ROBOTC Software Inspection Guide
with Additional Help Documentation

VEX Cortex Software Inspection Steps:

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2. Testing Cortex Robots using VEXnet

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1B. PIC Firmware Inspection using the IFI Loader

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2. Installing the USB-to-Serial Driver

3. VEX Cortex Configuration

4. VEXnet Joystick Configuration

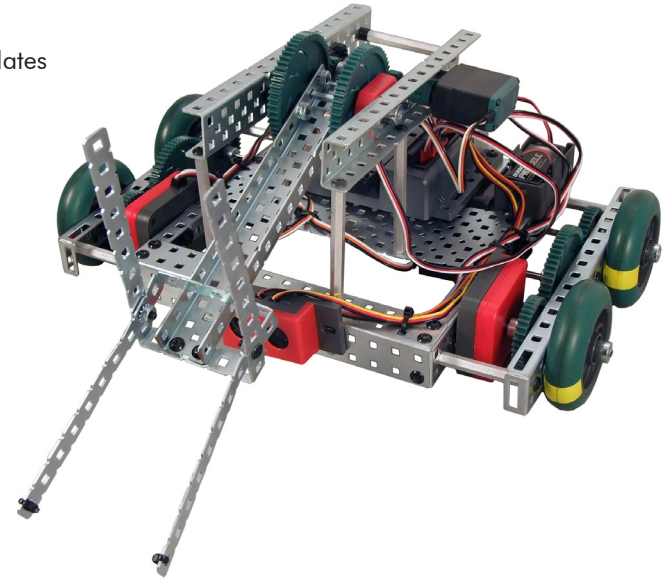
5. VEX PIC IFI Master Firmware

6. VEX PIC ROBOTC User Firmware

7. VEX PIC VEXnet Upgrade Instructions

8. Common ROBOTC Reserved Words

9. The ROBOTC Debugger



VEX ROBOTICS COMPETITION

Carnegie Mellon Robotics Academy

Cortex Firmware Inspection Using ROBOTC

This document is part of a software inspection guide for VEX Cortex based robots. Use this document to determine what versions of the Master firmware and ROBOTC user firmware are loaded on a robot. ***For the most up-to-date firmware files download the latest version of ROBOTC for Cortex and PIC at www.robotc.net.***

You will need:

- Your VEX Cortex Microcontroller with Battery
- Your VEXnet Joysticks with Batteries
- A computer with ROBOTC for Cortex and PIC 2.32 or later installed (available at www.robotc.net)
- A USB A-to-A Programming Cable

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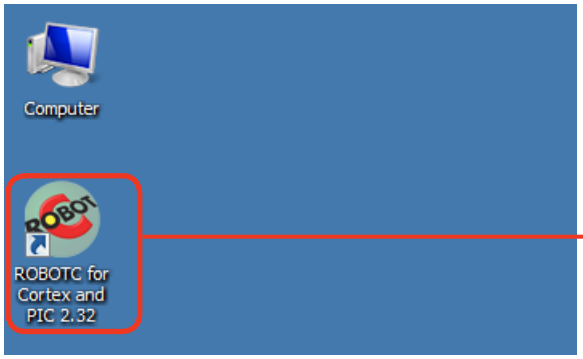
1. Plug one end of the USB A-to-A cable into the Cortex. Plug the other end of the USB A-to-A cable into a USB port on the computer.

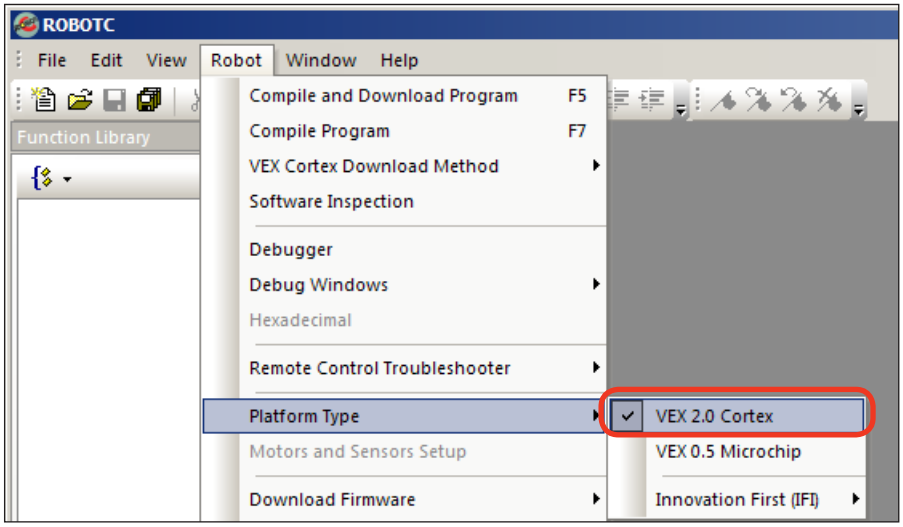
2. Open *ROBOTC for Cortex and PIC*. ROBOTC will automatically recognize which USB port your robot is connected to.



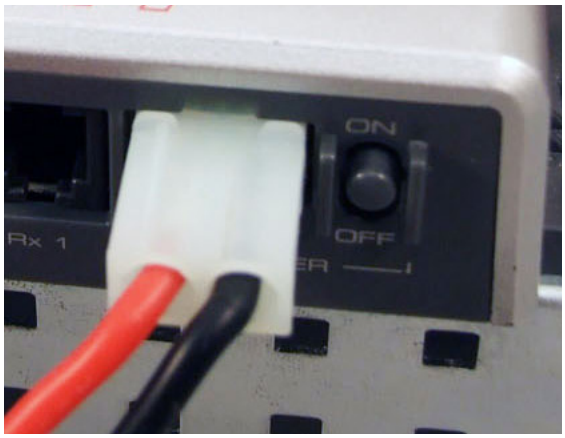
2. *Open ROBOTC for Cortex and PIC*
Open *ROBOTC for Cortex and PIC* from your Desktop or Start Menu.

