LABVIEW

BACKGROUND AND COMMON USES FOR THE LANGUAGE

LabVIEW is an acronym for Laboratory Virtual Instrument Engineering Workbench. LabVIEW is a product of National Instruments. It is a data-flow visual programming language. Most widely, this language is used in conjunction with National Instruments hardware to enable computers to operate as laboratory electronic instruments, such as oscilloscopes, signal generators and timers.

Currently, FIRST Robotics has adopted the National Instruments roboRIO Advanced Robotics Controller to control the robots that teams build to compete in the FIRST Robotics competitions, annually. The roboRIO may be programmed using the LabVIEW language, among others. The discussion here will focus on this application of LabVIEW and the associated tools provided for use in the FIRST competitions.

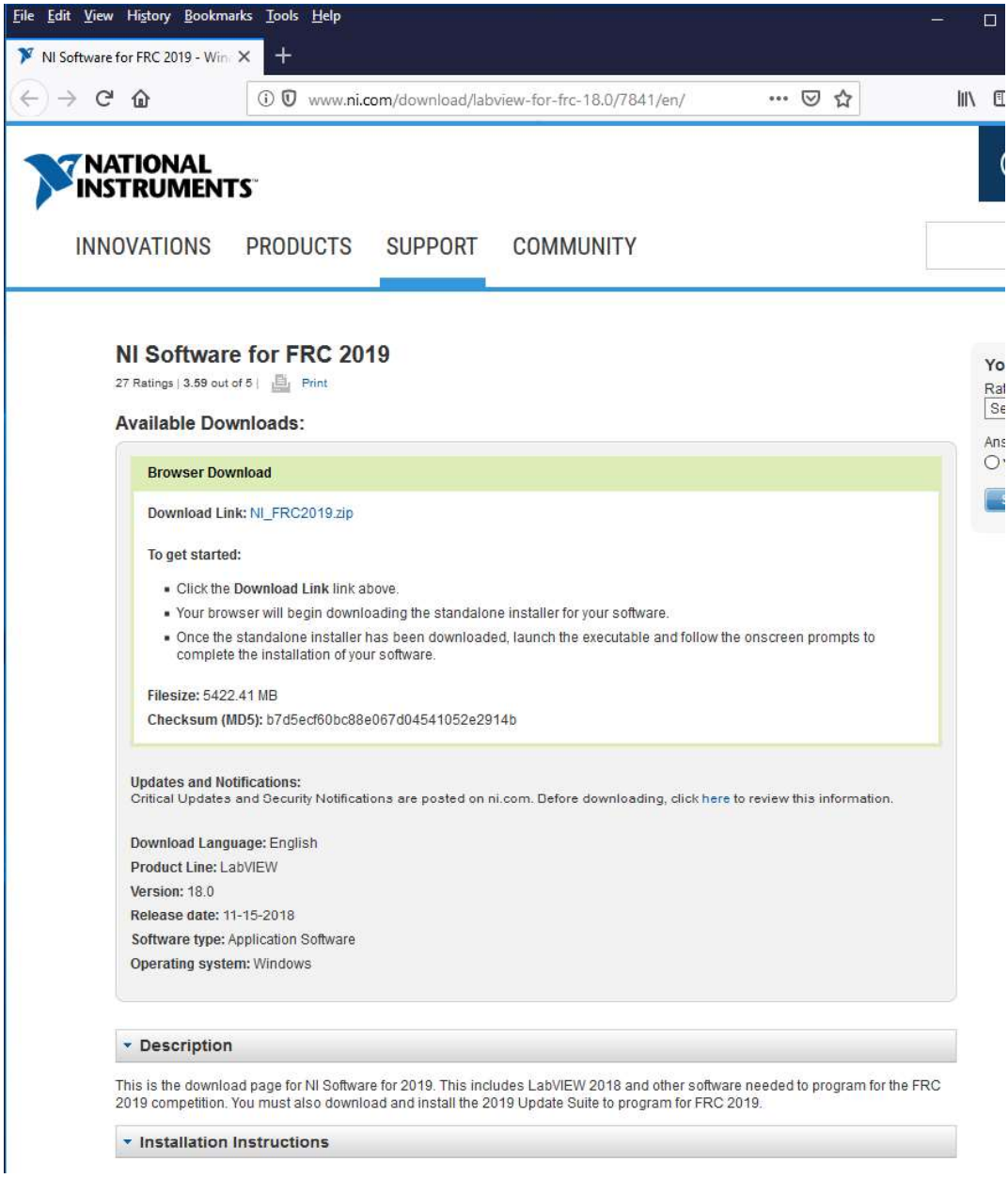
DEVELOPMENT TOOLS

Starting with the 2019 season, the LabVIEW software for use in the FIRST competition is distributed online from a webserver, rather than through an optical disc.

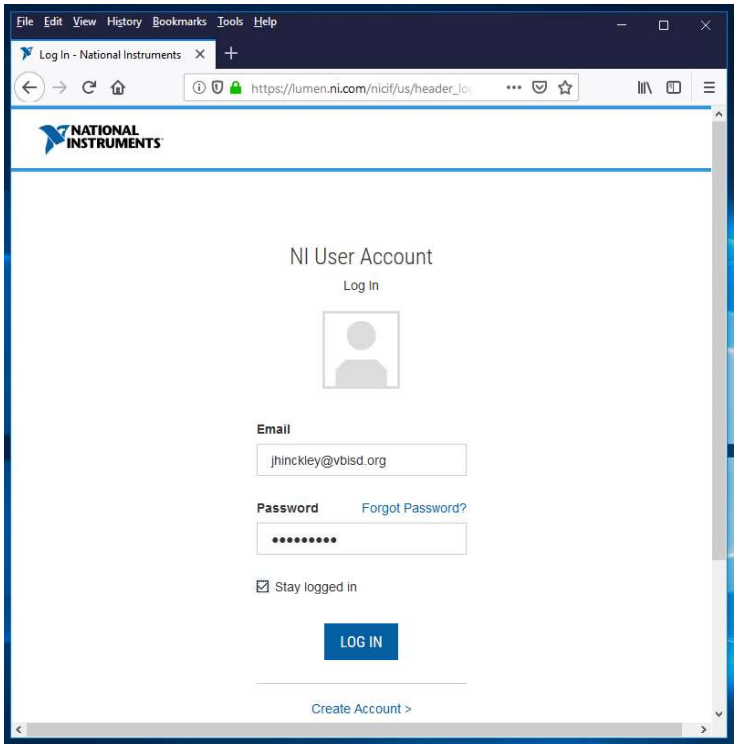
INSTALLATION OF THE DEVELOPMENT TOOLS

The following procedure is for installing the NI software for FRC 2019.

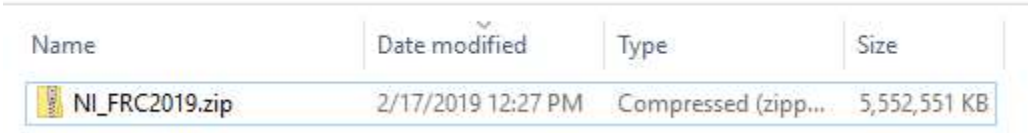
1. Navigate to http://www.ni.com/download/labview-for-frc-18.0/7841/en/ .



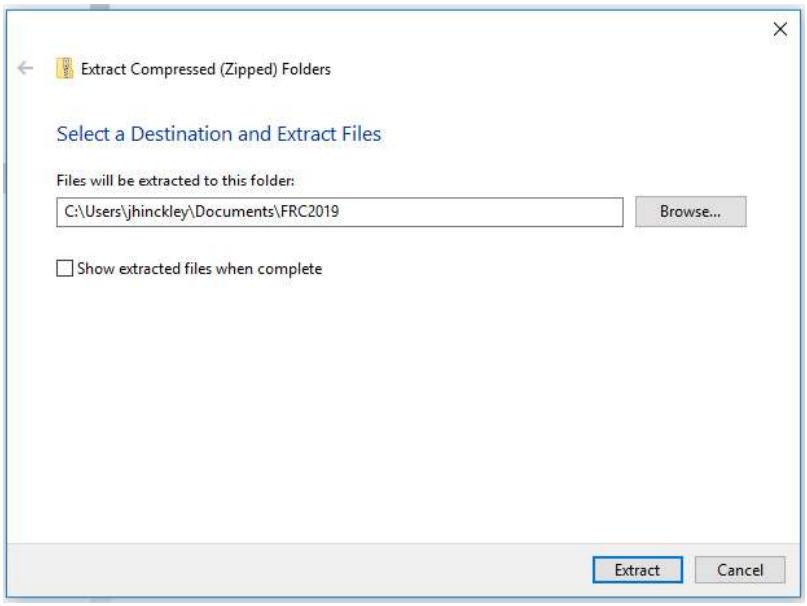
2. Download and unzip NI_FRC2019.zip.
    a. Press the download link. A log-in screen appears to log in to your National Instruments account. Create one if you don't already have one.



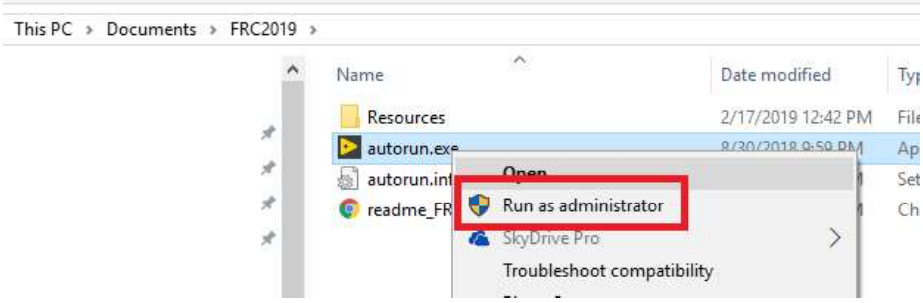
    b. Save NI_FRC2019.zip to your Downloads folder.



c. Extract the contents of the archive. The archive is large and the extraction will require about 15 minutes.

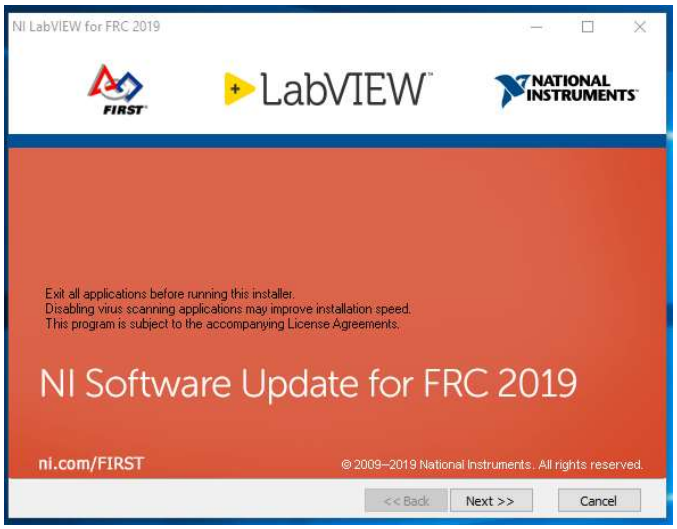


d. Run the executable autorun.exe as an administrator.

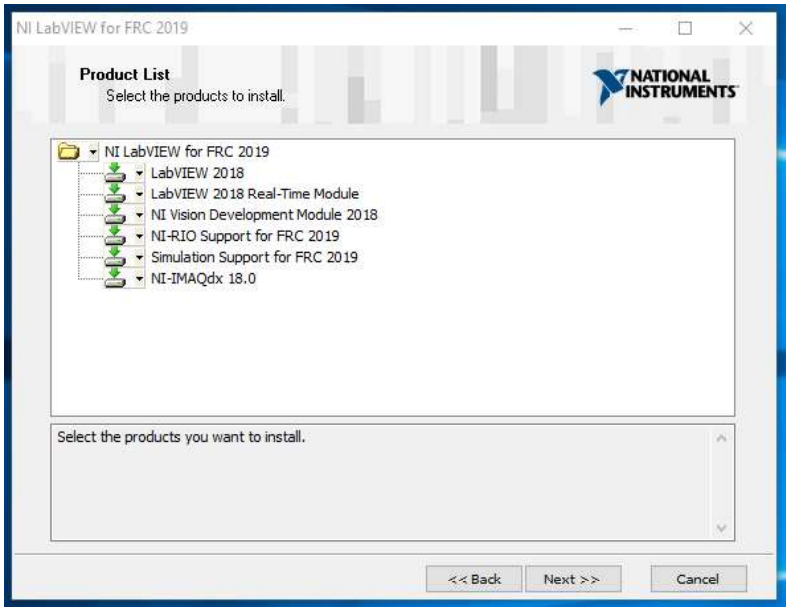


3. Select "Install Everything for LabVIEW Development.

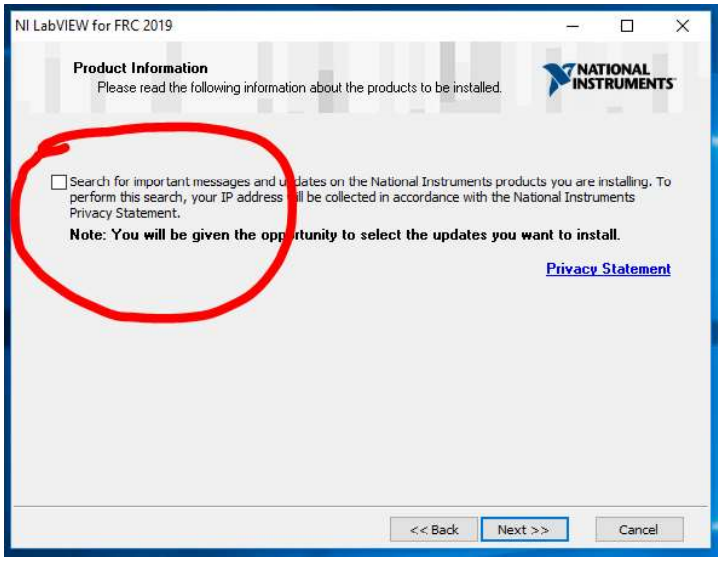
4. Press the Next button.



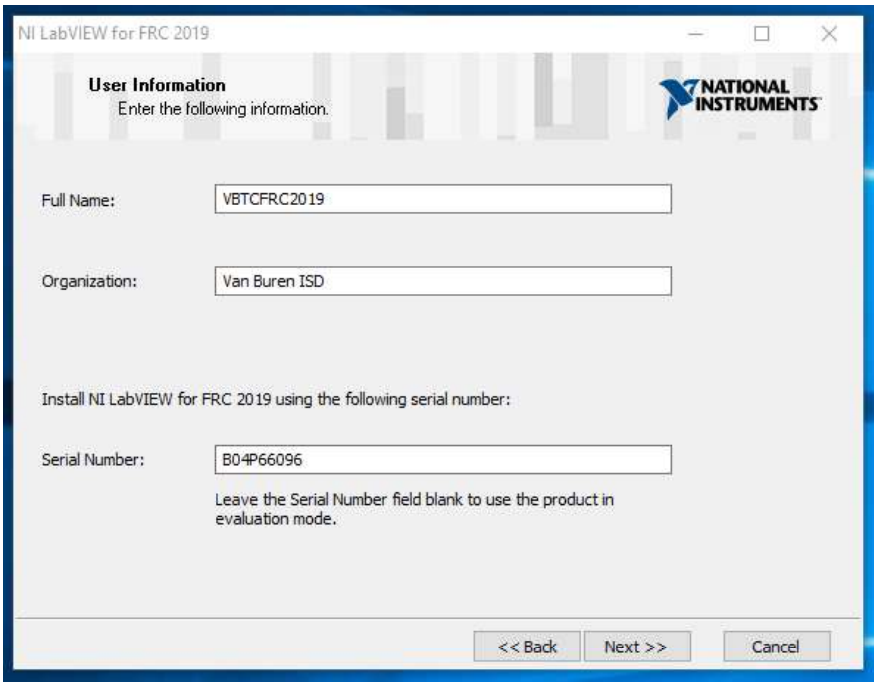
5. Leave all items selected for installation, as they are by default. Press the Next button.



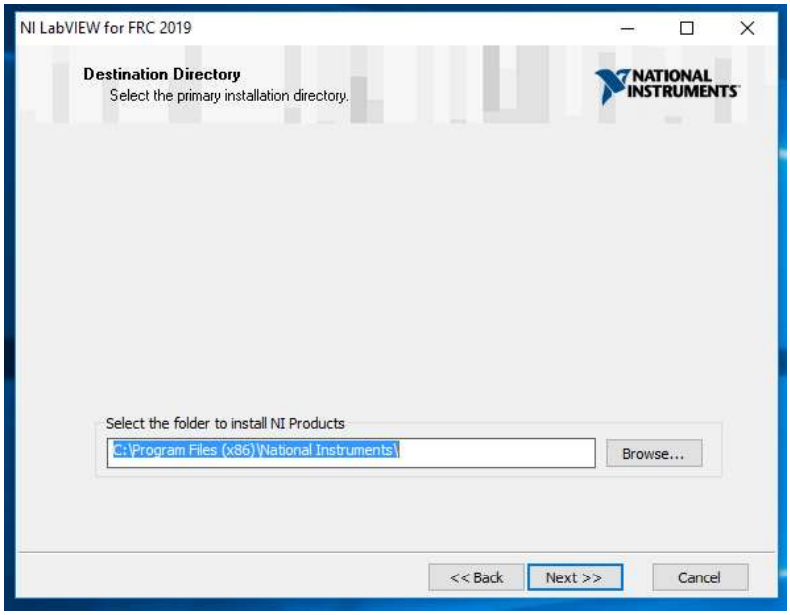
6. UNCHECK the search box on the next screen, then press the Next button.



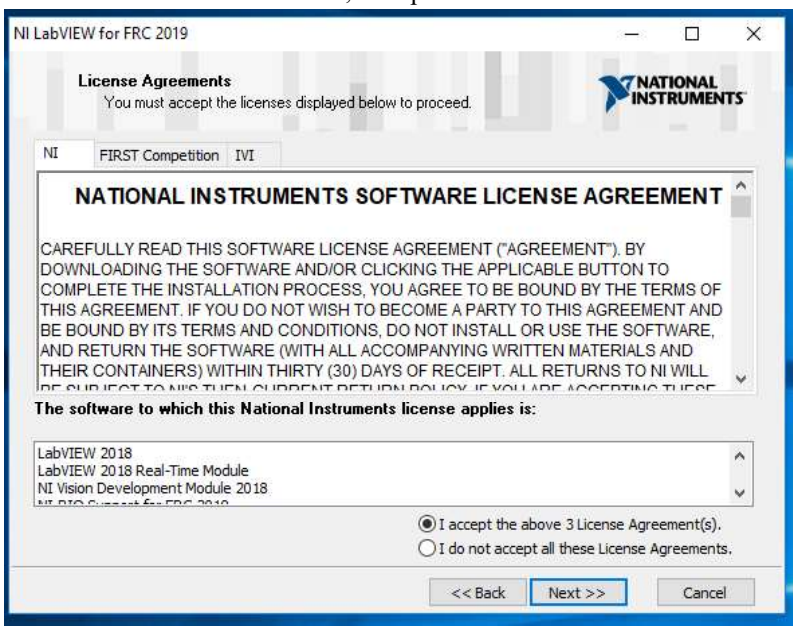
7. Enter VBTCFRC2019 as the Full Name. Enter the serial number B04P66096 (zeros, not ohs). Press the Next button.



