ UntilTouch for the bump switch to turn on the right motor forward at ½ speed and the LED on
- ❑ Then an UntilTouch for the limit switch to turn off the motor and LED

# IF STATEMENTS – ADVANCED

- When the robot reaches an IF statement in the program, it evaluates the “condition” contained between the ()
- If the “condition is true, any commands between the braces are run
- If the “condition” is false, those same commands are ignored
- Similar to a While loop, but the code does NOT repeat.

# IF-ELSE STATEMENT

- This is an expansion of the IF statement.
- The IF section still runs the commands inside the ()
- The ELSE allows for specific code to run only when the condition is false
- IF or ELSE is always run…

# STOP HERE AND DO THE EIGHTH TEST!

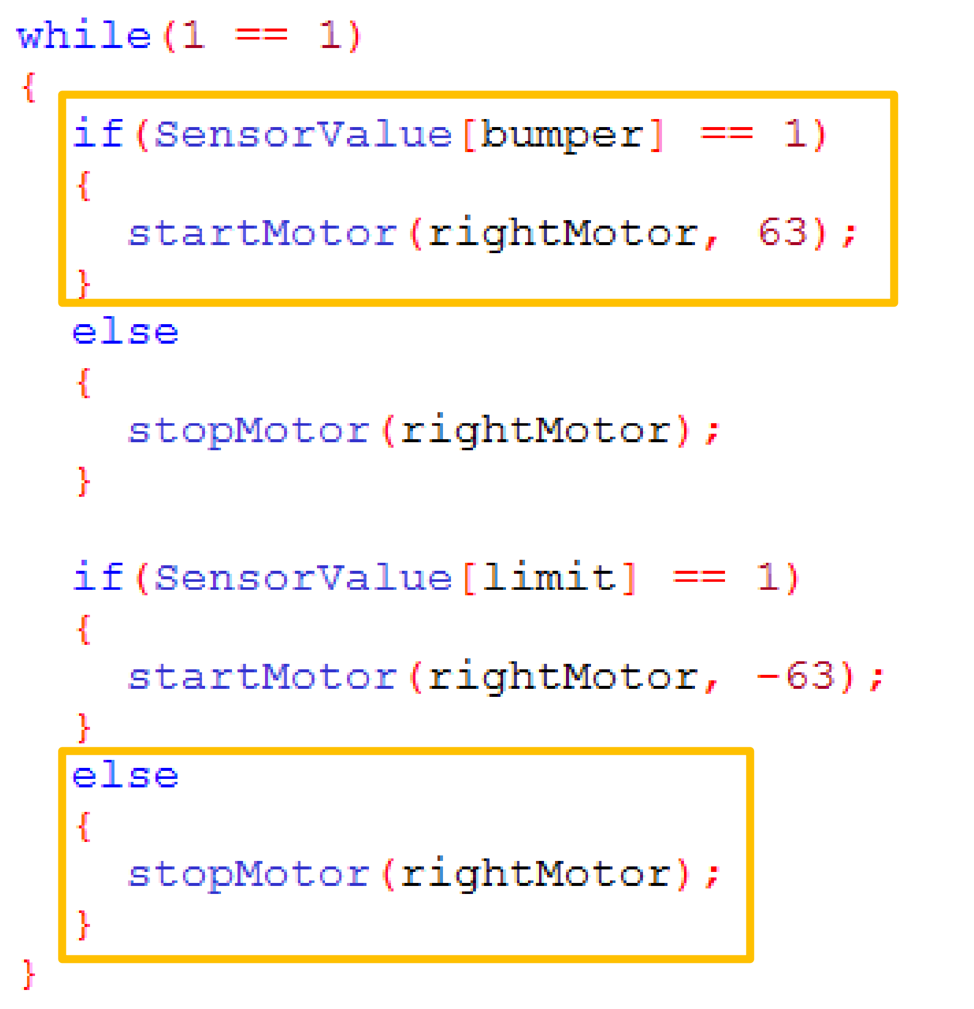
- ❑ Add an IF statement to turn of the LED if the bump switch is pressed and leave it off if it's released. Loop it forever (While…)
- ❑ Now try converting the IF to an IF-ELSE  statement that runs the right motor if the bump is pressed, Else the light is on and no motor runs…

# MULTIPLE IF-ELSE STATEMENTS

- Be careful when using two separate if-else statements, particularly when they are used to control the same mechanism.
- One branch of **each** if-else statement is **always** run, so you may create a scenario where the two sets “fight” each other.