Cortex Firmware Inspection Using ROBOTC *(cont.)*

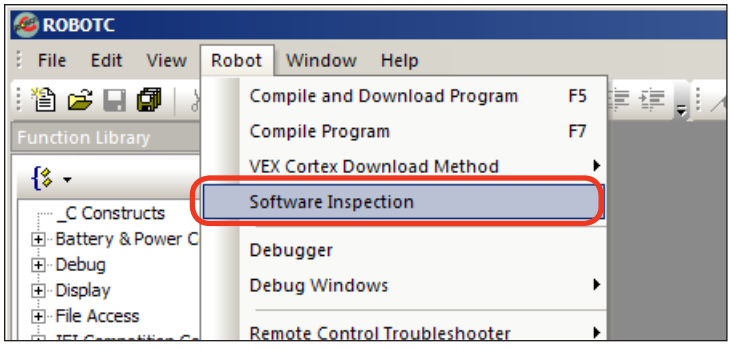
3. Verify that the Platform Type in ROBOTC is set to VEX 2.0 Cortex.



4. Turn the VEX Cortex ON.

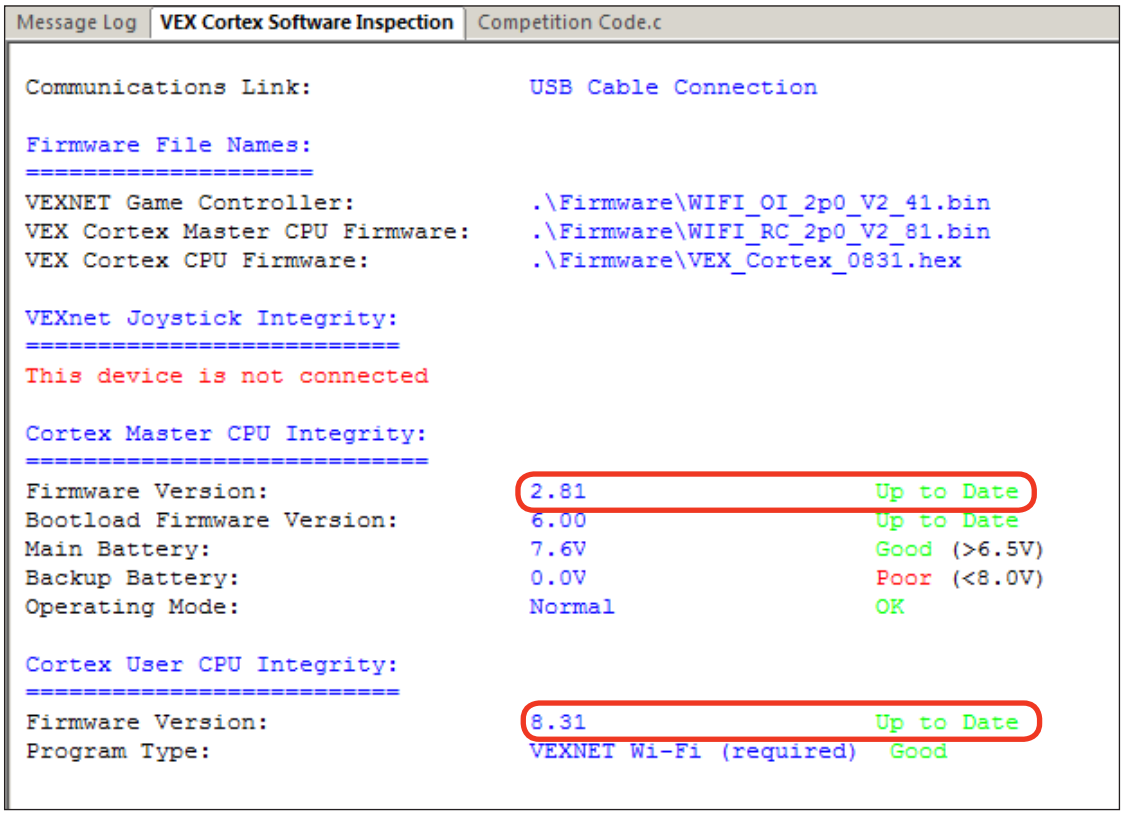


5. Select Software Inspection from the Robot menu in ROBOTC.



Cortex Firmware Inspection Using ROBOTC *(cont.)*

6. The VEX Cortex Software Inspection screen will open, and display information about your VEX Cortex configuration.



The Cortex Master CPU Integrity section displays the Firmware Version of the Master CPU Firmware, and whether it is up to date. If it is not up to date, you can download the Master Firmware by going to Robot > Download Firmware > Master CPU Firmware > Standard File. Note that if you download the Master CPU Firmware, you will have to re-sync the Cortex with the VEXnet Joysticks.

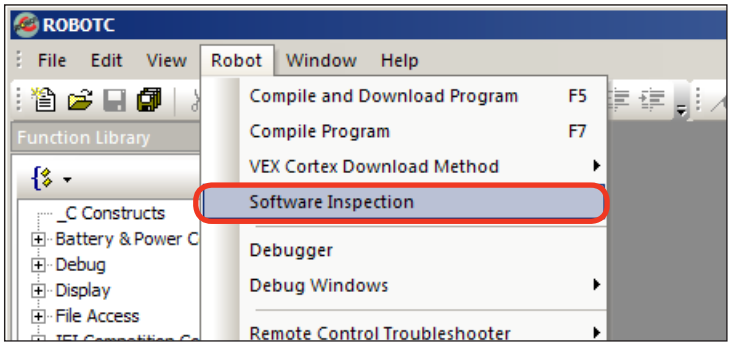
The Cortex User CPU Integrity section displays the Firmware version of the ROBOTC User Firmware, and whether it is up to date. If it is not up to date, you can download the ROBOTC Firmware by going to Robot > Download Firmware > ROBOTC Firmware > Standard File. Note that if you download the ROBOTC Firmware you will also have to redownload your program to the robot.

Note: The VEX Cortex Software Inspection screen contains many other pieces of useful information for making your robot competition-ready. Be sure to check the screen for any issues before your competition!