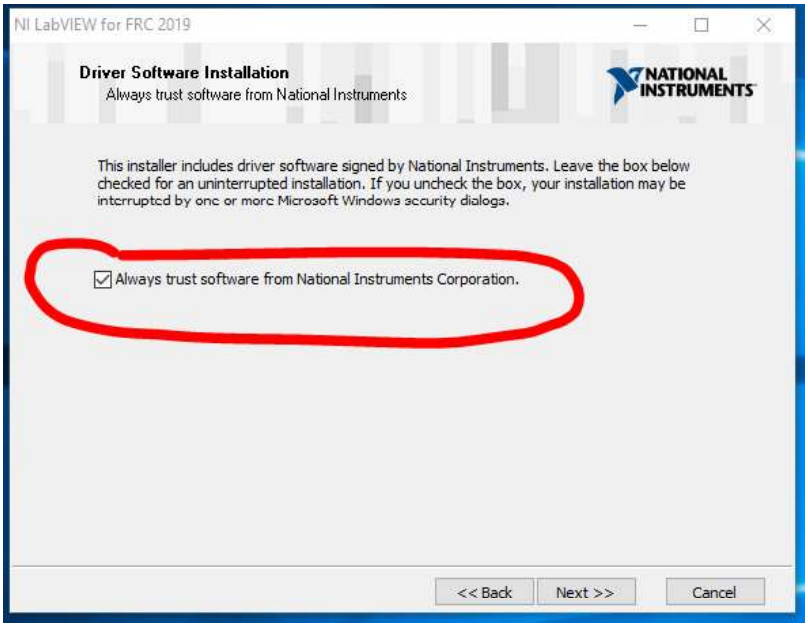
8. Leave the installation path as supplied by default and press the Next button.



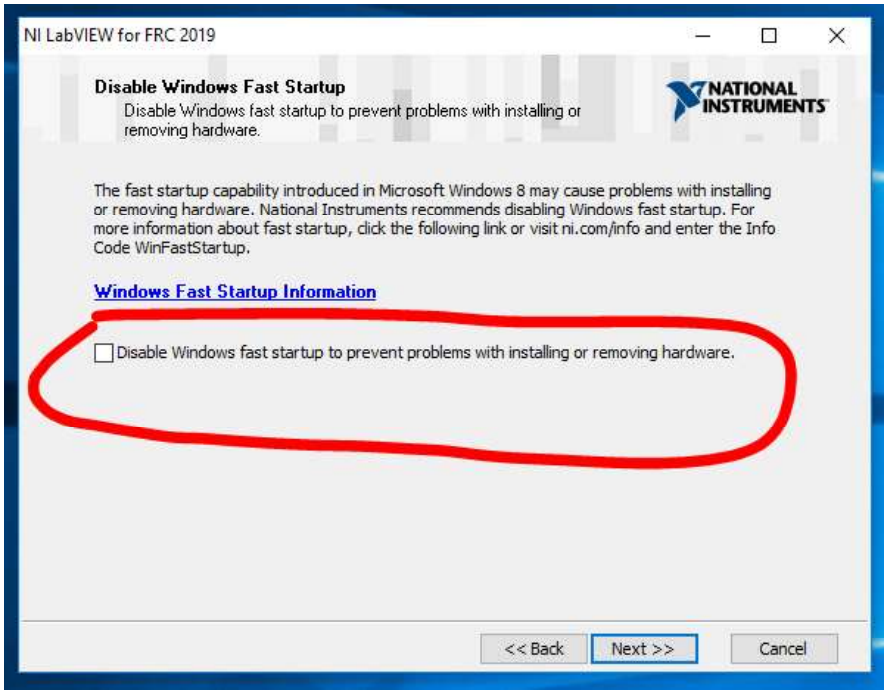
9. Press the ACCEPT radio button, then press the Next button. Do this twice.



10. Leave the trust box checked and press the Next button.



11. If you are working on a workstation and will not be using this computer in competition, uncheck the disable fast startup box. On the other hand, if this computer will be connected to the robot, leave the box checked. In either case, finally press the Next button.

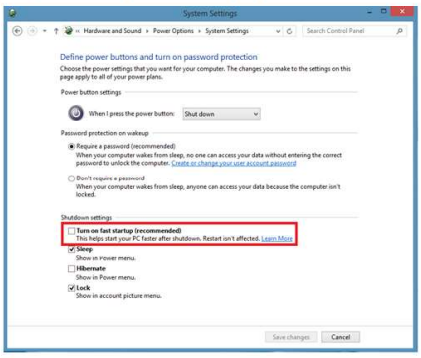


    a. If detection of the roboRIO becomes a problem, then fast startup can be disabled as follows (source: https://knowledge.ni.com/KnowledgeArticleDetails?id=kA00Z000000P9ErSAK&l=en-US):

- On Windows 8 and 10, the default is for the PC to do a Fast Startup. This might cause problems with hardware detection and the use of some drivers. With Fast Startup, modifications you make to the hardware in a PCI/PXI bus while the system is powered down may prevent rediscovery of the device. National Instruments recommends you disable the Fast Startup feature.

Disabling Fast Startup

Manually disable Fast Startup by deselecting **Turn on fast startup** on the **Systems Settings** page of the **Control Panel**.



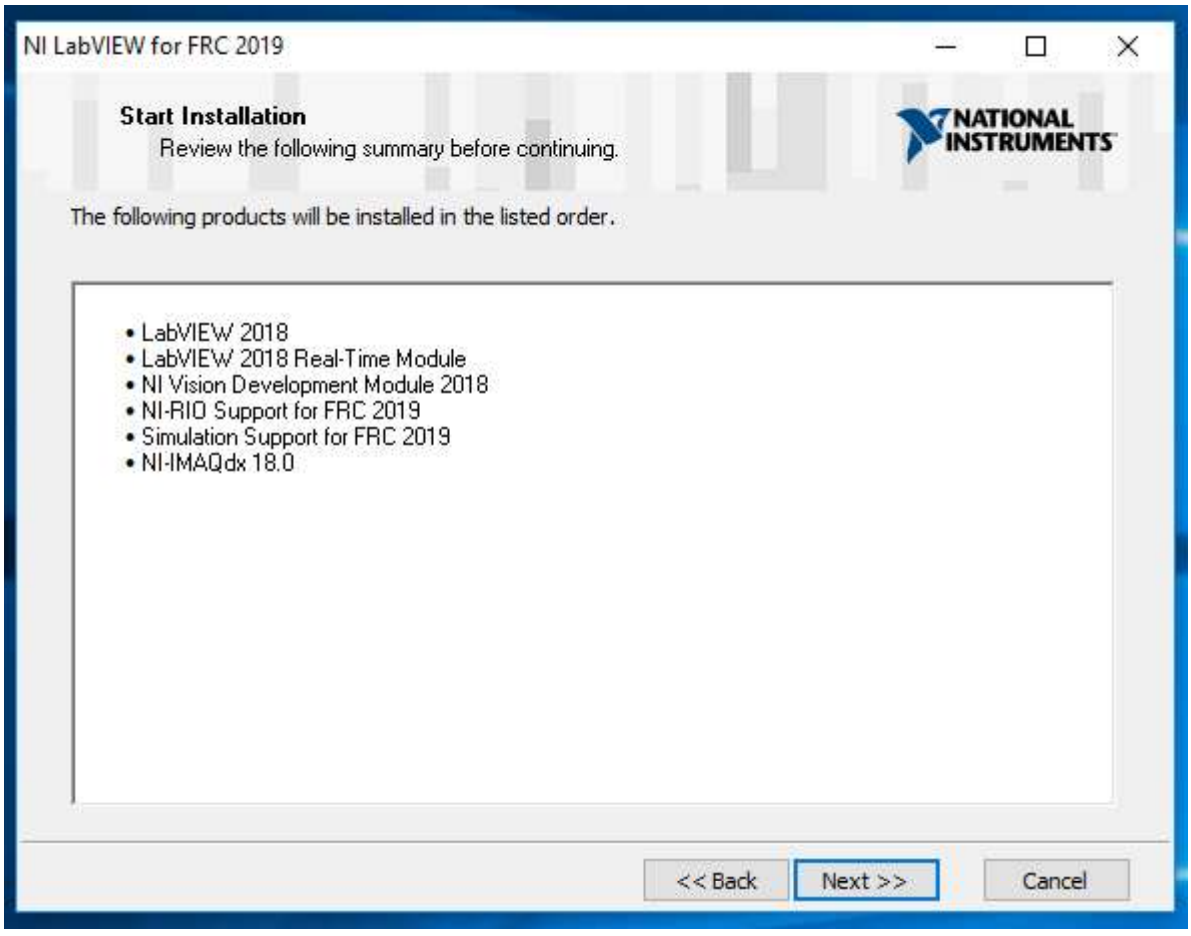
Fast Startup Group Policy:

Windows provides a Group Policy that enables Fast Startup Regardless of the local setting described above. To determine if this Group Policy is enabled:

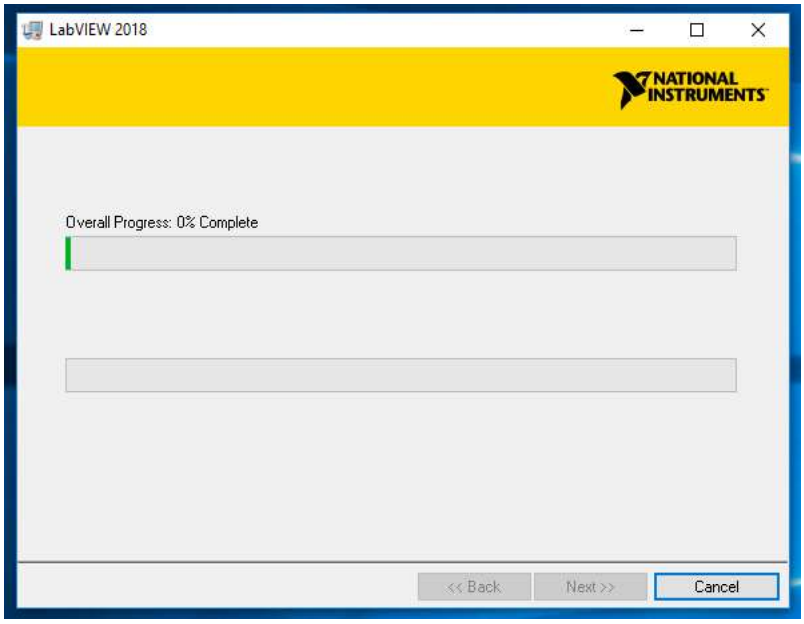
1. Open the **Local Group Policy Editor**
2. Browse to **Local Computer Policy** >> **Computer Configuration** >> **Administrative Templates** >> **System Shutdown** >> **Require use of fast startup**

If you are unable to disable this Group Policy, contact your administrator.

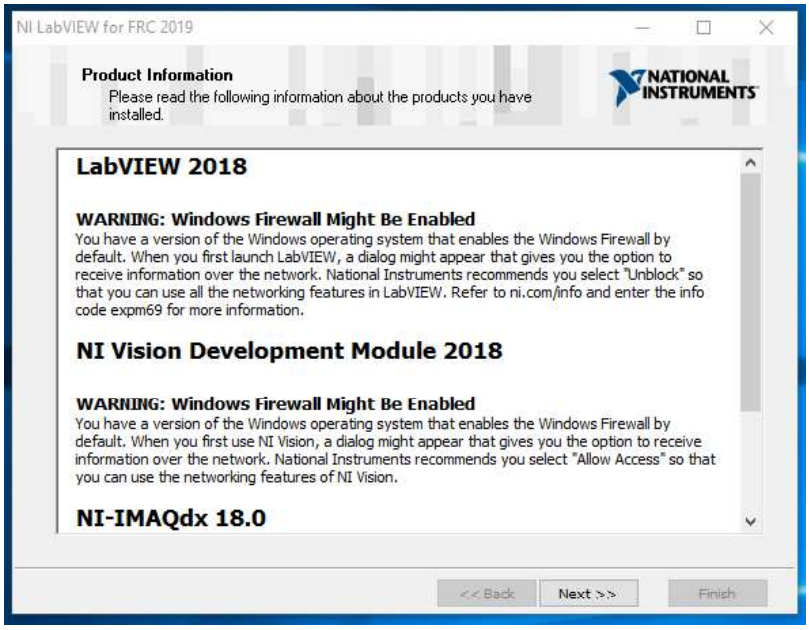
12. This screen lists the software to be installed. Press the Next button.



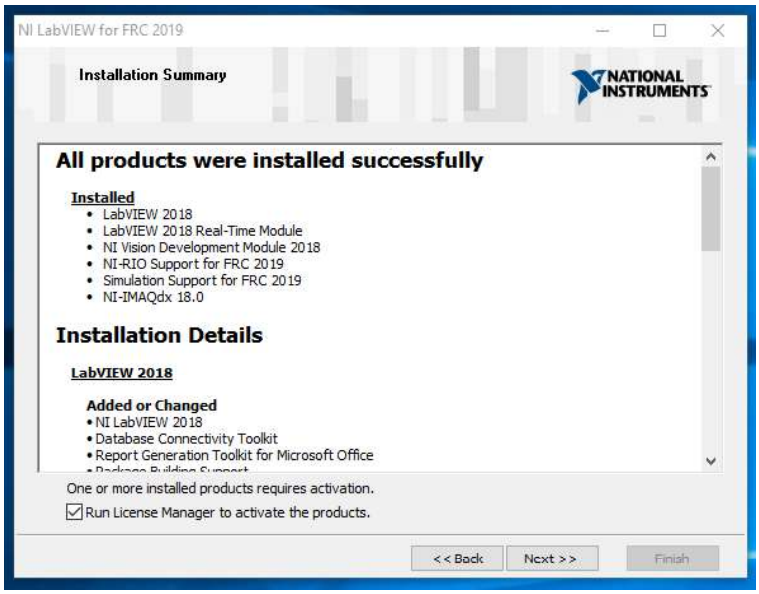
13. Installation begins. This takes a long time (almost an hour).



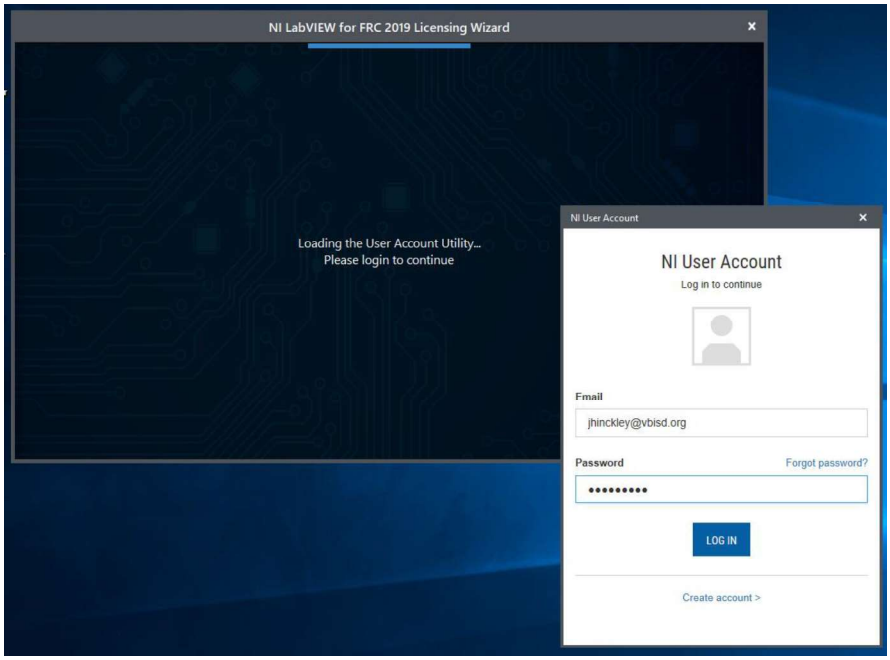
14. When installation finishes, this screen appears. Press the Next button.



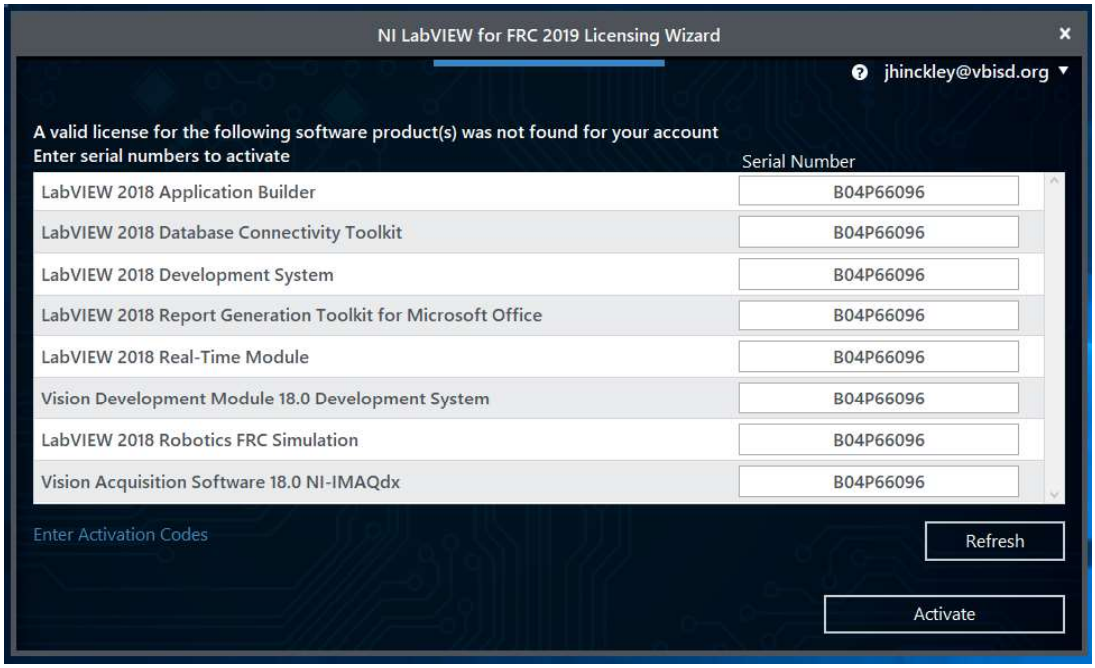
15. An installation summary is shown. Leave the "Run License Manager…" box checked and press the Next button.