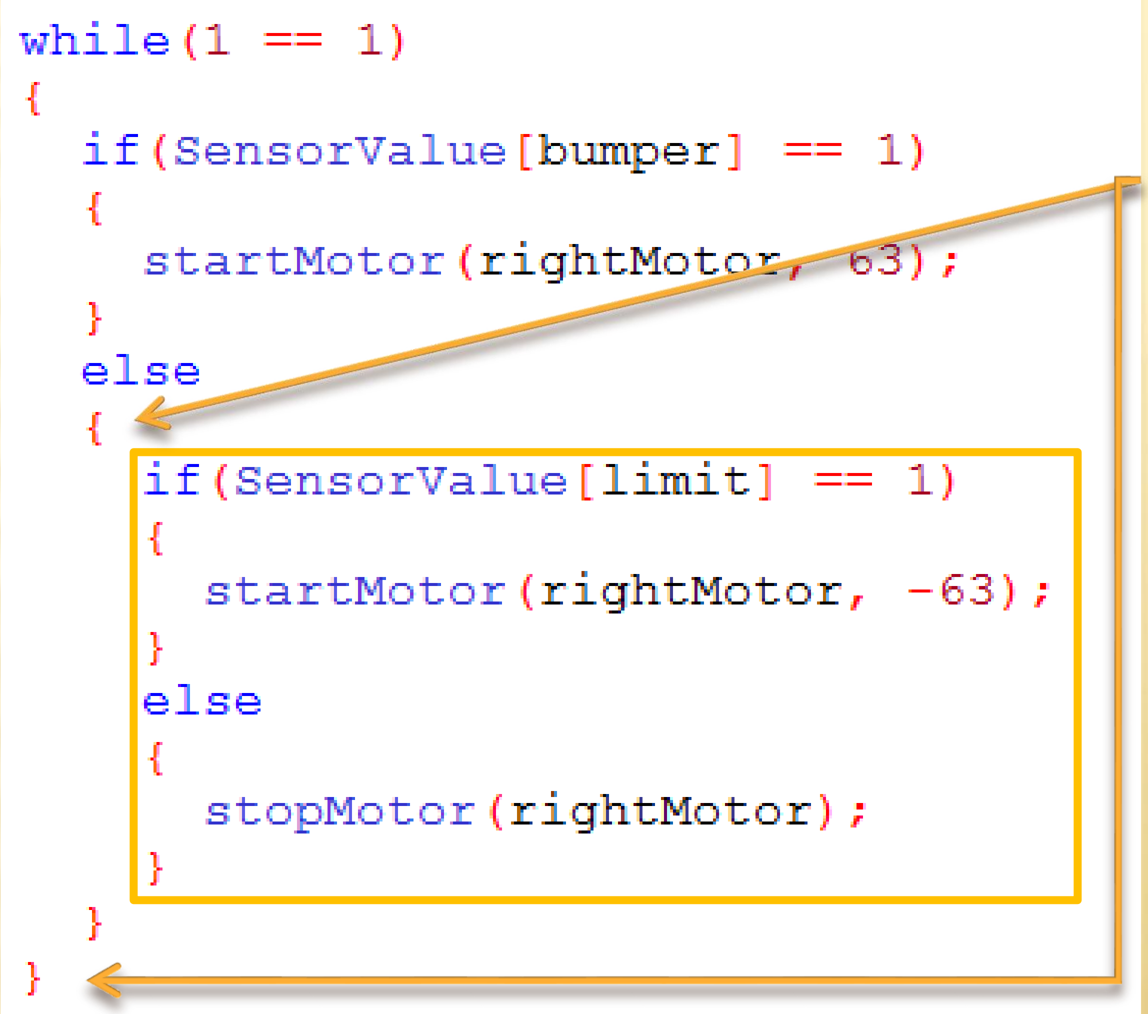
# MULTIPLE CONT…

- In this example, if one of the touch sensors is pressed, the rightMotor will be turned on in one if-else statement, and immediately turned off in the other.



```
while(1 == 1)
{
  if(SensorValue[bumper] == 1)
  {
    startMotor(rightMotor, 63);
  }
  else
  {
    stopMotor(rightMotor);
  }

  if(SensorValue[limit] == 1)
  {
    startMotor(rightMotor, -63);
  }
  else
  {
    stopMotor(rightMotor);
  }
}
```