Cortex Firmware Inspection Using ROBOTC *(cont.)*

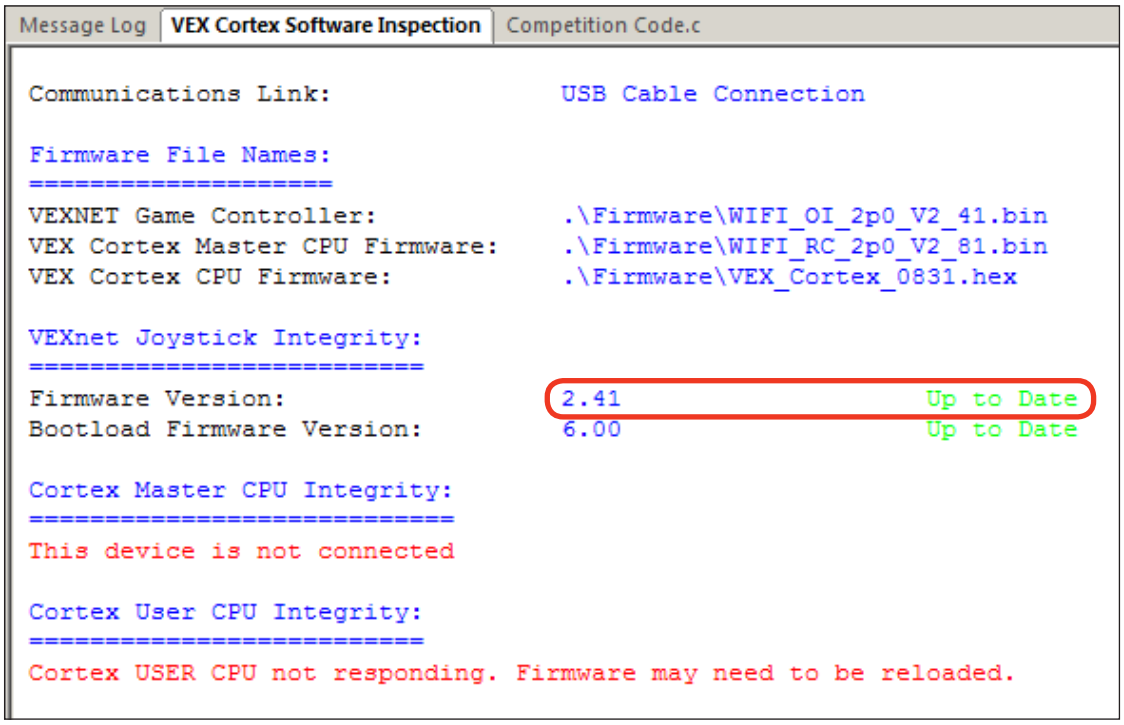
7. Unplug the Cortex. Plug one end of the USB A-to-A cable into the VEXnet Joysticks. Plug the other end of the USB A-to-A cable into a USB port on the computer.

8. Select Software Inspection from the Robot menu in ROBOTC.



Firmware Inspection Using ROBOTC *(cont.)*

9. The VEX Cortex Software Inspection screen will open, and display information about your VEXnet Joystick configuration.



The VEXnet Joystick Integrity section displays the Firmware Version of the VEXnet Joystick and whether it is up to date. If it is not up to date, you can download the VEXnet Joystick Firmware by going to Robot > Download Firmware > VEXnet Joystick Firmware > Standard File. Note that if you download the VEXnet Joystick Firmware you will also have to re-sync the joysticks with the Cortex and re-calibrate the joystick values.

Note: The VEX Cortex Software Inspection screen contains many other pieces of useful information for making your robot competition-ready. Be sure to check the screen for any issues before your competition!

Testing VEX Cortex Robots using VEXnet

This document is an inspection guide for VEX Cortex based robots.
Use this document to test if a robot is competition ready.

Method I. Using the ROBOTC Competition Debug Window

You will need:

- A VEX Cortex and VEXnet Joysticks that have been paired/synced
- A computer with ROBOTC for Cortex and PIC 2.32 (or later) installed
- A VEX Programming Kit
- An object to prop the robot up, off of its wheels

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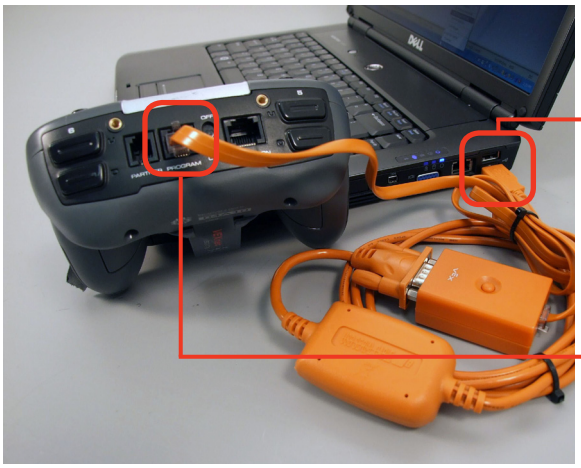
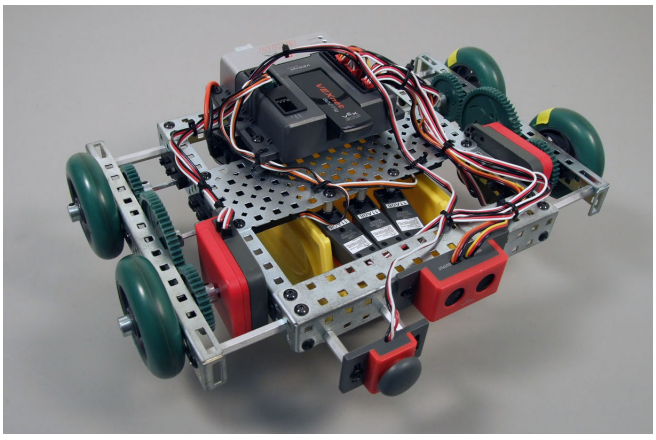
1. Connect the VEXnet Joysticks to the computer using the VEX Programming Kit.



1a. Connect to PC
Plug the USB connector on the Programming Kit into the PC.

1b. Connect to VEXnet Joysticks
Plug the "phone cable" end of the Programming Kit into the PROGRAM port on the VEXnet Joysticks.