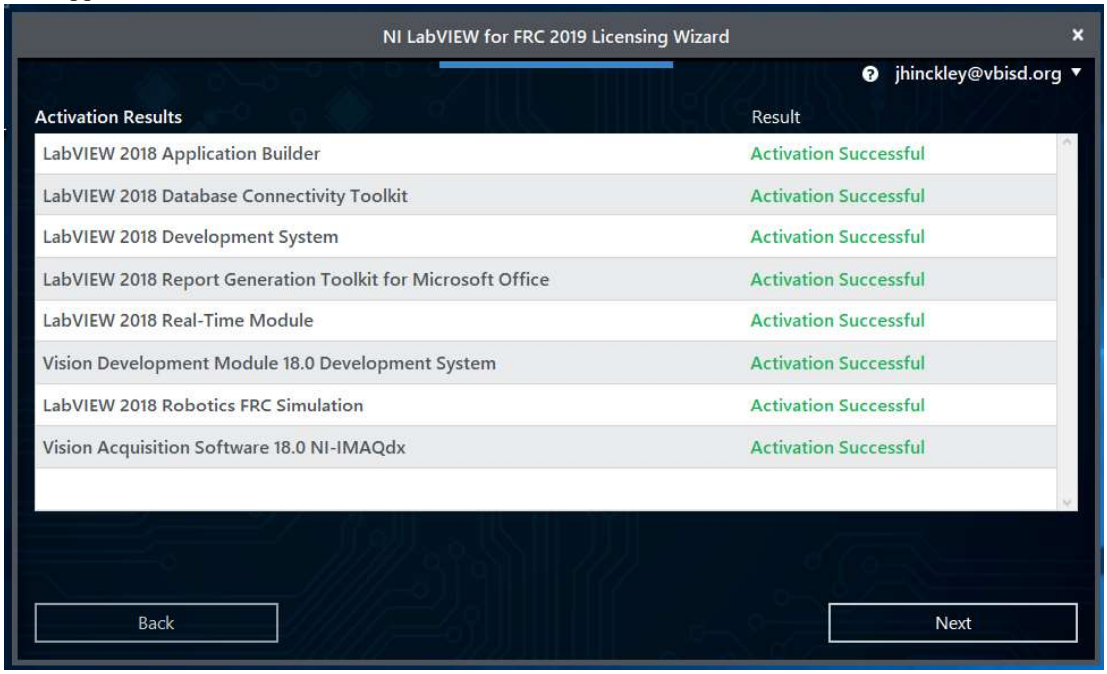
16. This appears next. Enter your National Instruments account ID and password. Then, press the Login button.



17. This is the next screen. The serial numbers should already be entered. Press the Activate button.

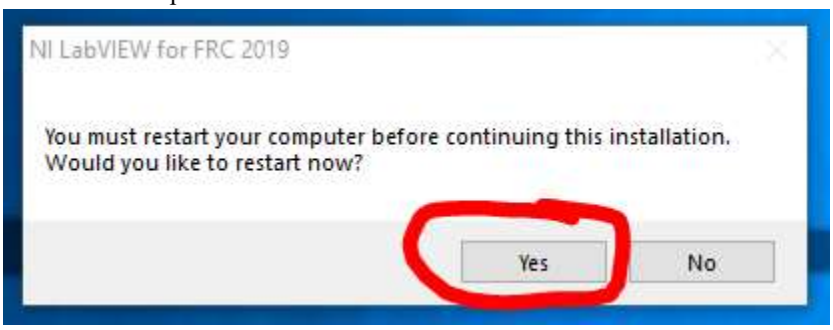


18. This appears next. Press the Next button.



19. Finally, press the Close button.

20. Restart the computer.

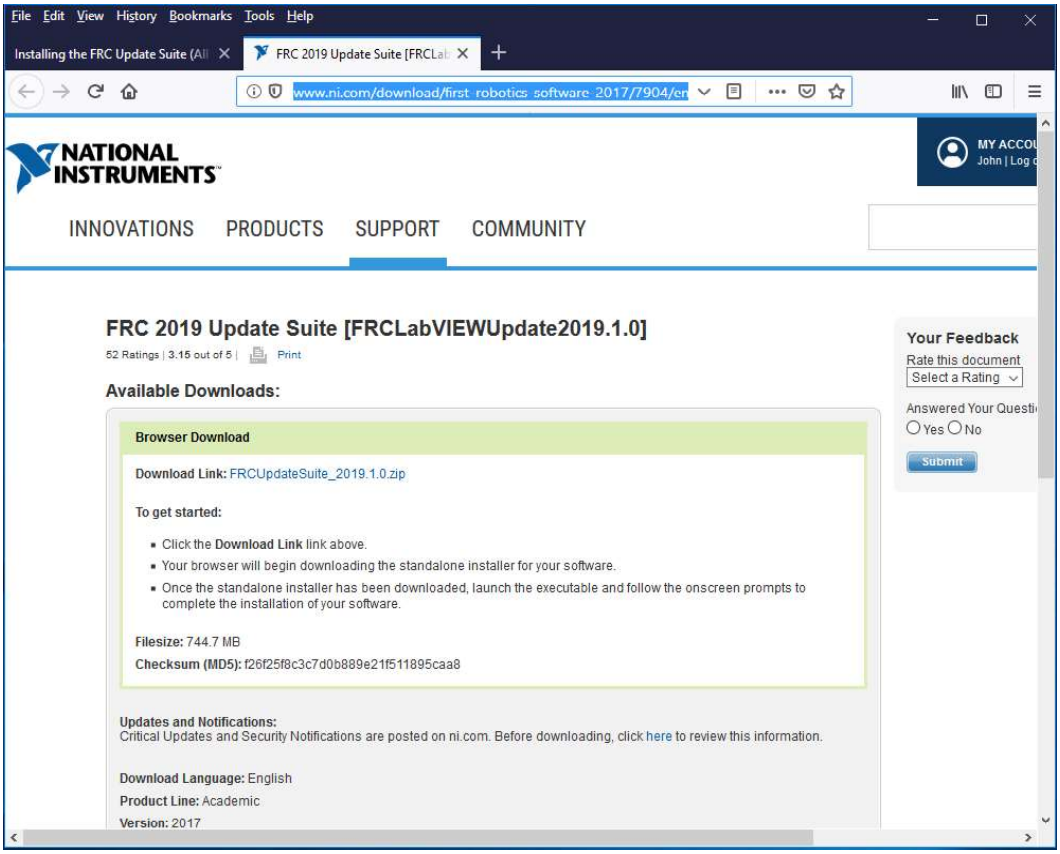


INSTALLATION OF THE FRC 2019 UPDATE

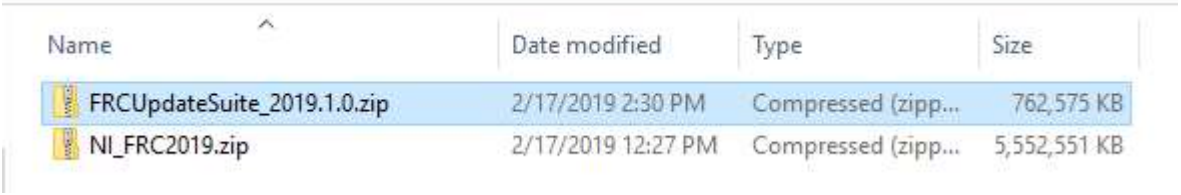
These instructions follow the guide presented at
https://wpilib.screenstepslive.com/s/currentCS/m/labview/l/1027502-installing-the-frc-update-suite-all-languages

The installation provides the LabVIEW update, the FRC Driver station and the FRC utilities.

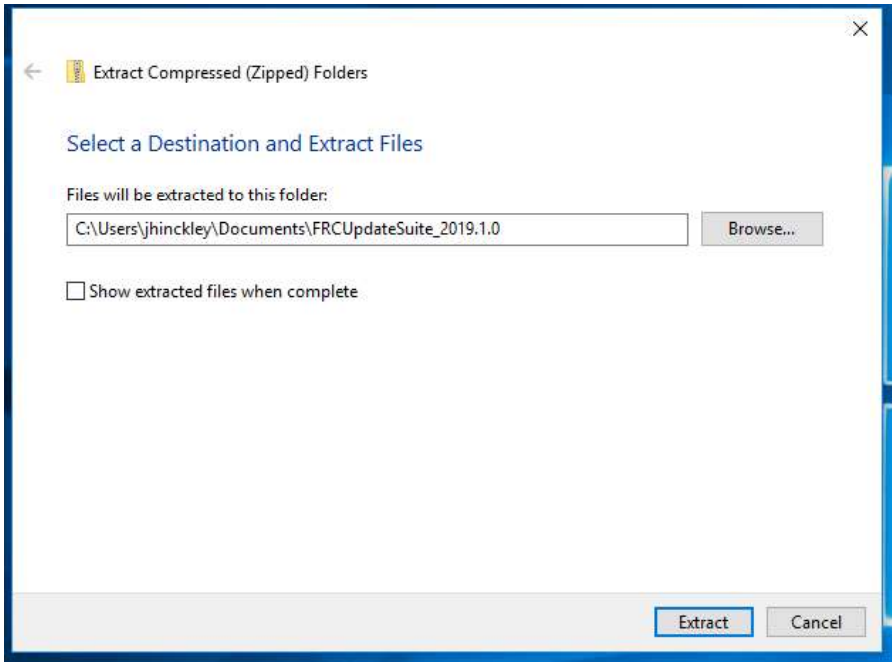
1. Navigate to http://www.ni.com/download/first-robotics-software-2017/7904/en/ .



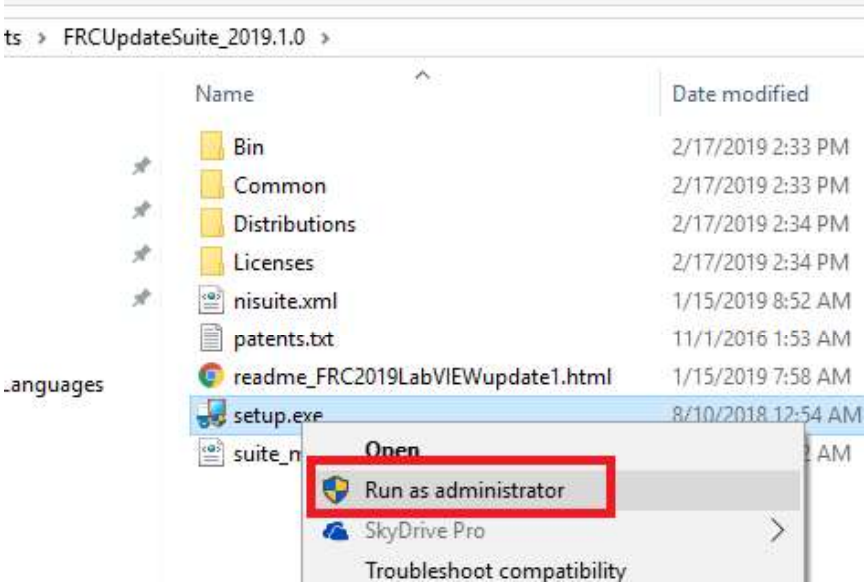
2. Press the download link, saving FRCUpdateSuite_2019.1.0.zip in your Downloads folder.



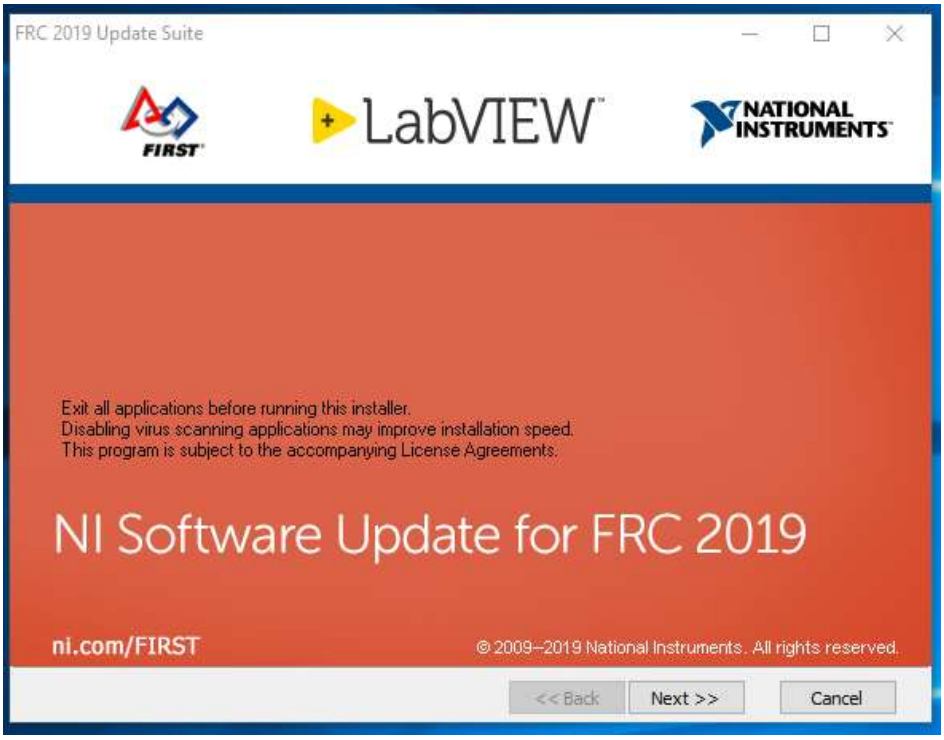
3. Extract this update archive.



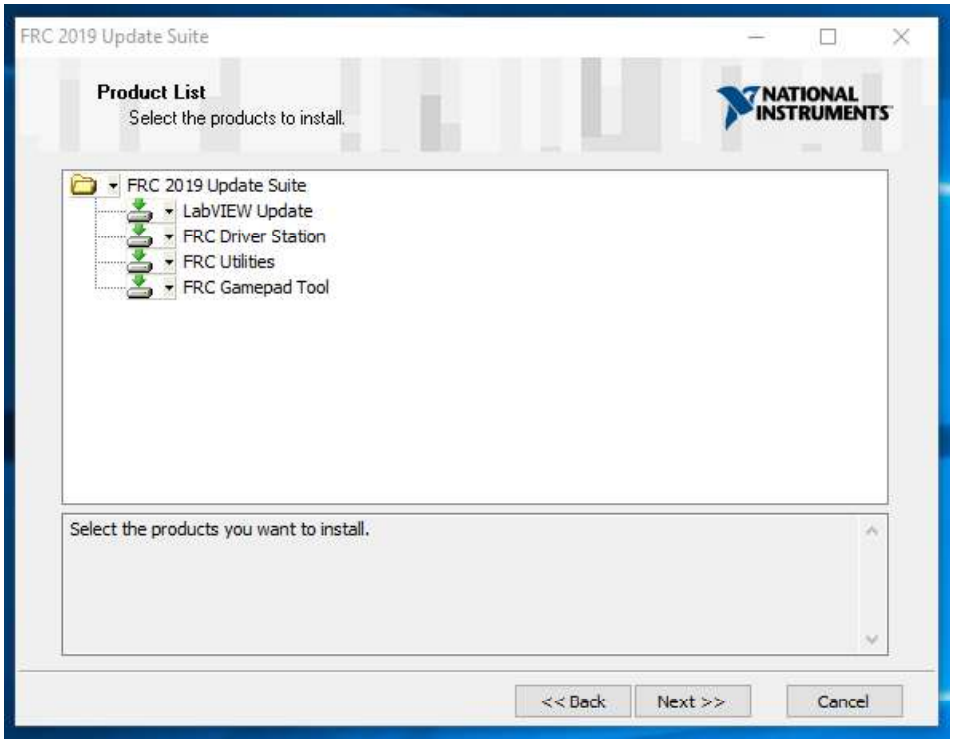
4. Run the setup.exe executable, as an administrator.



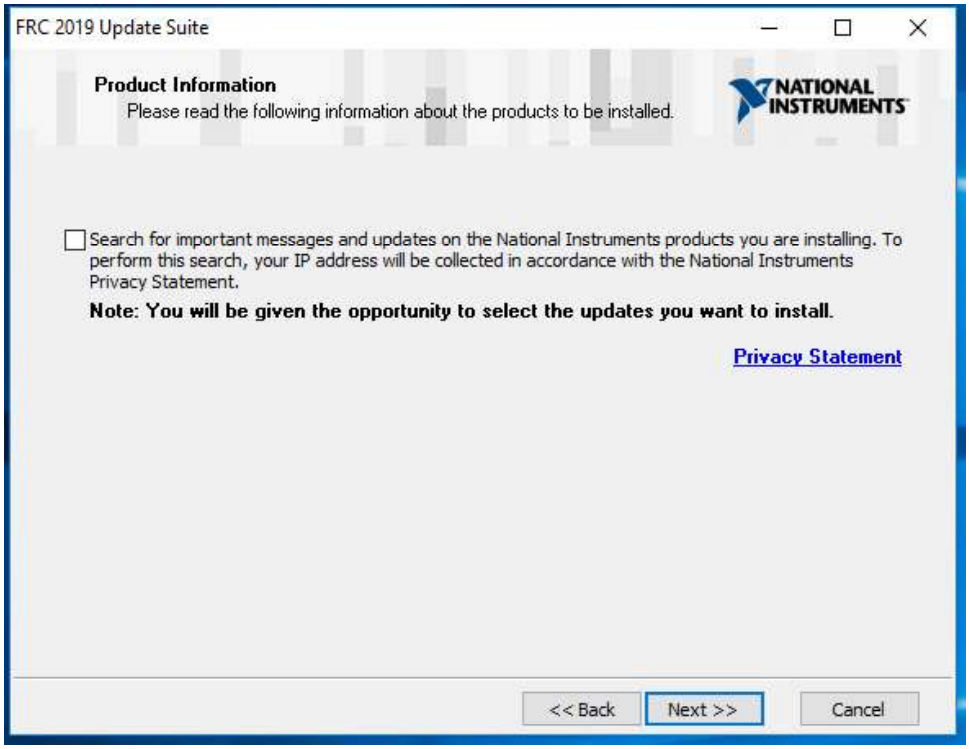
5. This is the initial screen of the update. Press the Next button.



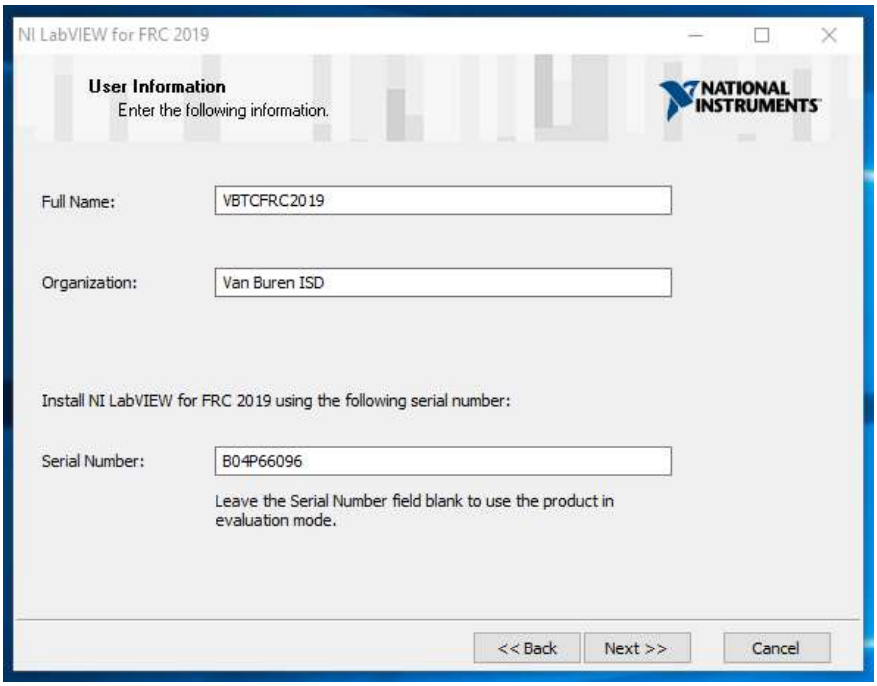
6. Leave the product list as it appears with all items selected. Press the Next button.