# MULTIPLE FIX…

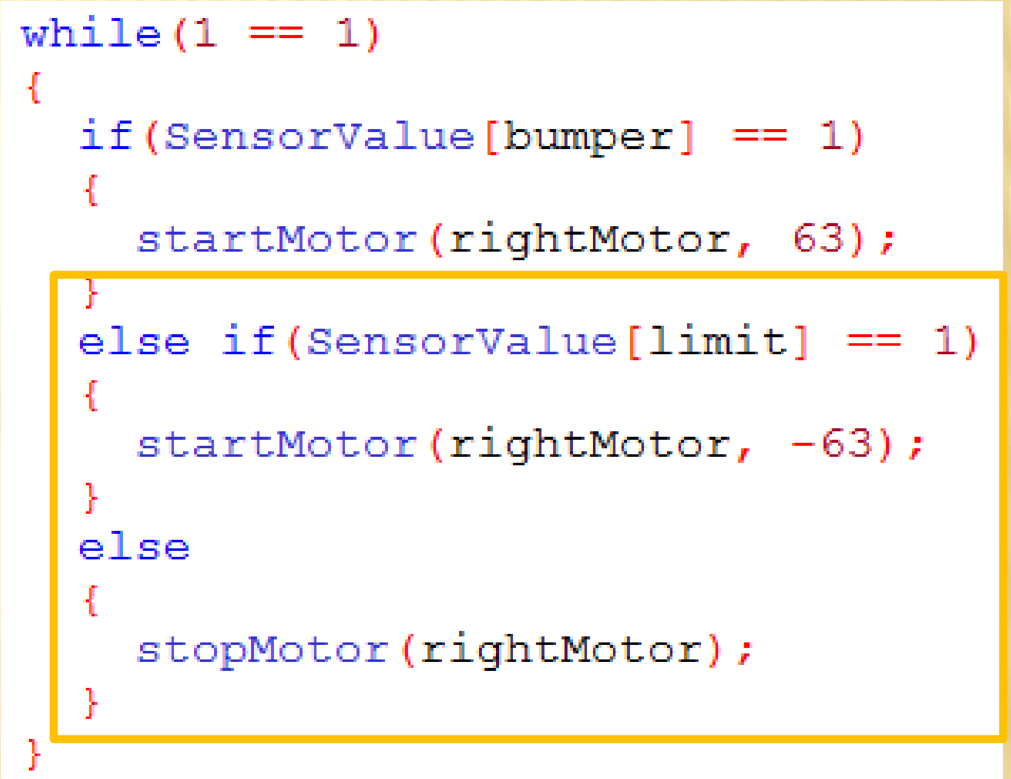


```
while(1 == 1)
{
  if(SensorValue[bumper] == 1)
  {
    startMotor(rightMotor, 63);
  }
  else
  {
    if(SensorValue[limit] == 1)
    {
      startMotor(rightMotor, -63);
    }
    else
    {
      stopMotor(rightMotor);
    }
  }
}
```

- This can be corrected by embedding the second if-else within the else branch of the first, so that it only runs if the first condition is false.

# IF-ELSE SHORTHAND

- An embedded if-else can also be represented as an **else if:**



```
while(1 == 1)
{
  if(SensorValue[bumper] == 1)
  {
    startMotor(rightMotor, 63);
  }
  else if(SensorValue[limit] == 1)
  {
    startMotor(rightMotor, -63);
  }
  else
  {
    stopMotor(rightMotor);
  }
}
```

# STOP HERE AND DO THE NINTH TEST!

- Use this information to write a multiple If-Else statement.