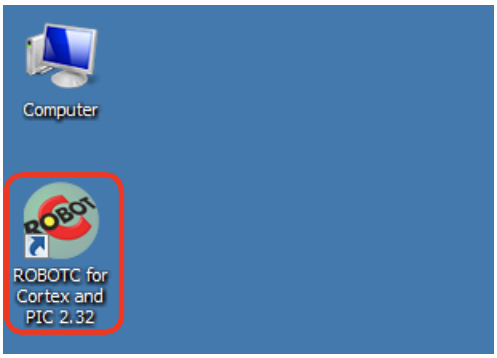
2. Prop the robot up, so that its wheels are no longer touching a surface.



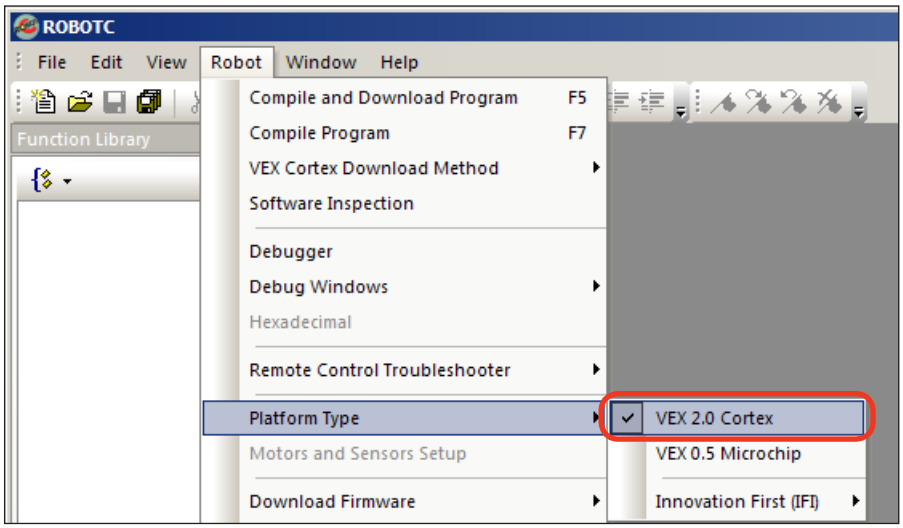
Testing VEX Cortex Robots using VEXnet *(cont.)*

3. Turn on the VEX Cortex and VEXnet Joysticks and allow them to pair.

4. Open ROBOTC for Cortex and PIC

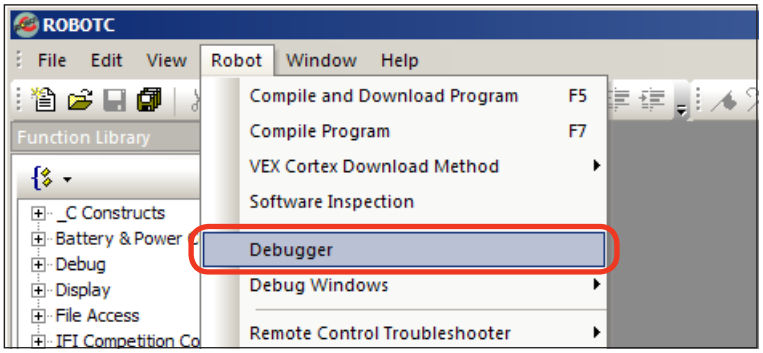


5. Verify that the Platform Type in ROBOTC is set to VEX 2.0 Cortex.

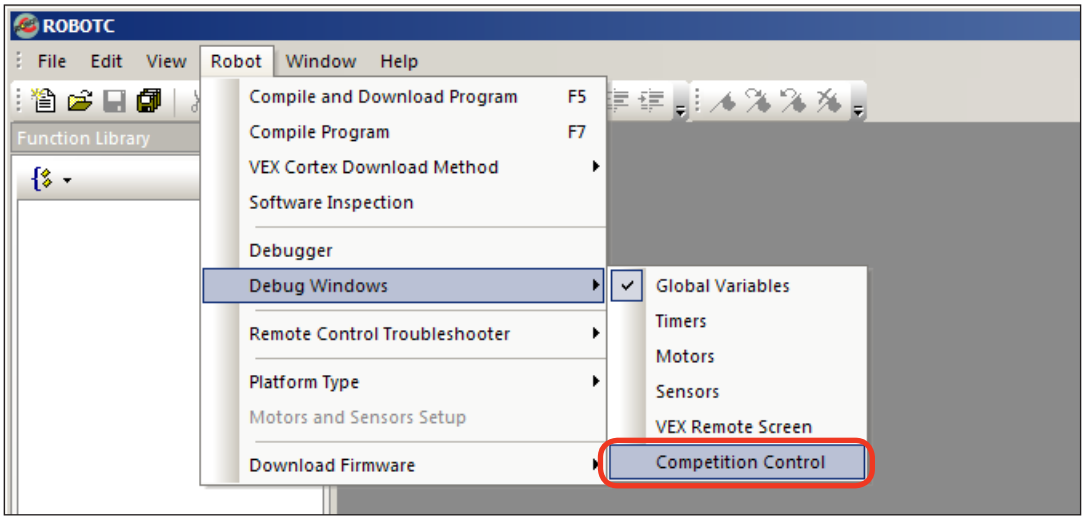


Testing VEX Cortex Robots using VEXnet *(cont.)*

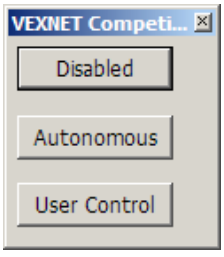
6. Establish a connection with the Cortex by going to the ***Robot*** menu and selecting ***Debugger***.



7. After a connection has been established and the ***Program Debug*** window appears, go to ***Robot*** > ***Debug Windows*** and select ***Competition Control***.

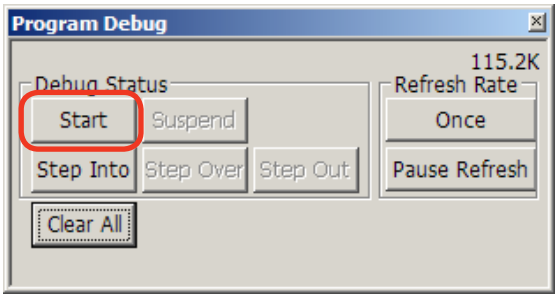


8. The *VEXnet Competition Control* debug window will appear.



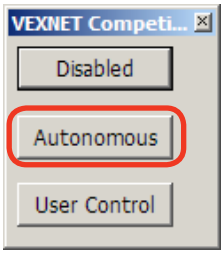
Testing VEX Cortex Robots using VEXnet *(cont.)*

9. Press the ***Start*** button on the ***Program Debug*** window.



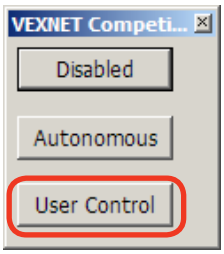
Note: After pressing the ***Start*** button, the robot will automatically go into User Control mode.