7. Uncheck the “Search for...” box and press the Next button.

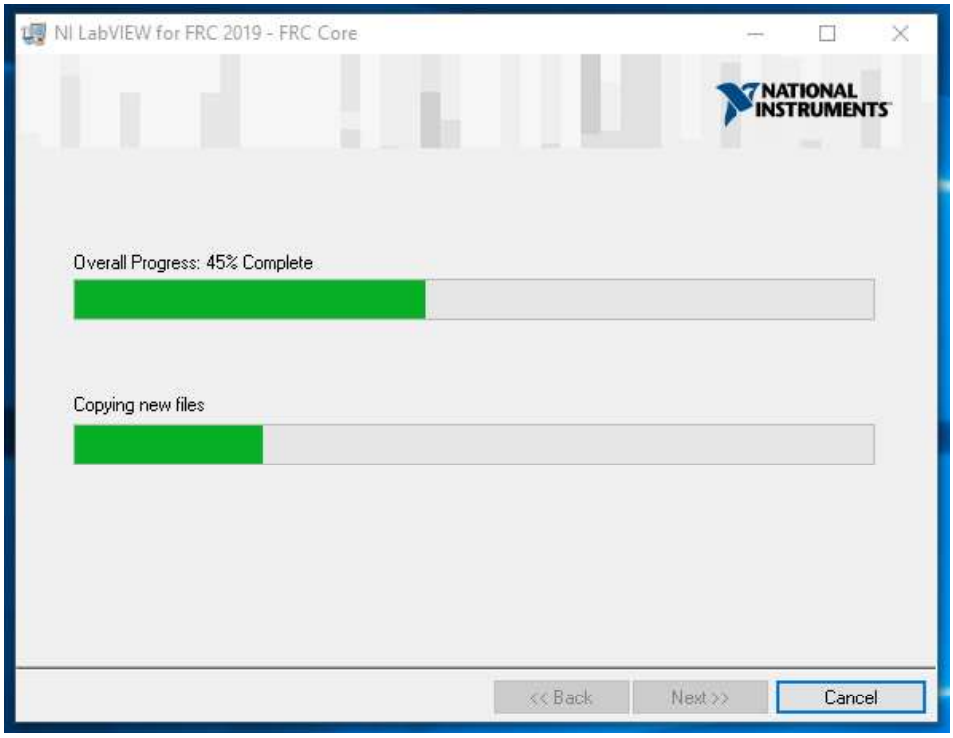


8. Enter VBTCFRC2019 as the Full Name. Enter the serial number B04P66096 (zeros, not ohs). Press the Next button.

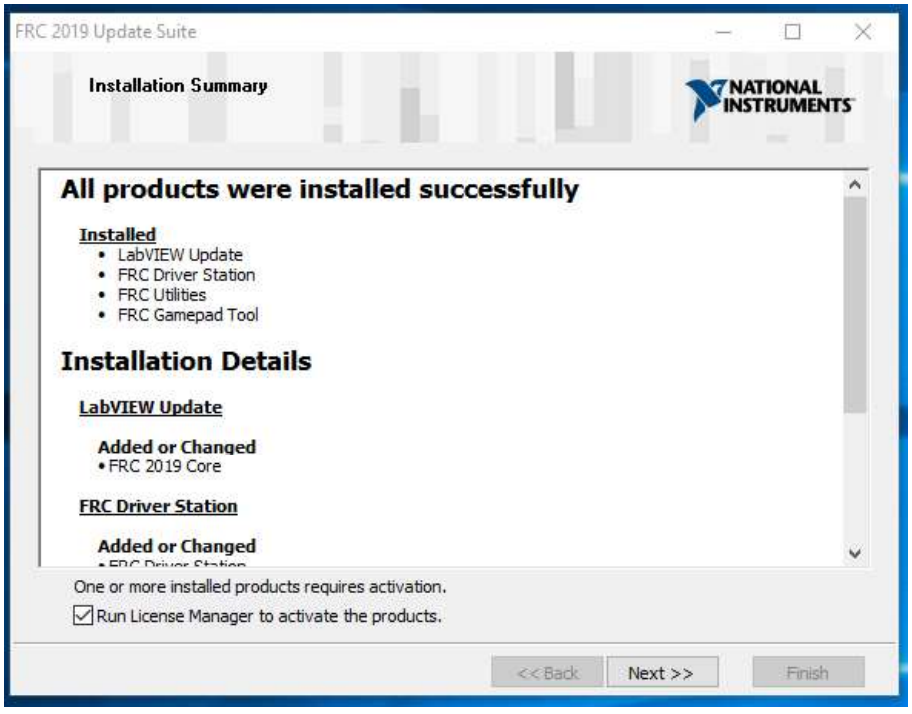


9. Accept the license agreements on the next two screens.

10. Installation begins.

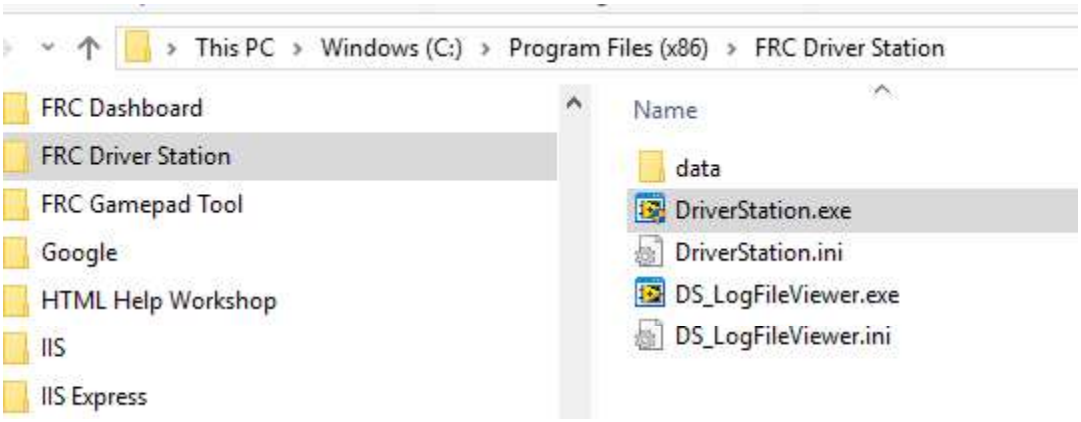


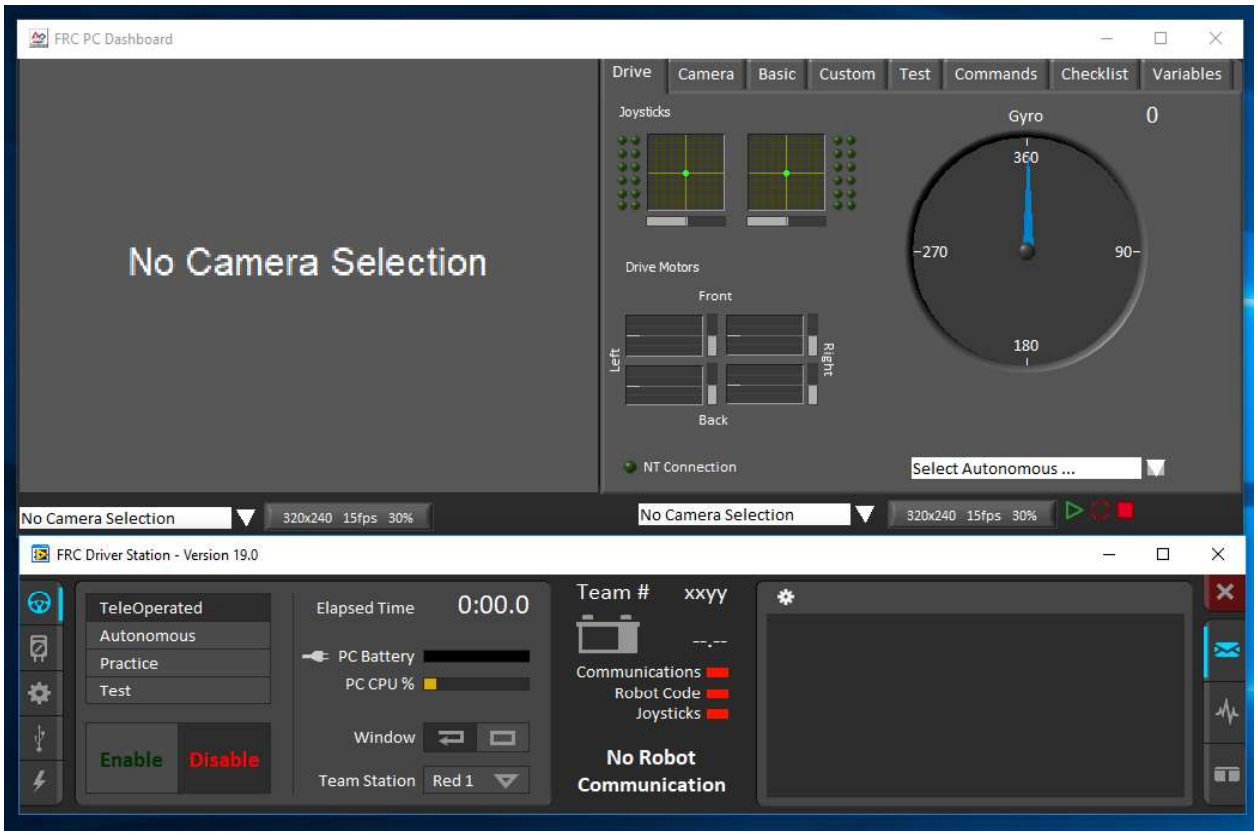
11. When it's done, leave the Run License Manager button checked and press the Next button.



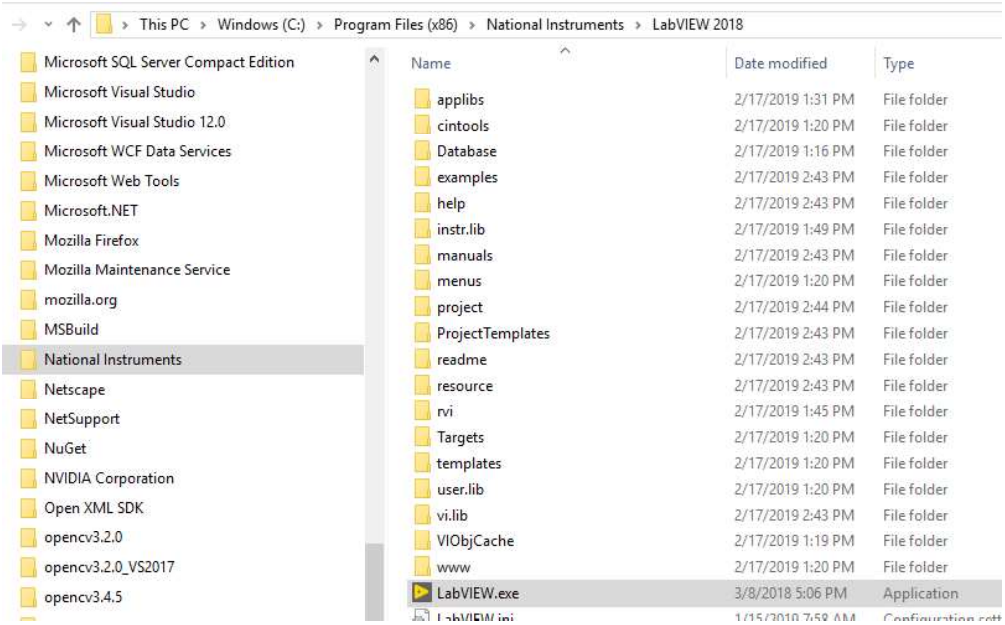
12. This appears to be the end of the installation process.

13. The Driver Station is located in C:\Program Files (x86)\FRC Driver Station. Running the Driver Station will automatically start the Dashboard, too.

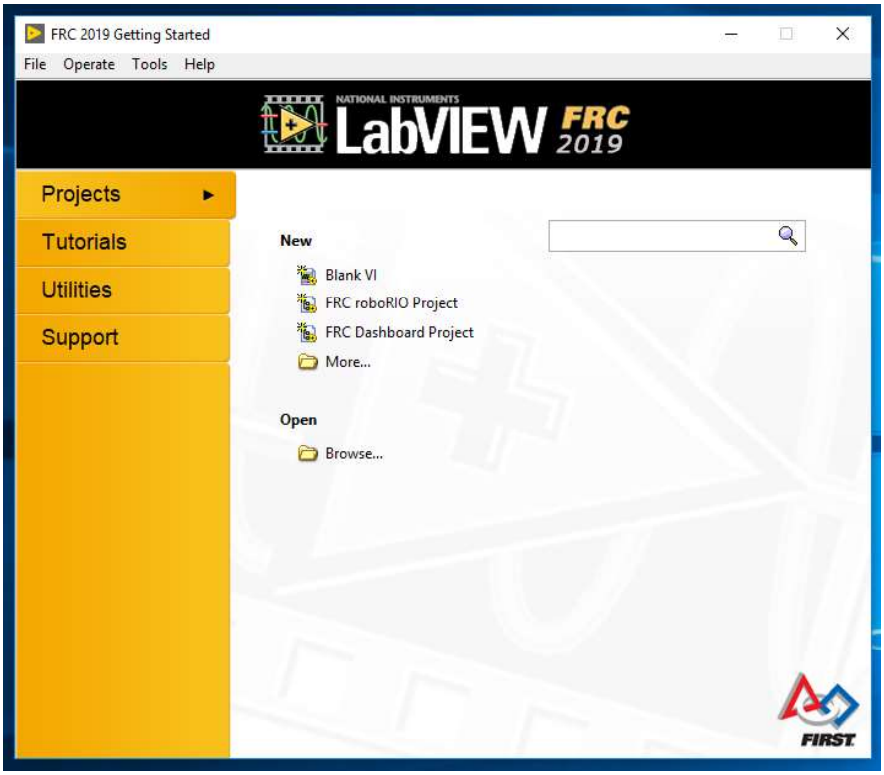




14. The LabVIEW program is located in C:\Program Files (x86)\National Instruments\LabVIEW 2018.



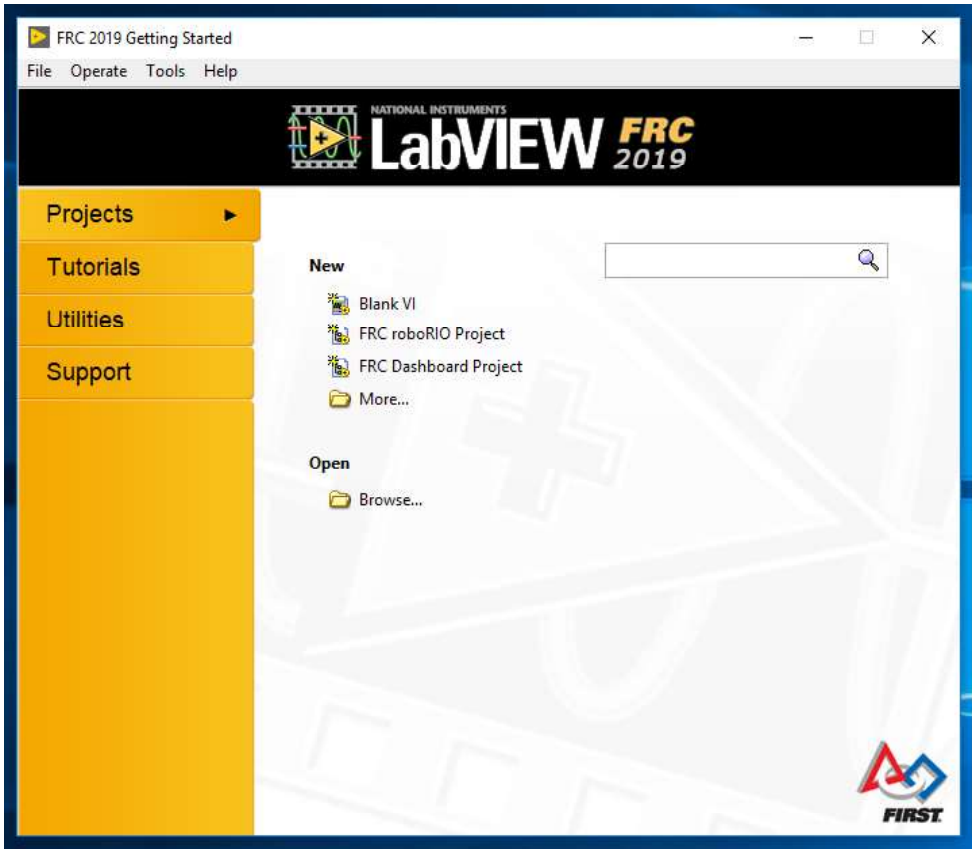
15. Running this brings up the LabVIEW development environment.



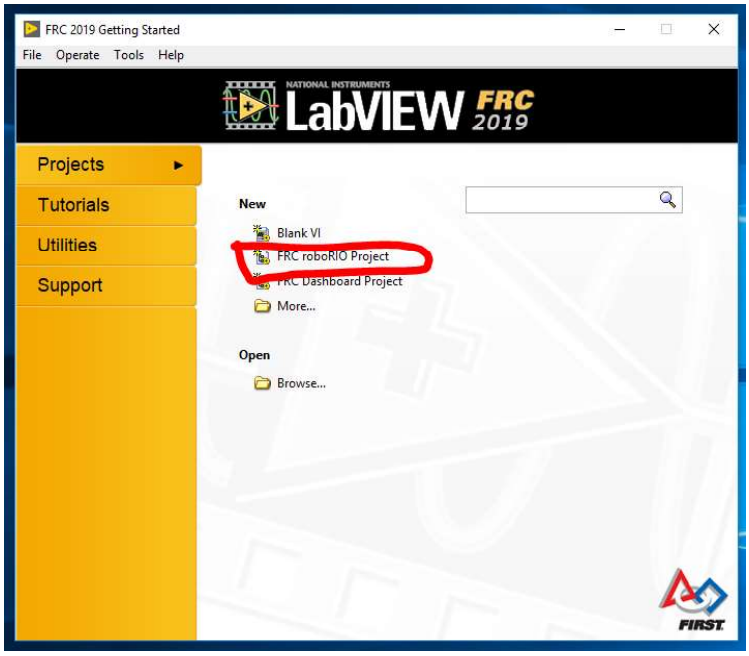
CREATION OF A BASIC ROBOT PROGRAM

This is the procedure for creating a basic arcade drive robot project.

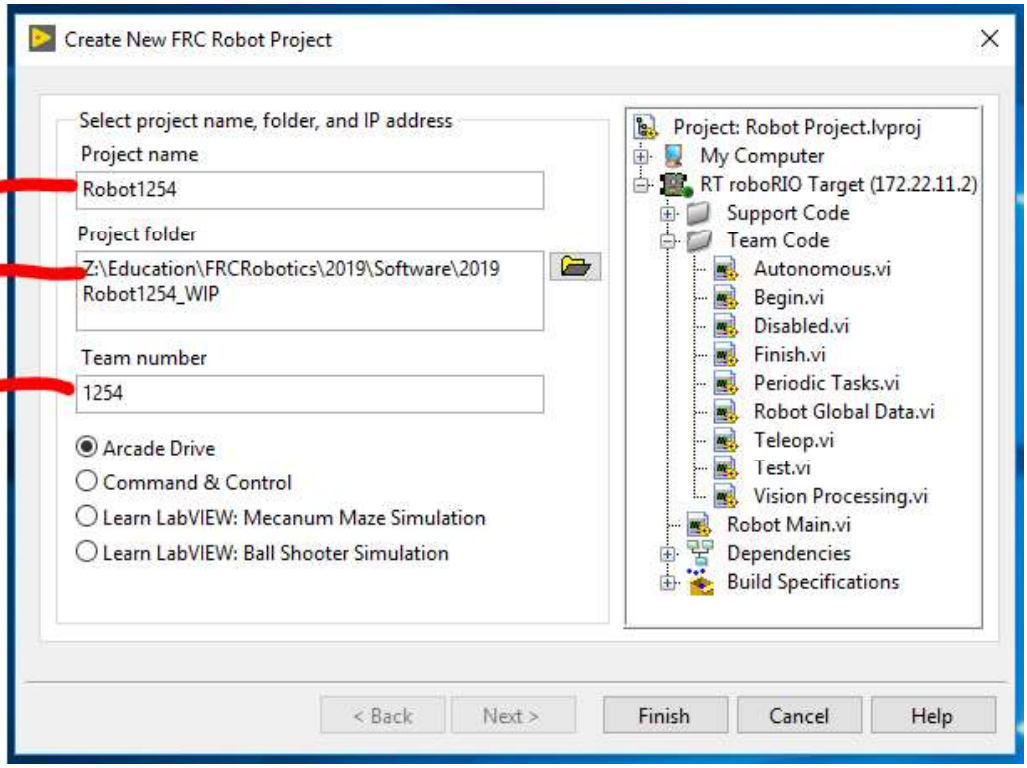
1. Start LabVIEW.



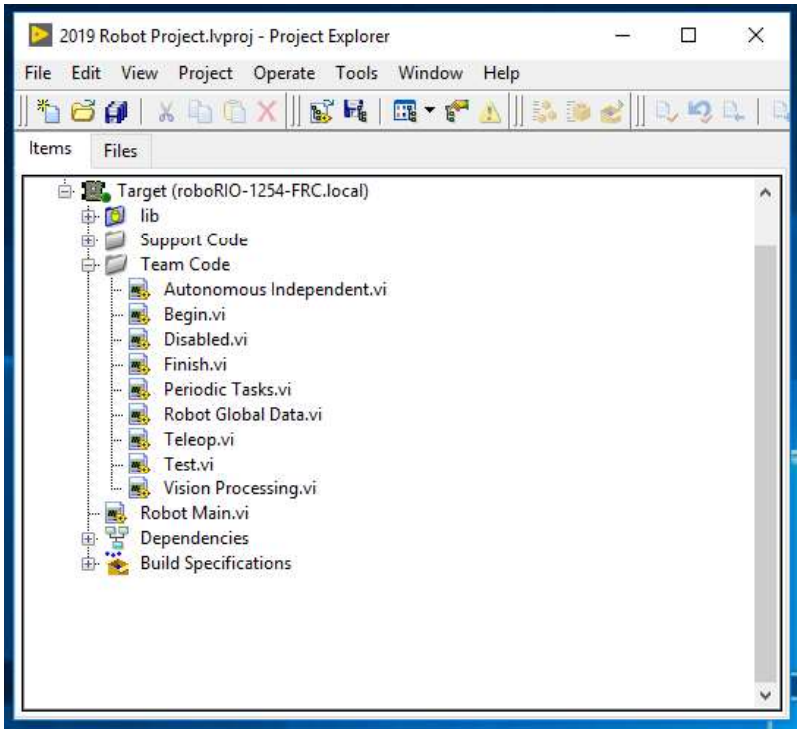
2. Under Projects, select FRC roboRIO Project.



3. This screen appears. Set the desired project name, project folder and team number. Then, press the Finish button.

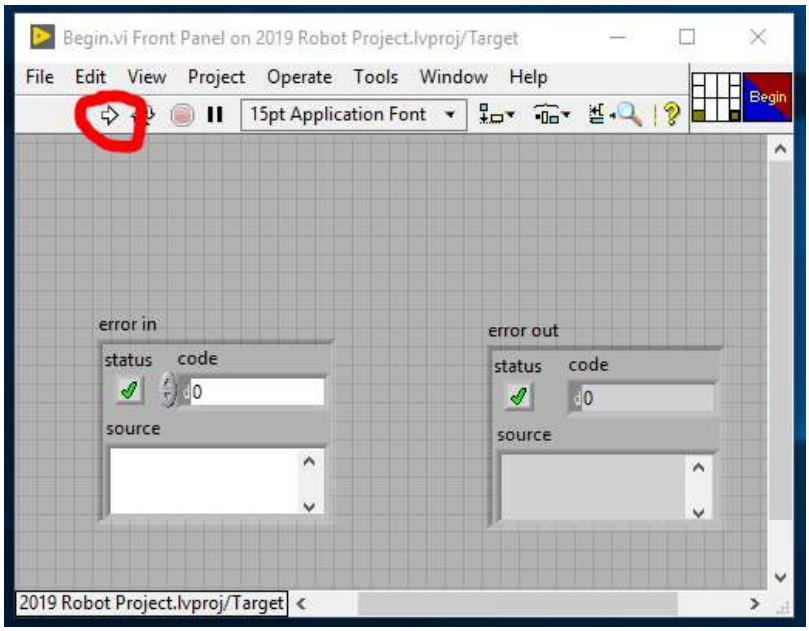


4. When done, the Project Explorer appears, thus:



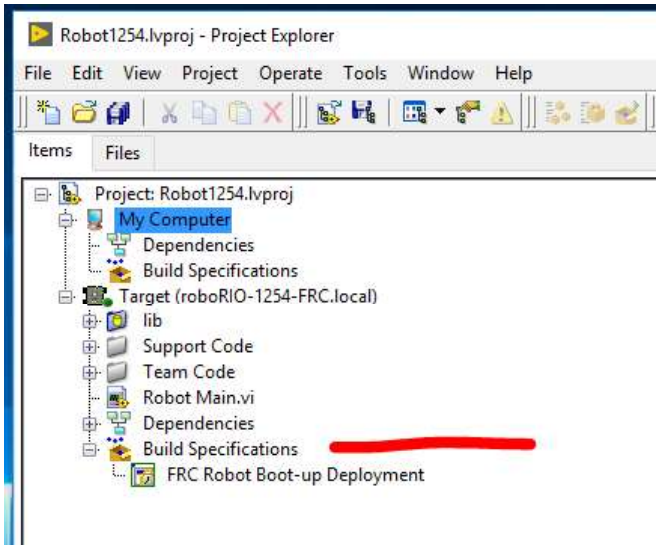
RUNNING AND DEBUGGING A PROGRAM IN THE DEVELOPMENT ENVIRONMENT

1. Start the Driver Station
2. Open the project in LabVIEW.
3. Open Begin.vi.
4. Press the Run arrow icon in the toolbar.

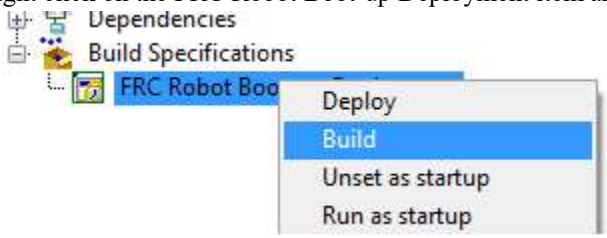


NON-VOLATILE INSTALLATION AND RUNNING OF A PROGRAM ON THE ROBORIO

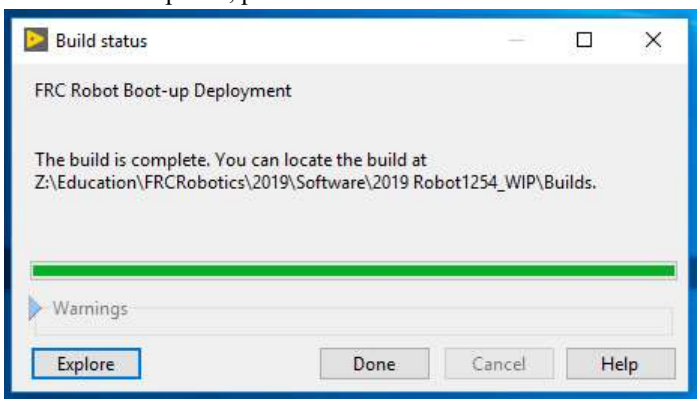
1. In the Project Explorer, expand the Build Specifications.



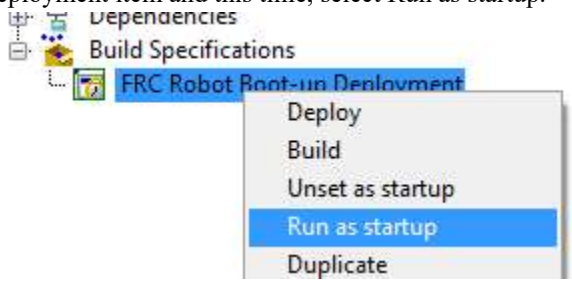
2. Right click on the FRC Robot Boot-up Deployment item and select Build from the pop-up menu.



3. When this completes, press the Done button in the Build status dialog.



4. Assuming that your computer is connected to the roboRIO, again right-click on the FRC Robot Boot-up Deployment item and this time, select Run as startup.



5. If all goes well, the code now lives on the roboRIO and will still be there after power cycling the robot.

EXAMPLE: DEVELOPMENT OF THE CODE FOR THE 2019 SEASON

The specifications and requirements for this robot are as follows:

Structure

1. It uses a holonomic drive with four mecanum wheels.
2. Each wheel is powered by two variable speed motors.
3. On each wheel, one motor is controlled by a Talon SRX speed controller. The other motor is controlled by a Victor speed controller.
4. The robot has a motor-driven hoist. This hoist is driven by two motors, each of which is controlled by a Victor speed controller. These motors turn together, in the same direction.

5. The robot has an actuator positioned on the end of a pivoting arm. Positioning of this arm is controlled by a double-acting pneumatic cylinder.
6. The actuator at the end of the arm involves a suction cup that can (1) pull in air to create a suction, (2) block air flow and (3) push air out to eject what it is holding.

Control requirements

1. The drive motors are controlled by the left joystick. Forward and backward motion is obtained by pushing the joystick forward and backward, respectively. Left and right translation is obtained by pushing the joystick left and right, respectively. Pivoting clockwise and counter clockwise is obtained by twisting the joystick correspondingly.
2. The hoist motors are controlled by the right joystick. Raising the hoist is obtained by pushing the joystick forward and lowering it is obtained by pulling it back.
3. The tilt action of the actuator arm is controlled by buttons 3 and 5 on the left joystick. Pressing button 3 causes the arm to tilt DOWN. Pressing button 5 causes the arm to tilt UP.
4. The air flow of the suction cup at the end of the arm is controlled by buttons 7, 9 and 11 on the left joystick. Pressing button 7 causes it to draw air in, to hold an object. Pressing button 9 causes it to stop all air flow in the suction cup. Pressing button 11 causes it to push air out, to release the object.

Hardware mapping

PWM (pulse-width modulated) signals for wheels:

Wheel	Position	Controller	PWM id
1	Rear Left	Talon SRX	1
“	“	Victor	2
2	Front Left	Talon SRX	3
“	“	Victor	4
3	Front Right	Talon SRX	5
“	“	Victor	6
4	Rear Right	Talon SRX	7
“	“	Victor	8

PWM signals for hoist:

Motor	Controller	PWM id
1	Victor	0
2	Victor	9

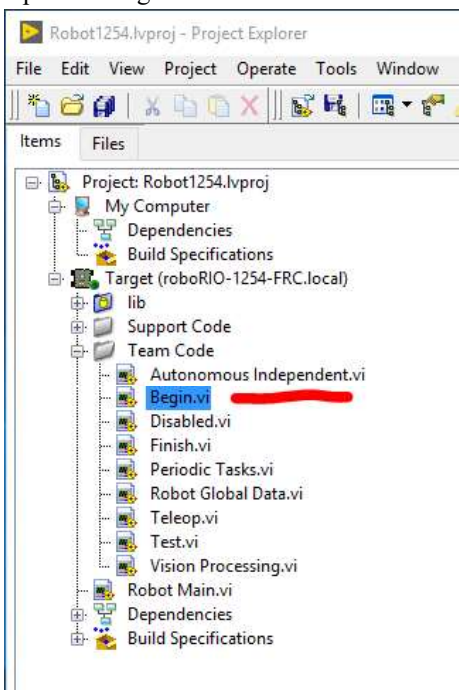
PCM (pneumatic control module) signals for air cylinders:

Solenoid	End	Solenoid channel
Tilt	1	0
“	2	1
Suction	1	2
“	2	3

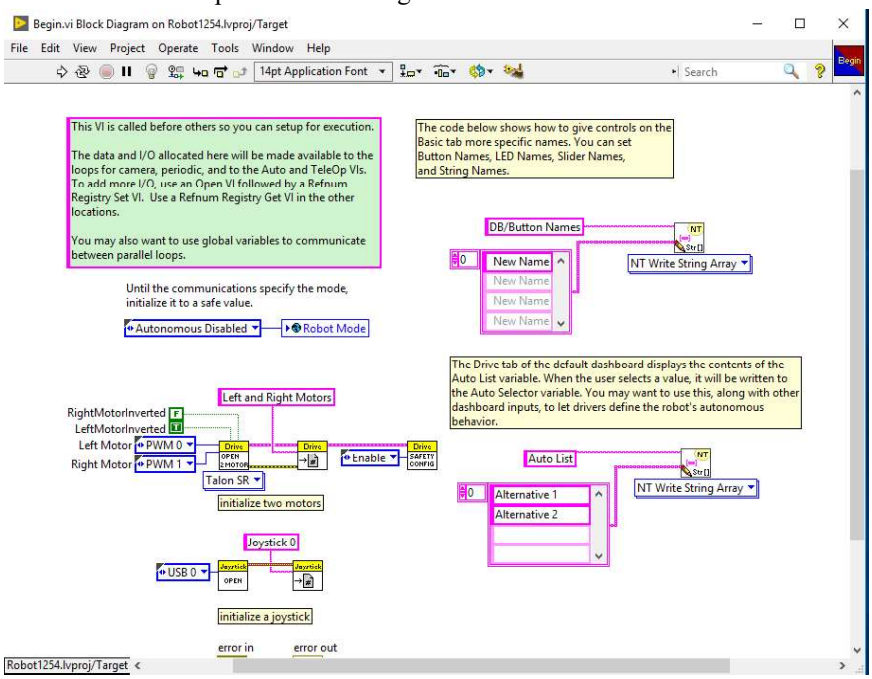
Software Development

1. Create a basic arcade drive project, as outlined above.

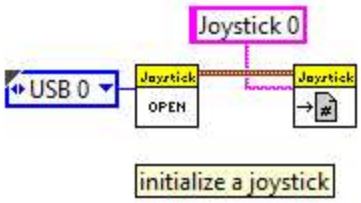
2. Program the joysticks.
    a. Begin.vi
        i. Open the Begin.vi.



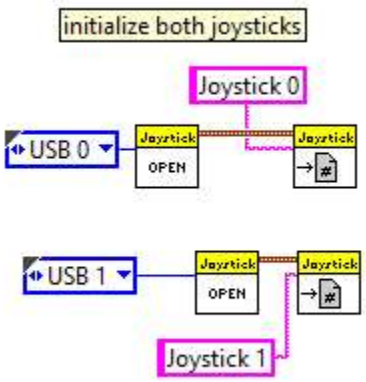
ii. Press control-E to open the block diagram.



iii. The initial code is this:



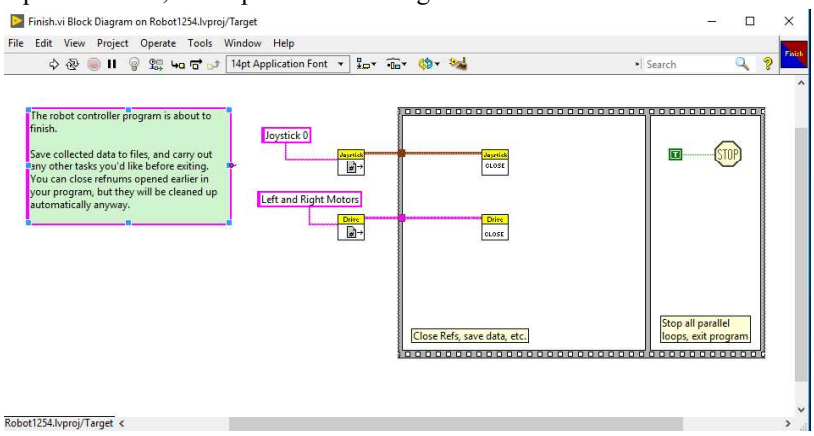
iv. Modify this to include a second joystick on USB 1. Name it Joystick 1.



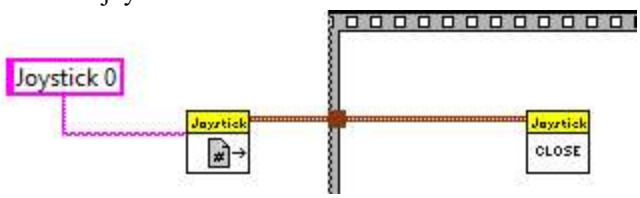
v. Save and close Begin.vi.

b. Finish.vi

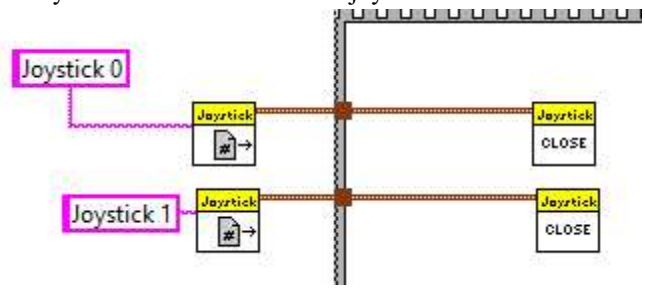
i. Open Finish.vi, then open its block diagram.



ii. The initial joystick code is this.



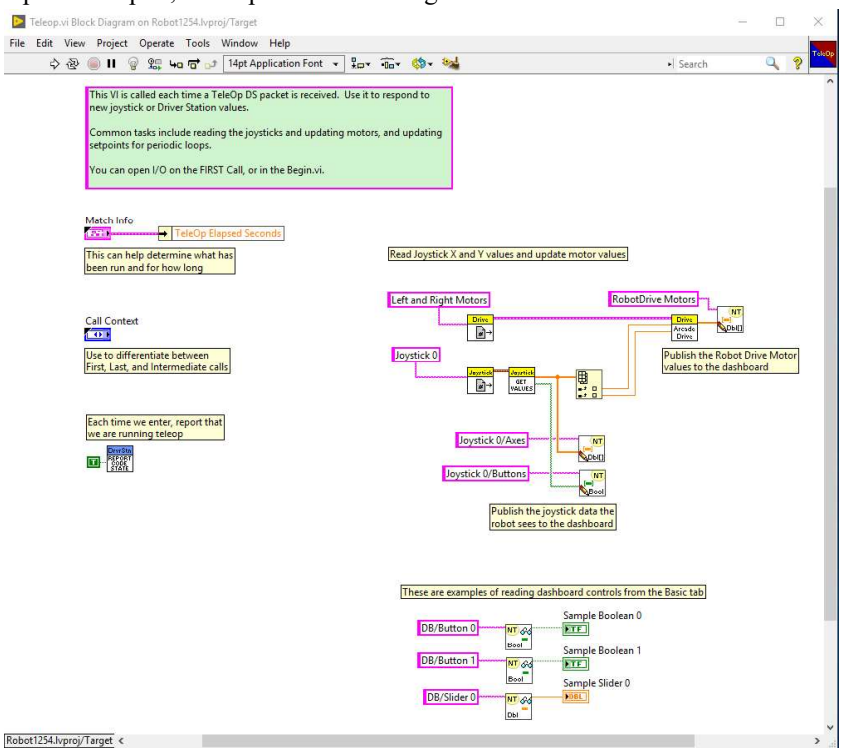
iii. Modify this to include the second joystick.