10. To test the robot's autonomous mode, press the ***Autonomous*** button on the ***VEXnet Competition Control*** window.



The code for autonomous mode will run once, until it is finished, or until you press the ***Disabled*** button on the ***VEXnet Competition Control window***. A stopwatch can be used to time the duration of the autonomous mode, if desired. To run the code for the autonomous period again, simply press the Autonomous button again.

11. To test the robot's user control mode, press the ***User Control*** button on the ***VEXnet Competition Control*** window.



The code for user control mode will run until you press the ***Disabled*** button on the ***VEXnet Competition Control window***. To restart the code for the user control period period, simply press the User Control button again.

Testing VEX Cortex Robots using VEXnet *(cont.)*

Method II. Using the VEXnet Competition Switch

You will need:

- A VEX robot and transmitter with paired VEXnet Upgrades
- A VEXnet Competition Switch
- An Ethernet Cable
- An object to prop the robot up, off of its wheels

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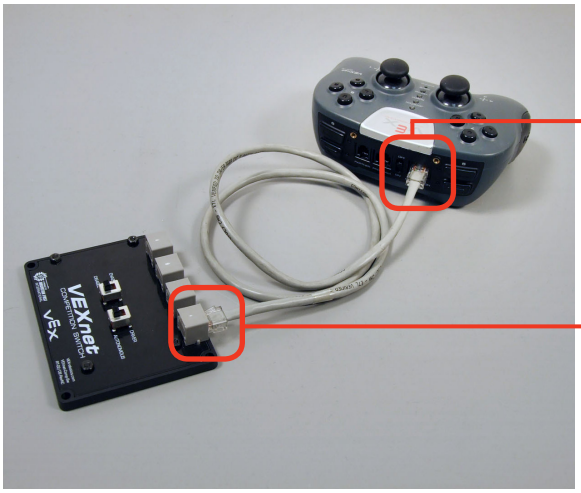
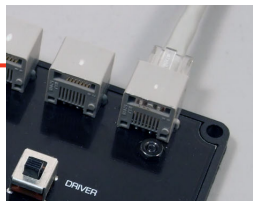
1. Connect the VEXnet Joysticks to the VEXnet Competition Switch using an ethernet cable.



1a. Connect to the Joysticks
Plug one end of the ethernet cable into the COMPETITION port on the VEXnet Joysticks.

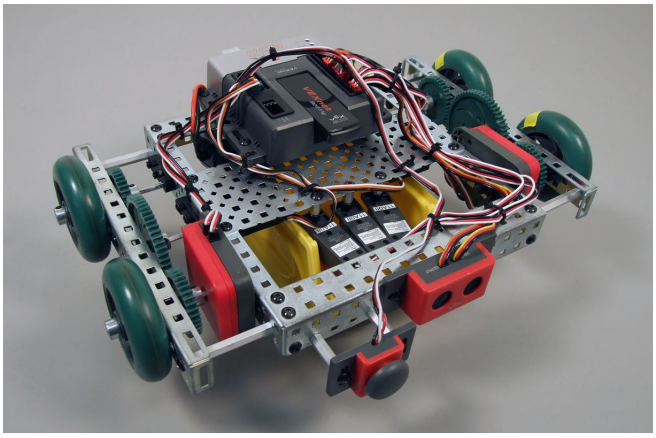


1b. Connect to Switch
Plug the the other end of the ethernet cable into one of the ports on the VEXnet Competition Switch.

2. Set the ENABLE/DISABLE switch to **DISABLE** and the DRIVER/AUTONOMOUS switch to **AUTONOMOUS**.

Testing VEX Cortex Robots using VEXnet *(cont.)*

3. Prop the robot up, so that its wheels are no longer touching a surface.



4. Turn on the VEX Cortex and VEXnet Joysticks and allow them to pair.

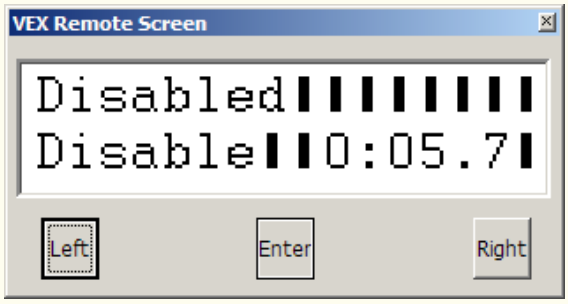
To test the robot's autonomous mode, verify that the DRIVER/AUTONOMOUS switch is set to **AUTONOMOUS** and change the ENABLE/DISABLE switch to **ENABLE**. The code for the autonomous period will run once, until it is finished, or until it is disabled on the VEXnet Competition Switch. A stopwatch can be used to time the duration of the autonomous mode, if desired. To run the code for the autonomous period again, toggle the ENABLE/DISABLE switch to DISABLE and then to ENABLE.

To test the robot's user control mode, first verify that the ENABLE/DISABLE switch is set to **DISABLE**. Then, set the DRIVER/AUTONOMOUS switch to **DRIVER** and change the ENABLE/DISABLE switch to **ENABLE.** The code for the user control period will run until it is disabled on the VEXnet Competition Switch. To restart the code for the user control period again, toggle the ENABLE/DISABLE switch to DISABLE and then to ENABLE.