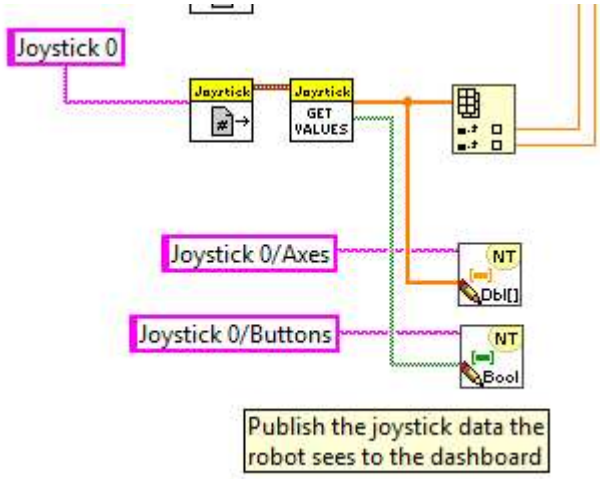
iv. Save and close Finish.vi.

c. Teleop.vi

i. Open Teleop.vi, then open its block diagram.

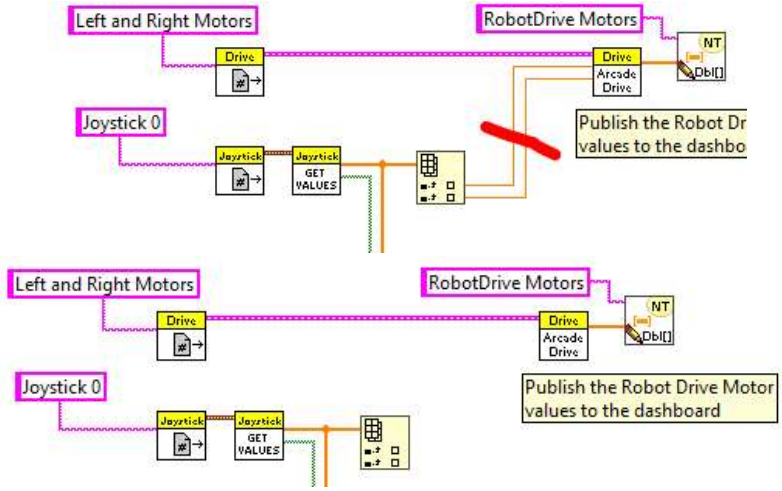


ii. The original joystick code is this.

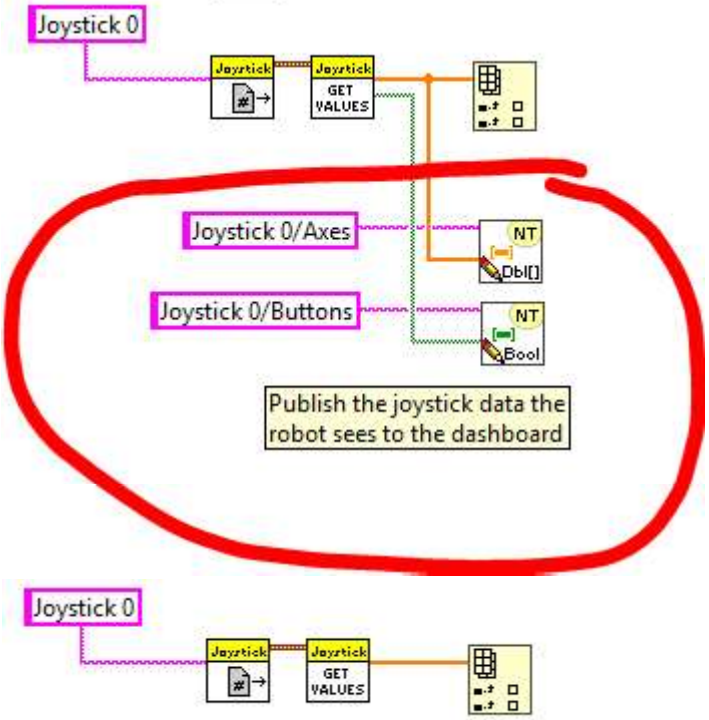


iii. Modify the code for joystick 0 as follows.

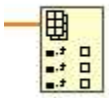
1. Disconnect joystick 0 Axes values from the Drive by removing the wire.



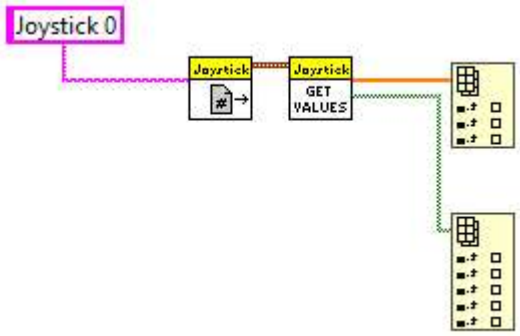
2. Remove the dashboard indicators.



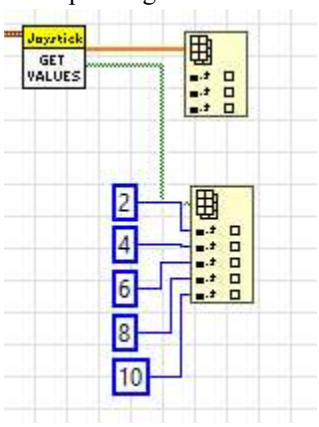
3. Resize the index array function to have three elements, instead of two. These will be the three control axes of the joystick.



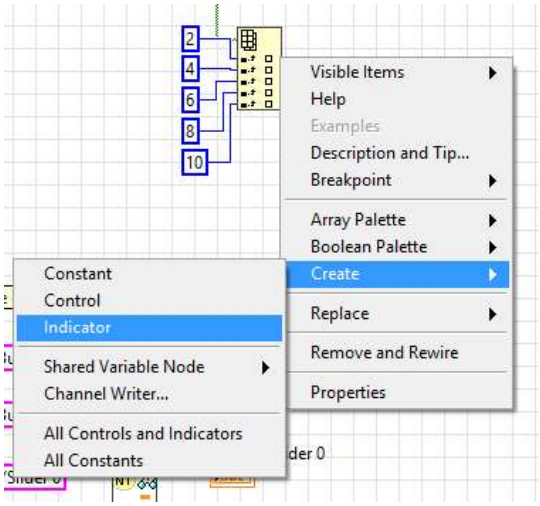
4. Add a new index array function to the block diagram. Resize it to have five elements. Wire the buttons from the joystick 0 to it.



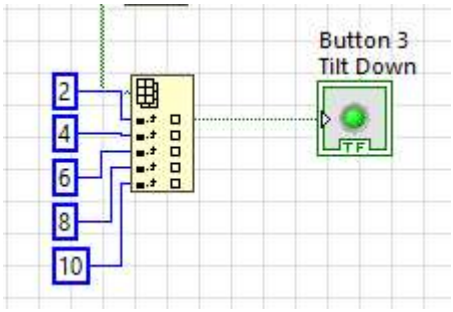
5. Add zero-based indices to the left side of the index array function, corresponding to the buttons that will be used on the joystick.



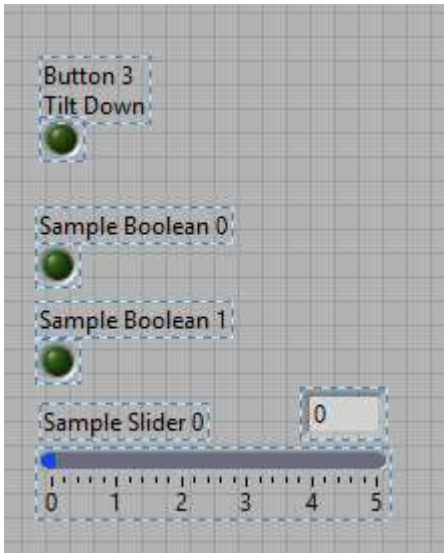
6. On the right side of the index array function, right-click on an element and select create indicator.



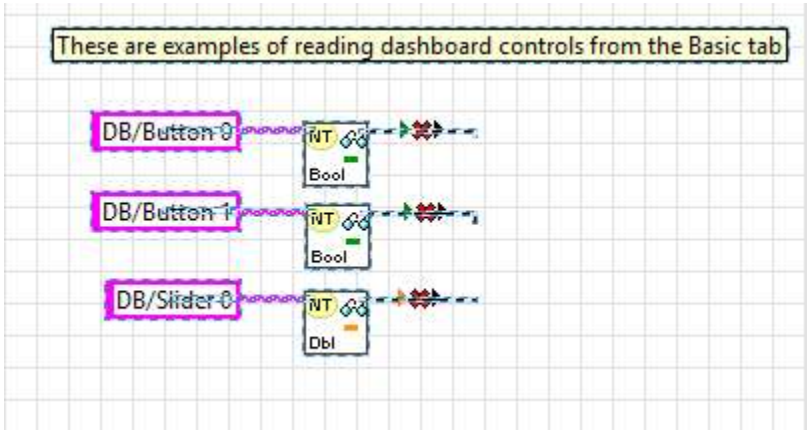
7. Label the indicator Button 3 \nTilt Down.



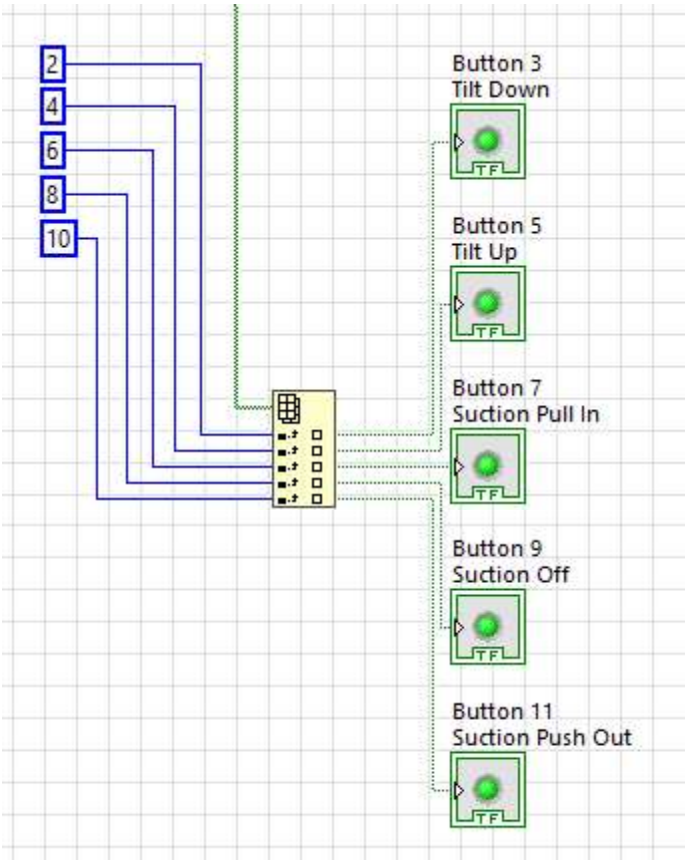
8. On the Teleop.vi front panel, move the corresponding indicator into the desired position. Delete the example Boolean and Slider indicators.



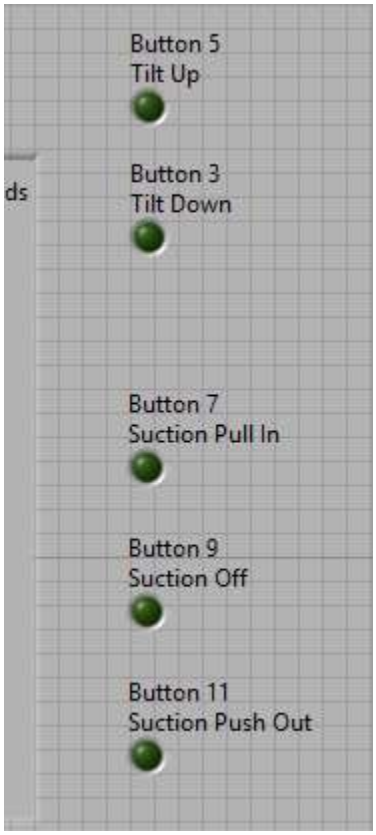
9. Delete this stuff from the Teleop.vi block diagram.



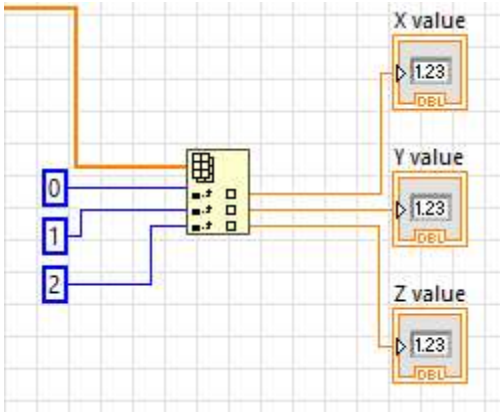
10. Following a similar procedure, add indicators to the remaining four elements of the index array function. Label them as shown.


2
4
6
8
10
Button 3
Tilt Down
Button 5
Tilt Up
Button 7
Suction Pull In
Button 9
Suction Off
Button 11
Suction Push Out

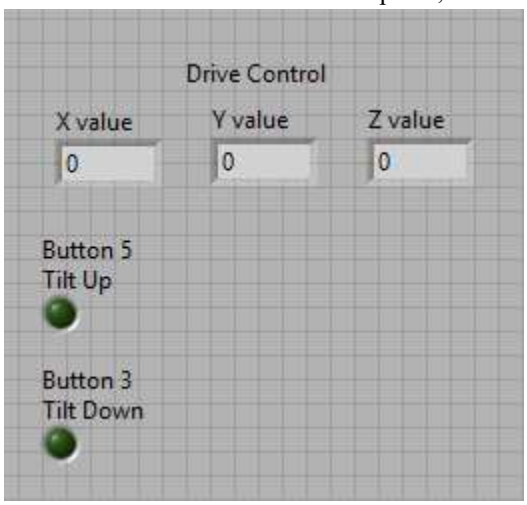
11. Position the corresponding indicators on the front panel, as desired.



12. By a similar procedure, add indices to the index inputs of the three-element index array function for the joystick axes and add corresponding indicators.

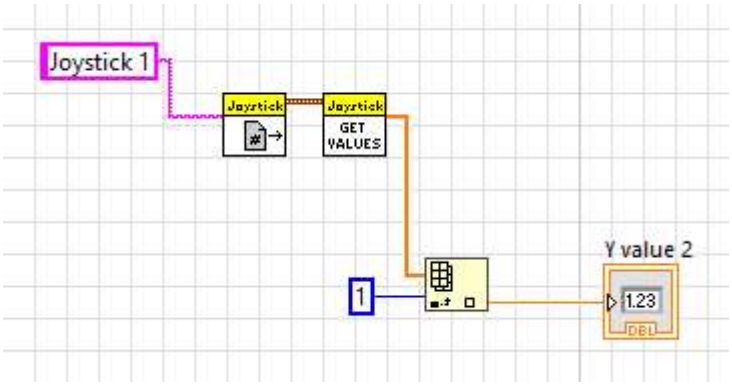


13. Position the indicators on the front panel, as desired.



iv. Add code for joystick 1 as follows.

1. Add code to the block diagram, by the above procedure.

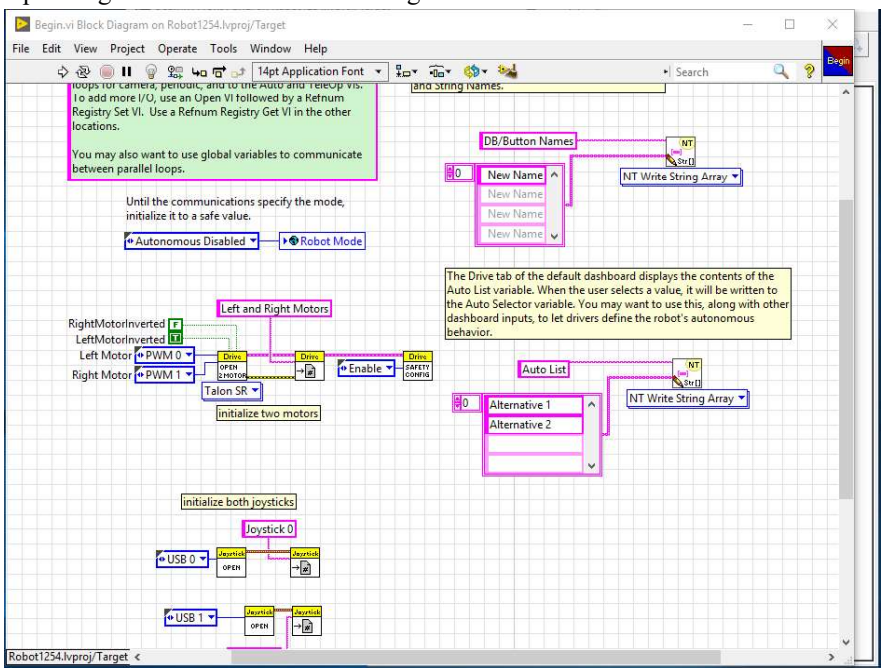


2. Position the indicator on the front panel, as desired.

3. Program the drive and hoist motors.

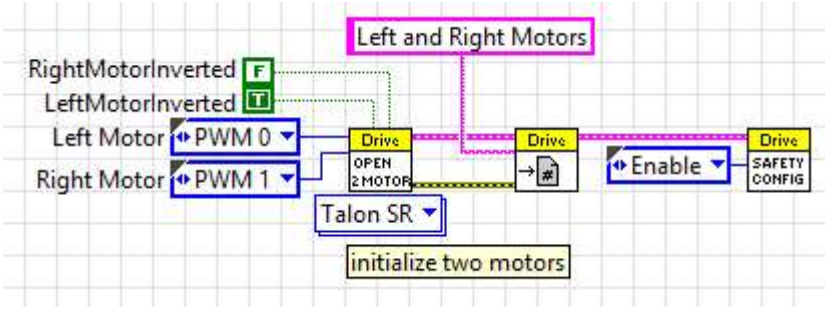
   a. Begin.vi

      i. Open Begin.vi and view the block diagram.

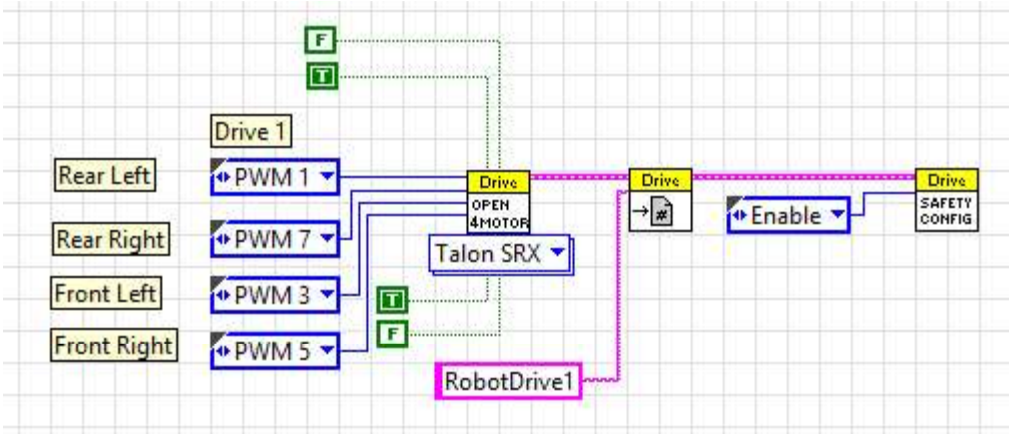


      ii. Change the drive motor initialization as follows.

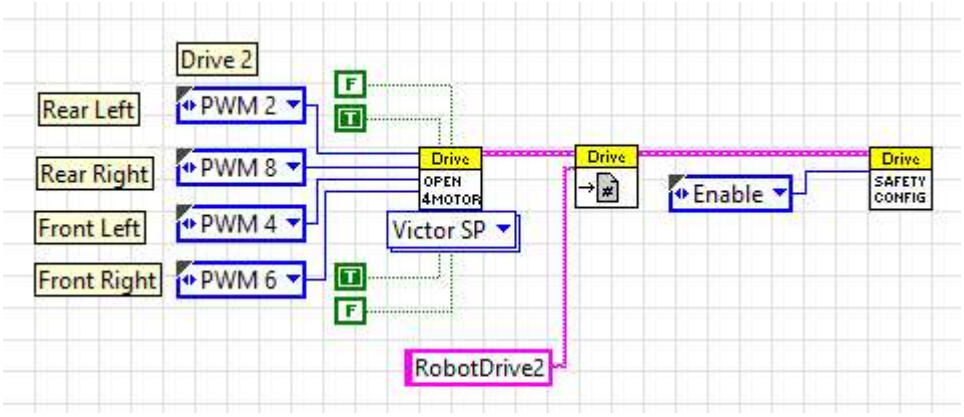
         1. Delete the original code.



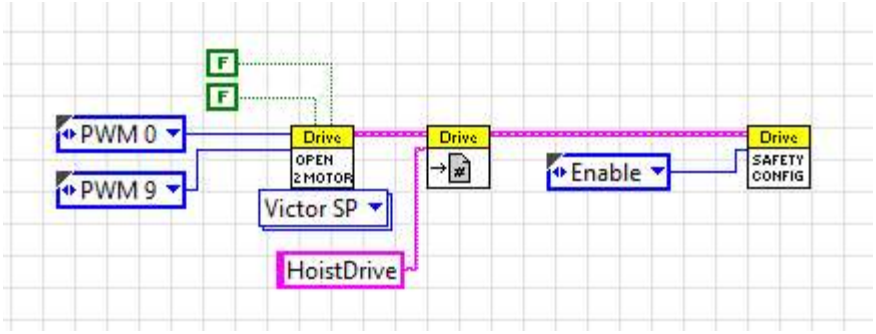
         2. Add the following for the Talon SRX controlled Holonomic drive.



3. Add similar code for the Victor controlled Holonomic drive.



4. Add the following code for the Victor controlled hoist motors.

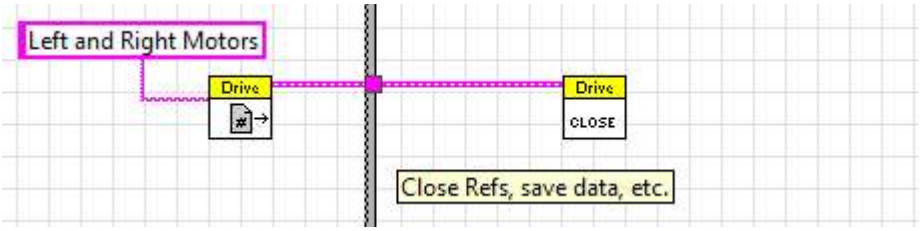


iii. Save and close Begin.vi.

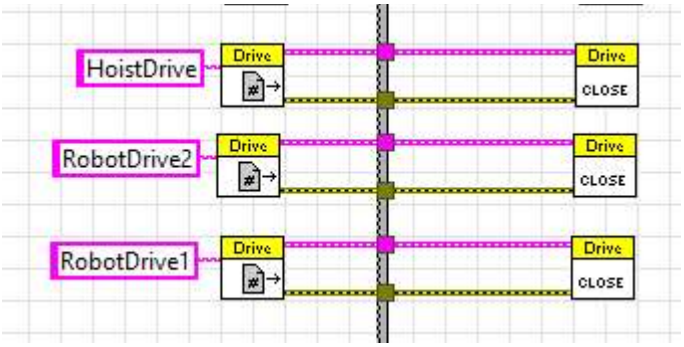
b. Finish.vi

i. Open Finish.vi and view the block diagram.

ii. Delete the initial code for the motors.



iii. Add the following code for the three drives.

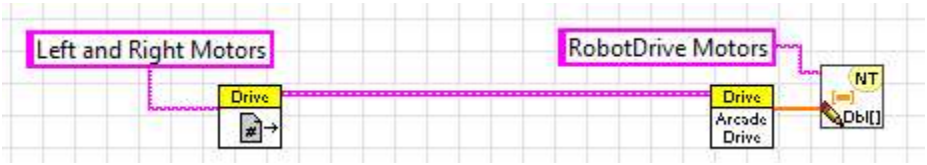


iv. Save and close Finish.vi.

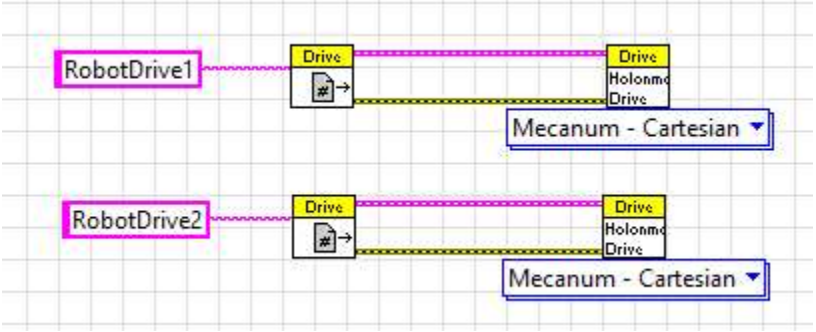
c. Teleop.vi

i. Open Teleop.vi and view the block diagram.

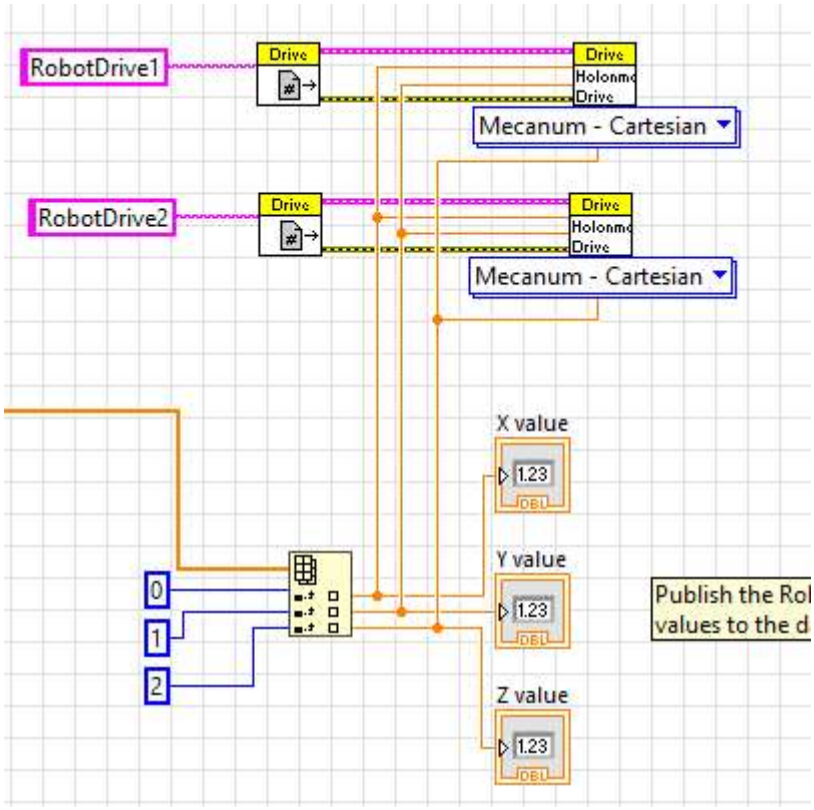
ii. Delete the initial code for the motors.



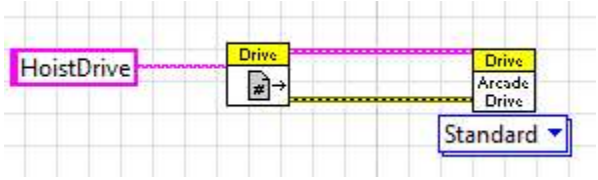
iii. Add the following code for the Talon SRX and Victor-controlled Holonomic drives.



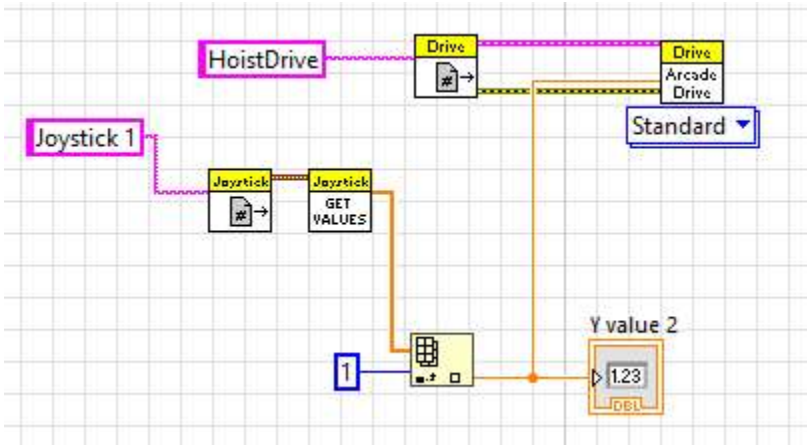
iv. Connect the Holonomic drives to the index array function from joystick 0.



v. Add the following code for the Victor-controlled hoist motors.



vi. Connect the hoist motors to the index array function from joystick 1.



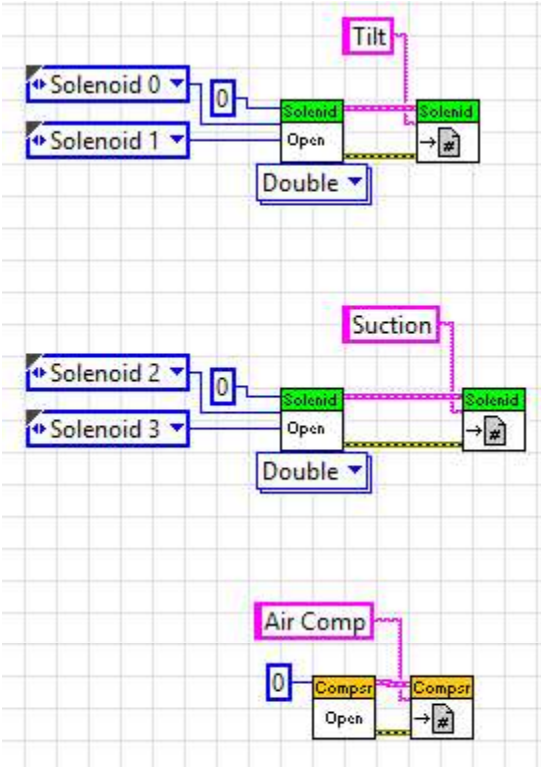
vii. Save and close Teleop.vi.

4. Program the joystick buttons.

    a. Begin.vi

        i. Open Begin.vi and view the block diagram.

        ii. Add the following code to initialize the pneumatic components (solenoids and air compressor).

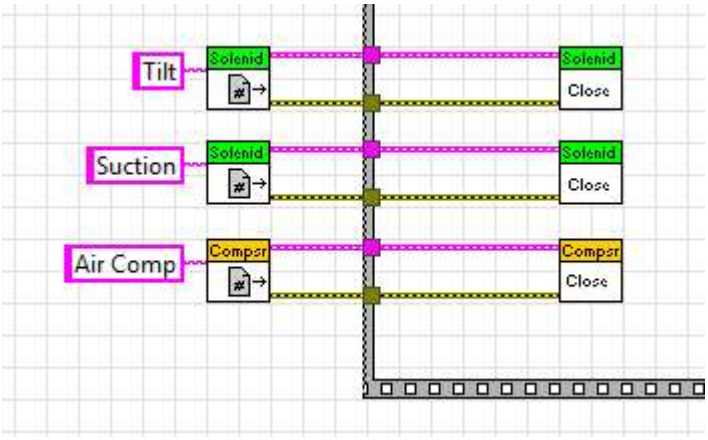


        iii. Save and close Begin.vi.

    b. Finish.vi

        i. Open Finish.vi and view the block diagram.

ii. Add the following code.

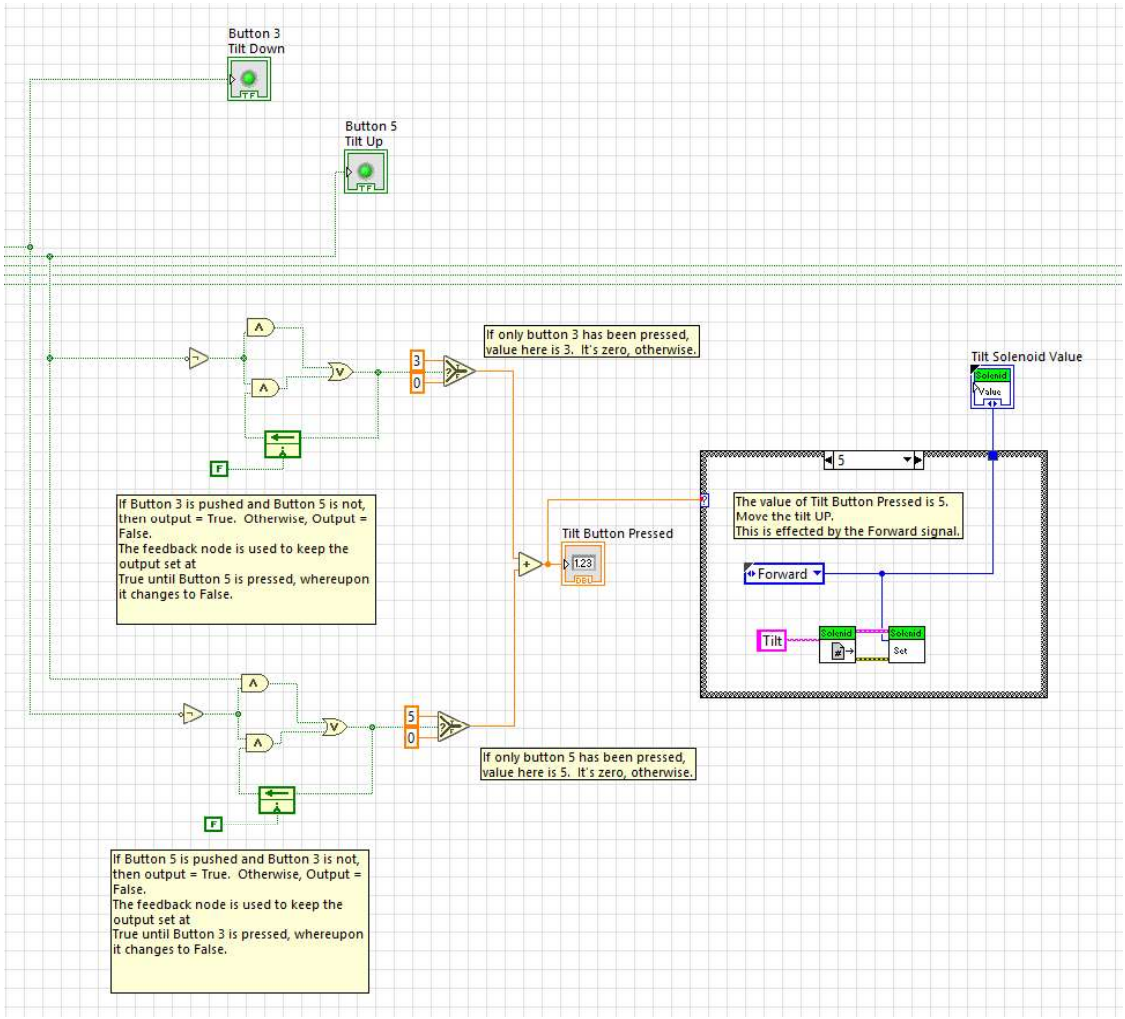


iii. Save and close Finish.vi.

c. Teleop.vi

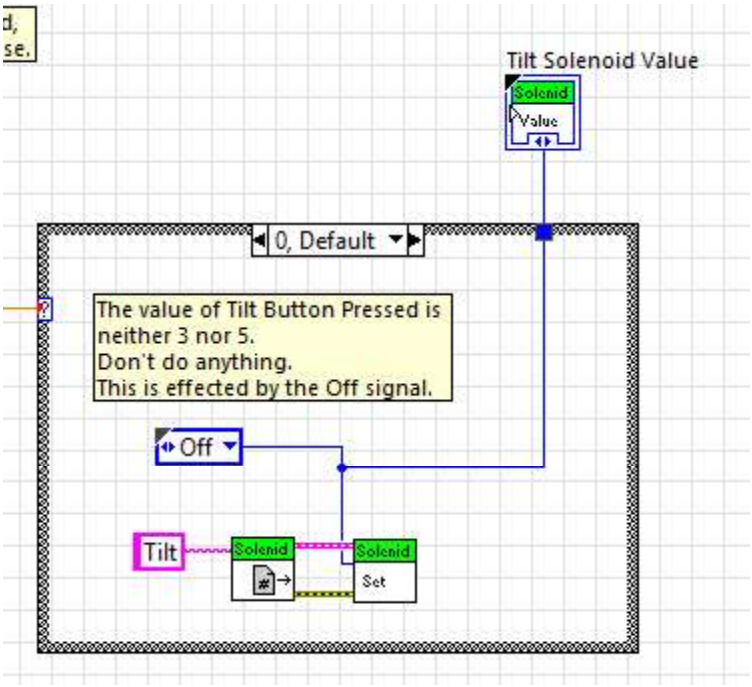
i. Open Teleop.vi and view the block diagram.

ii. Add the following code for the tilt control.