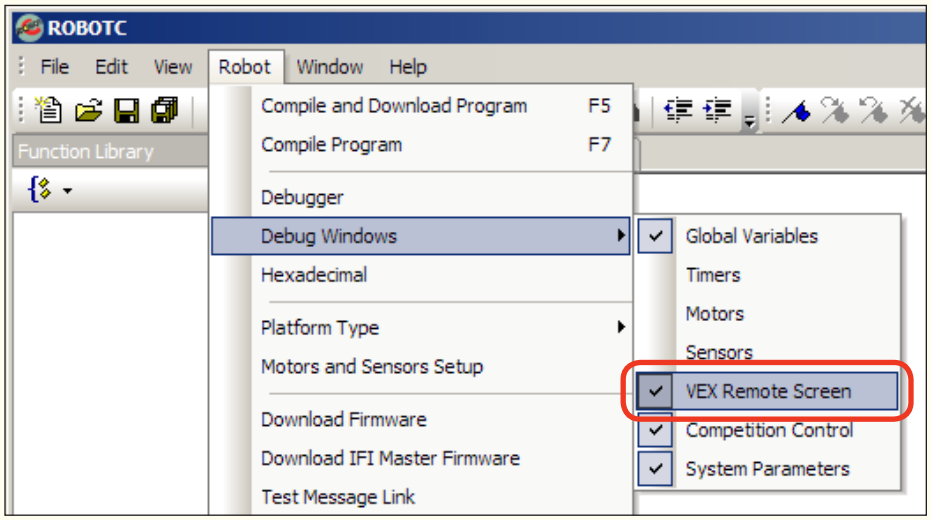
Testing VEX Cortex Robots using VEXnet *(cont.)*

Useful Information - The VEX Remote Screen

The ROBOTC Competition Templates are pre-programmed to display status information to the VEX LCD Screen. Even if you don't have the VEX LCD Screen attached to your robot, you can use the ROBOTC VEX Remote Screen to view the information (along with any other information you choose to display yourself).



*To open the **VEX Remote Screen**, first open the ROBOTC **Debugger**. Then go to **Robot** > **Debug Windows**, and select **VEX Remote Screen**.*



*Programming help for the VEX LCD Screen / VEX Remote Screen can be found in the **ROBOTC Help** documentation under **ROBOTC Functions** > **Display**.*

VEX PIC Firmware Inspection Using ROBOTC

This document is part of a software inspection guide for VEX PIC based robots. Use this document to determine what versions of the IFI Master firmware and ROBOTC user firmware are loaded on a robot. ***For the most up-to-date firmware files download the latest version of ROBOTC for Cortex and PIC at www.robotc.net.***

You will need:

- Your VEX PIC Microcontroller with Battery
- A computer with ROBOTC for Cortex and PIC 2.32 or later installed (available at www.robotc.net)
- A VEX Programming Kit

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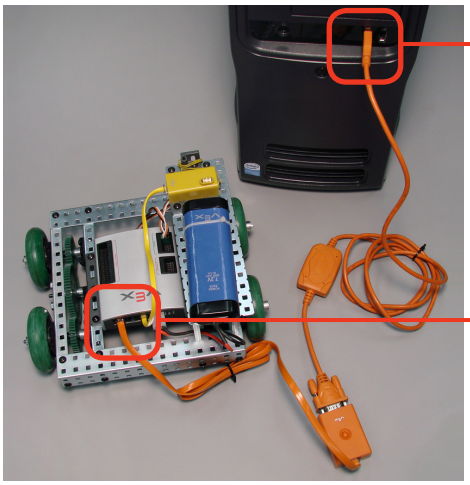
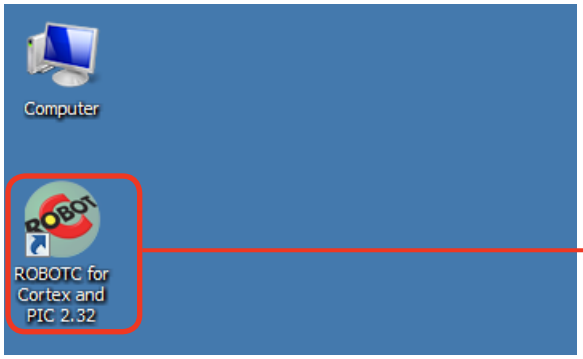
1. Plug the USB connector end of the Programming cable into a USB port on your computer. Plug the other unconnected end of the cable into the SERIAL port of your VEX Microcontroller.



1a. Connect USB to PC
Plug the USB connector on the Programming Kit into the PC.

1b. Connect to VEX
Plug the other end into the SERIAL port on the VEX Microcontroller. If your robot has the VEXnet Upgrade, temporarily disconnect it.

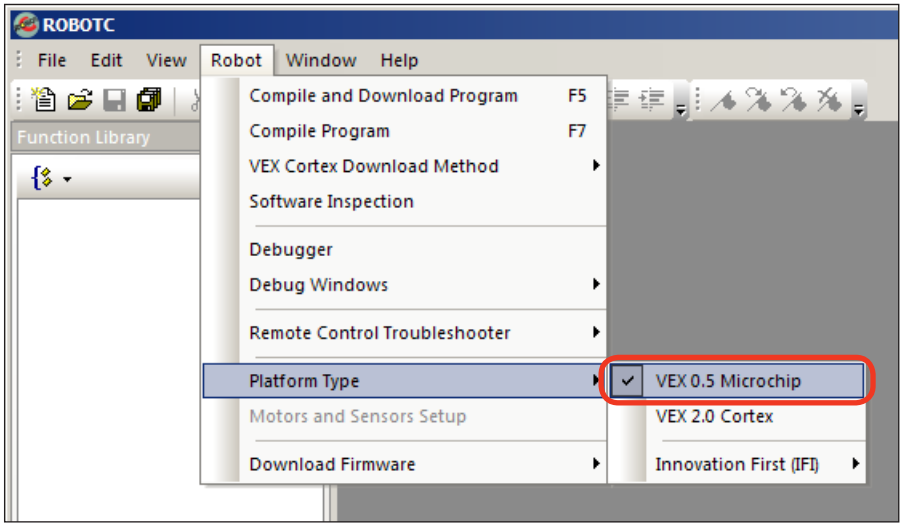
2. Open ***ROBOTC for Cortex and PIC***. ROBOTC will automatically recognize which USB port your robot is connected to.