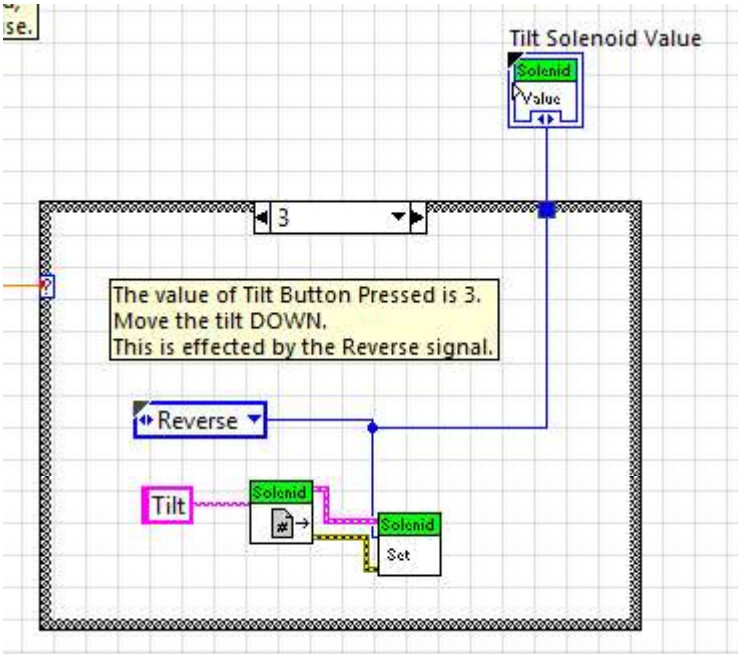


iii. The case structure supports three cases: 0 (or default), 3 and 5.

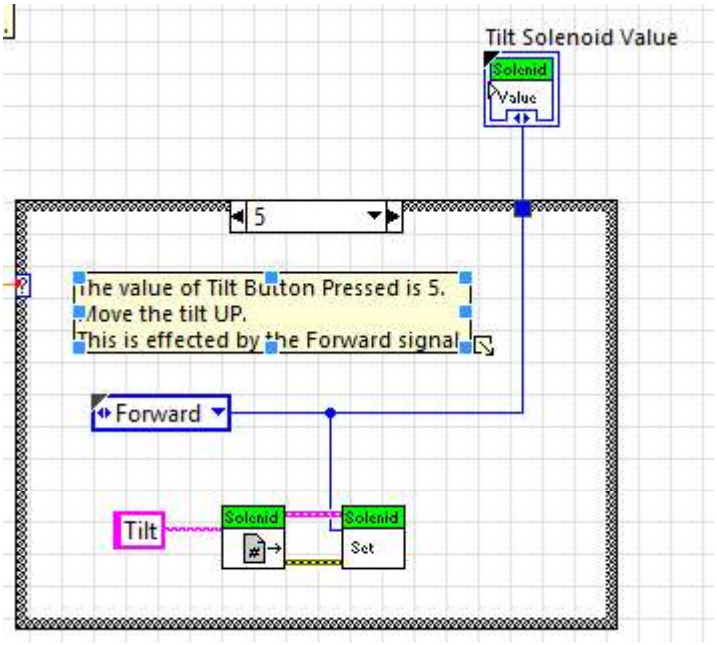
- This is the code for the 0 (default) case:



- This is the code for the 3 case.

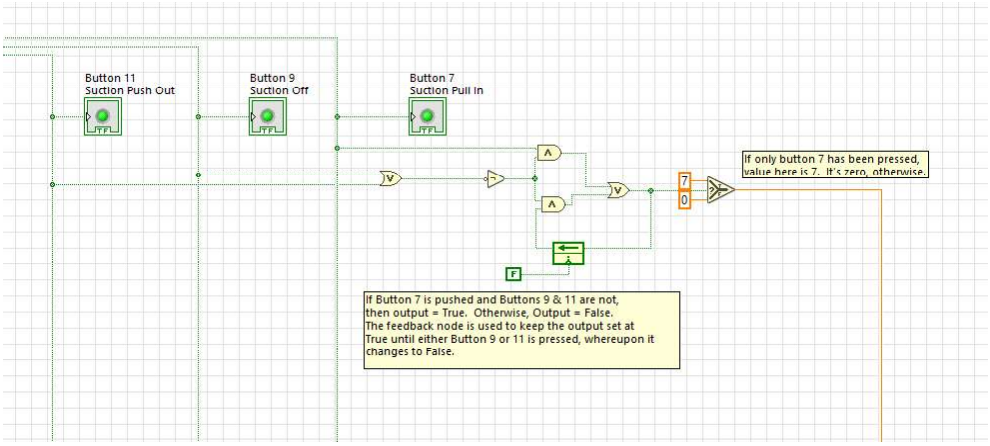


- This is the code for the 5 case.

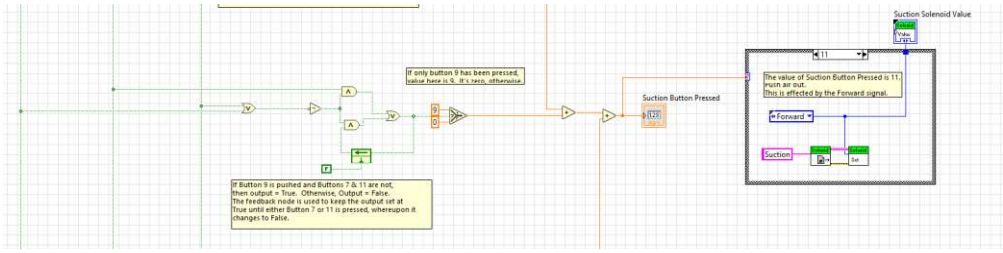


iv. Add the following code for the suction control.

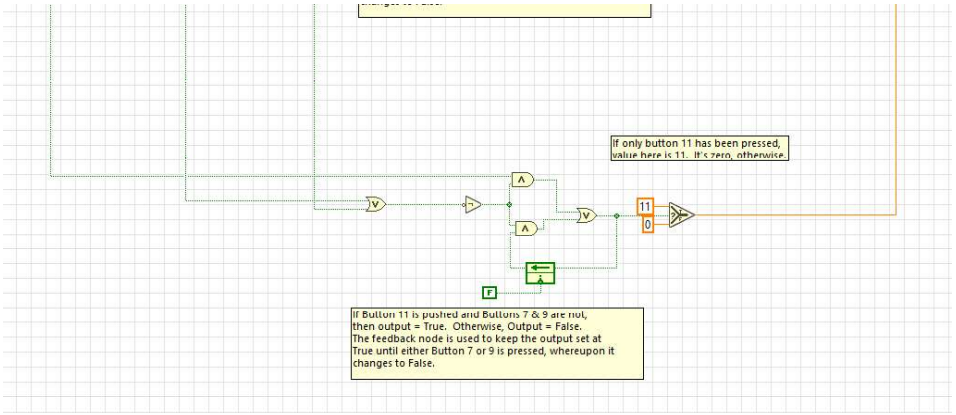
1. Button 7 pushed (suction pull in):



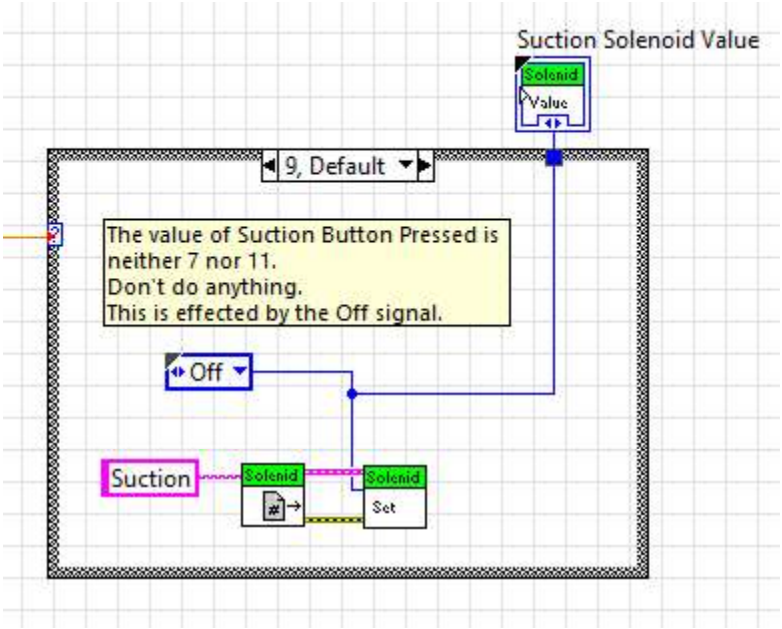
2. Button 9 (suction off):



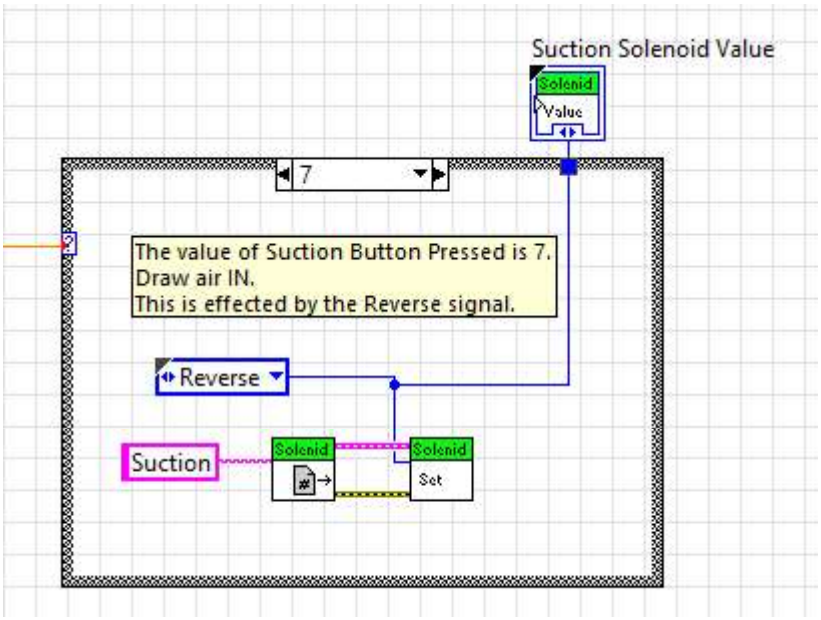
3. Button 11 (suction push out)



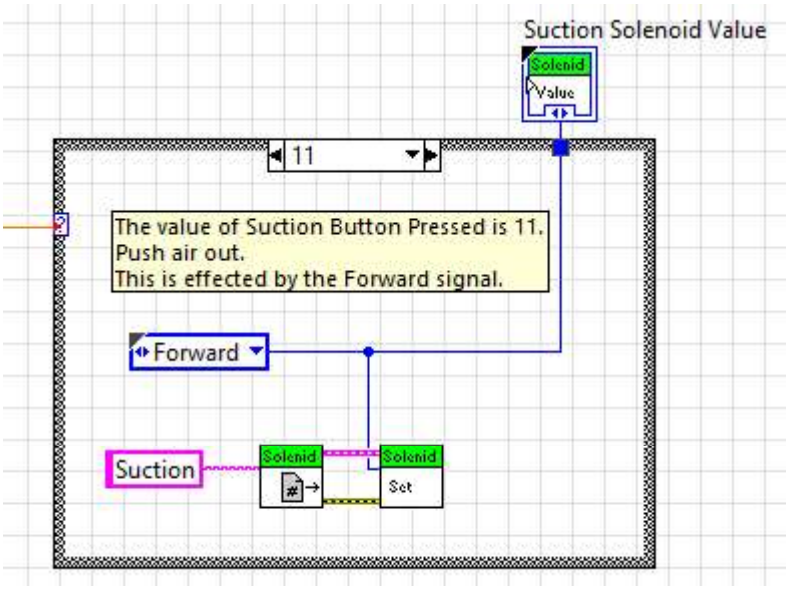
4. The case structure supports four values 9 (default), 7 and 11.
   - Code for case 9 (default):



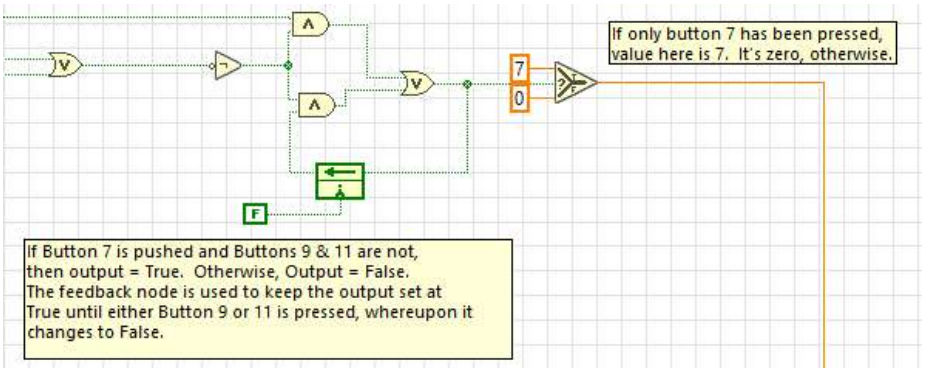
- Code for case 7:



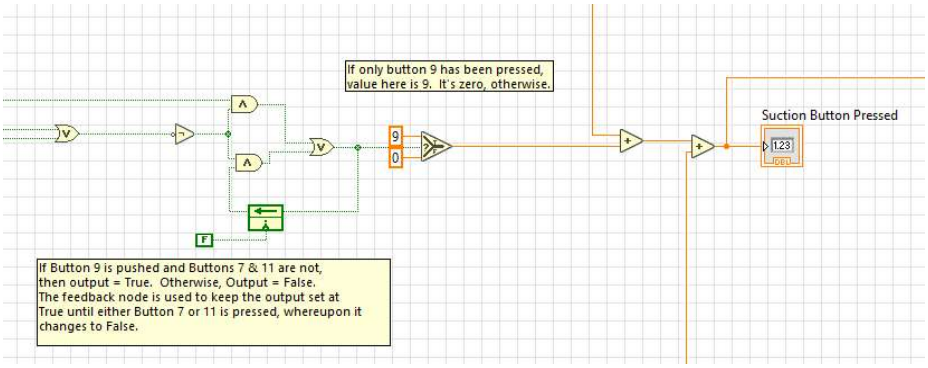
- Code for case 11:



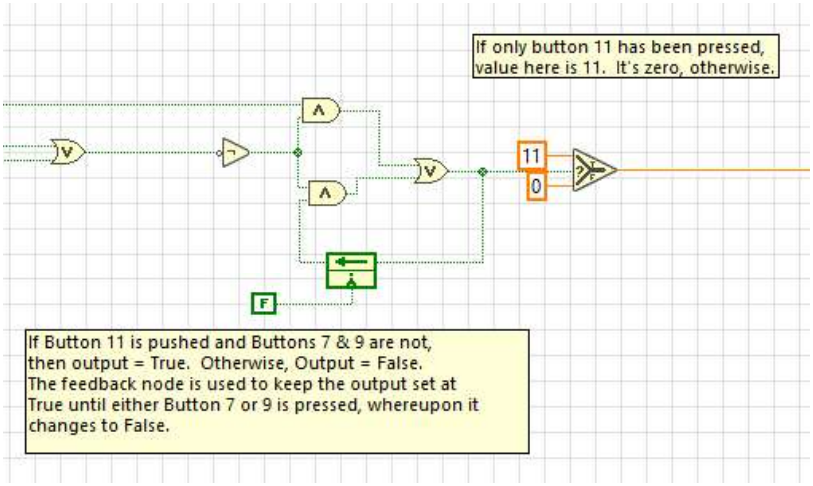
5. The following are details of the logic code for each button:
   - Button 7:



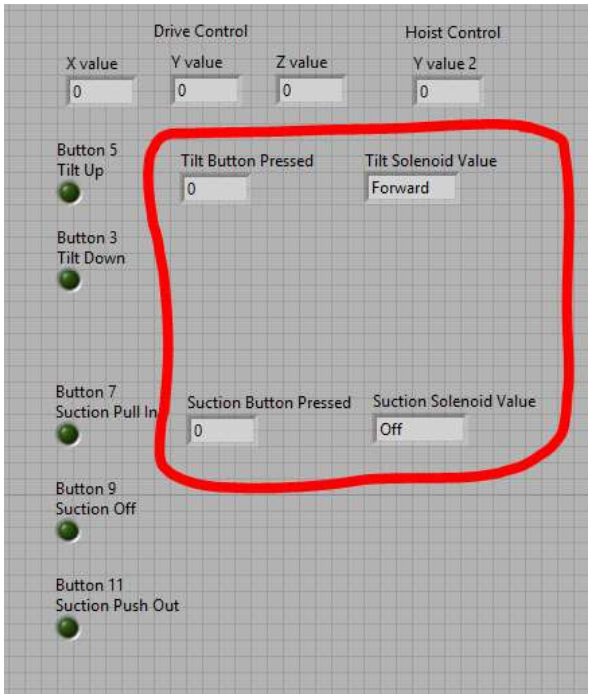
- Button 9:



- Button 11:

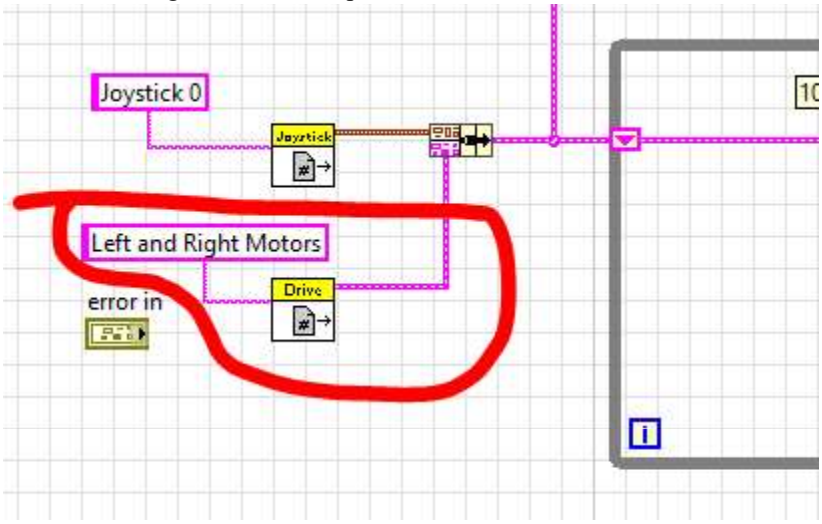


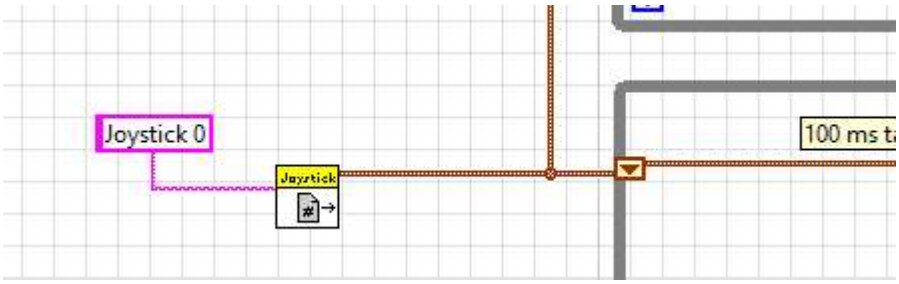
v. Position the pneumatic indicators on the front panel.



vi. Save and close the Teleop.vi.

5. Miscellaneous
   a. Remove the original drive from periodic tasks.





b. Save and close Periodic Tasks.vi.