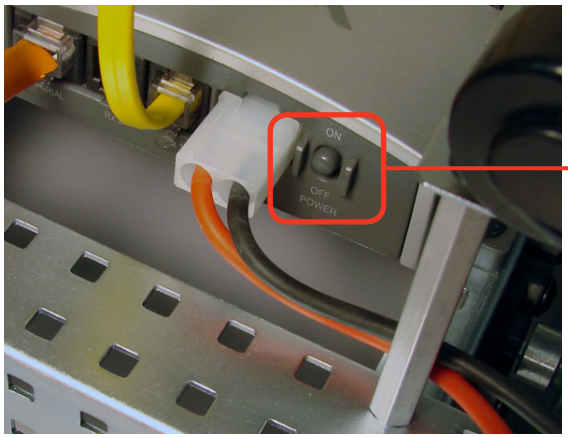
2. Open ROBOTC for Cortex and PIC
Open *ROBOTC for Cortex and PIC* from your Desktop or Start Menu.

VEX PIC Firmware Inspection Using ROBOTC *(cont.)*

3. Verify that the Platform Type in ROBOTC is set to VEX 0.5 Microchip.

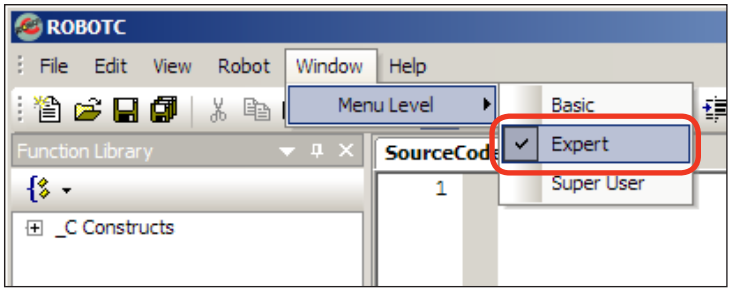


4. If the VEX Microcontroller is not already turned on, turn it on now.



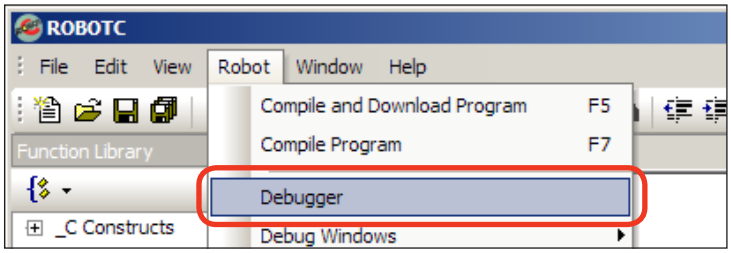
4. Turn the VEX Microcontroller on
Flip the small switch on your VEX Microcontroller to turn your robot on, if it is not on already. Make sure that a charged battery pack is connected.

5. Different features and options are available in ROBOTC depending on what mode is set. Change to "Expert" mode by going to *Window* > *Menu* Level and selecting *Expert*.



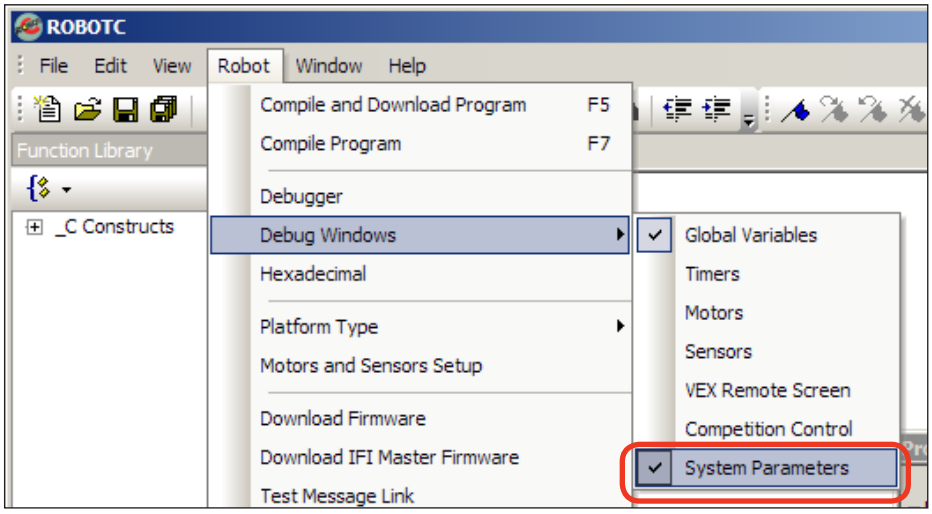
VEX PIC Firmware Inspection Using ROBOTC *(cont.)*

6. Establish a connection to the VEX Microcontroller by going to the ***Robot*** menu and selecting ***Debugger***.



Note: The IFI Loader software and other VEX programming solutions also establish connections with the VEX Microcontroller. If any of the other software programs are open, close them to ensure that ROBOTC will be able to connect to the robot.

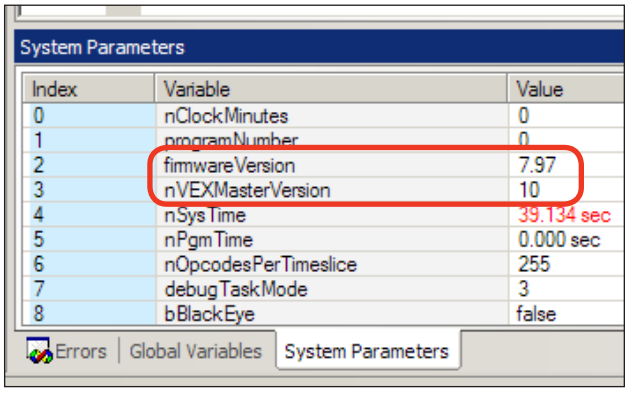
7. Once a connection is established, the ***Program Debug*** window will appear, along with any of the other optional ROBOTC debug windows. Open the ***System Parameters debug*** window by going to ***Robot*** > ***Debug Windows*** and selecting ***System Parameters***.



8. The ***System Parameters*** debug window will appear as its own window, or docked as a tab within the ROBOTC interface.

The **firmwareVersion** parameter refers to the ROBOTC user firmware and should be at least **7.31**.

The **nVEXMasterVersion** parameter refers to the VEX master firmware and should be at least **10**.



Note: If either firmware is out of date, they can be downloaded using ROBOTC by going to the ***Robot*** menu and selecting ***Download Firmware*** for the ROBOTC firmware, or ***Download IFI Master Firmware*** for the master firmware.

If you download the master firmware, you must also download the ROBOTC firmware. After downloading firmware, you must also re-download the user program to the VEX PIC.

Firmware Inspection Using IFI Loader

This document is part of a software inspection guide for VEX v0.5 (75 MHz crystal) and VEX v1.5 (VEXnet Upgrade) microcontroller-based robots. Use this document to determine what versions of the IFI Master firmware and ROBOTC user firmware are loaded on a robot.

You will need:

- Your VEX Microcontroller
- A computer with the IFI Loader software installed (available at http://www.vexforum.com/wiki/index.php/Software_Downloads)
- A VEX Programming Kit

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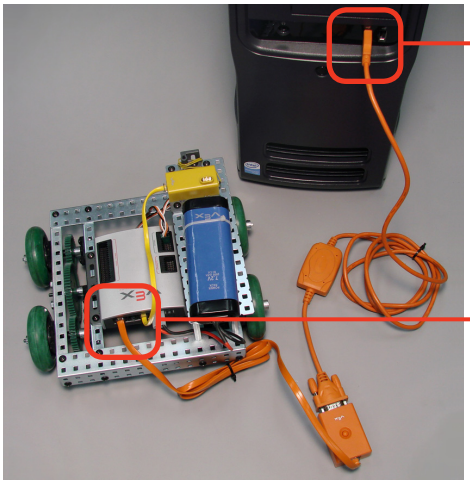
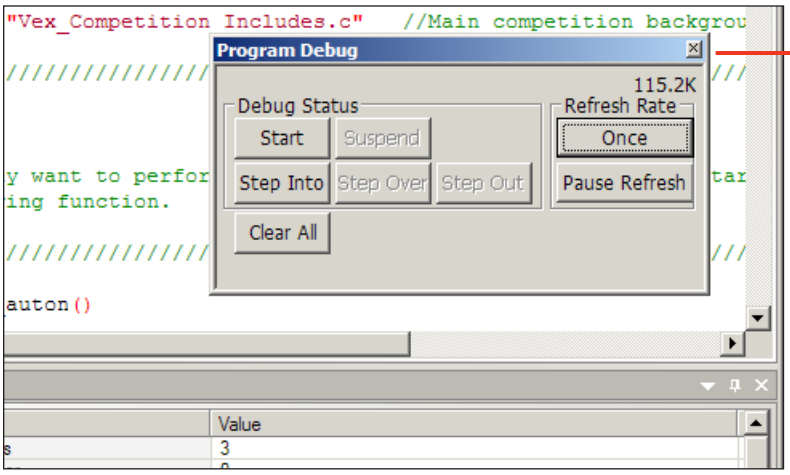
1. Plug the USB connector end of the Programming cable into a USB port on your computer. Plug the other unconnected end of the cable into the SERIAL port of your VEX Microcontroller.



1a. Connect USB to PC
Plug the USB connector on the Programming Kit into the PC.

1b. Connect to VEX
Plug the other end into the SERIAL port on the VEX Microcontroller. If your robot has the VEXnet Uprade, temporarily disconnect it.

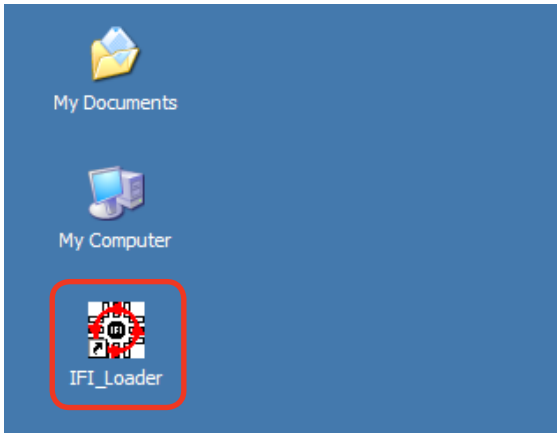
2. If the VEX was already connected to the computer with ROBOTC open, make sure that the ***Program Debug*** window is closed to end the connection between ROBOTC and the robot.



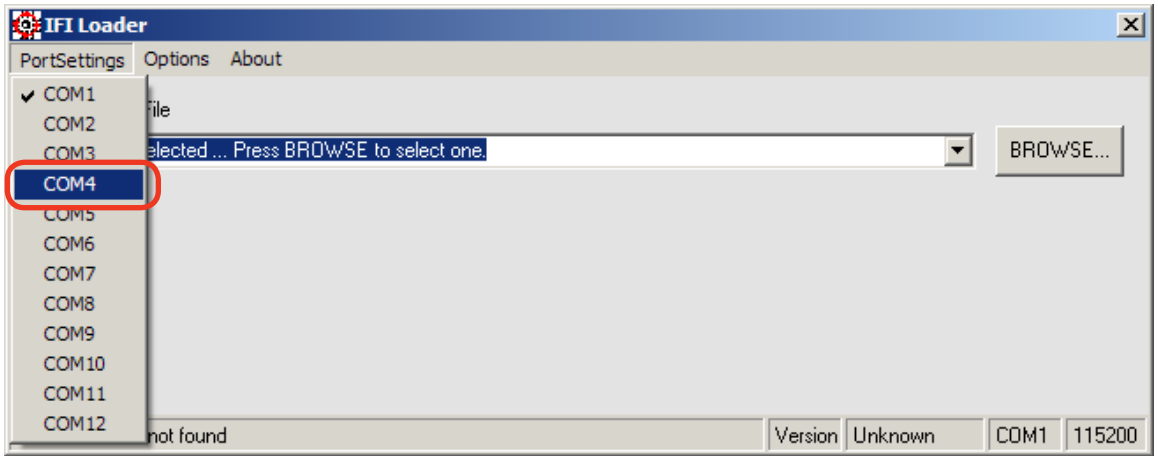
2. Close the Debugger
If the Program Debug window is open, close it to end the connection between ROBOTC and the robot.

Firmware Inspection Using IFI Loader *(cont.)*

2. Open the ***IFI Loader*** software from your Desktop or Start menu. The IFI Loader can be downloaded from http://www.vexforum.com/wiki/index.php/Software_Downloads.



3. Once the IFI Loader software opens, select the port on your computer that the Programming Kit is connected to by going to ***PortSettings*** and selecting the appropriate COM Port.

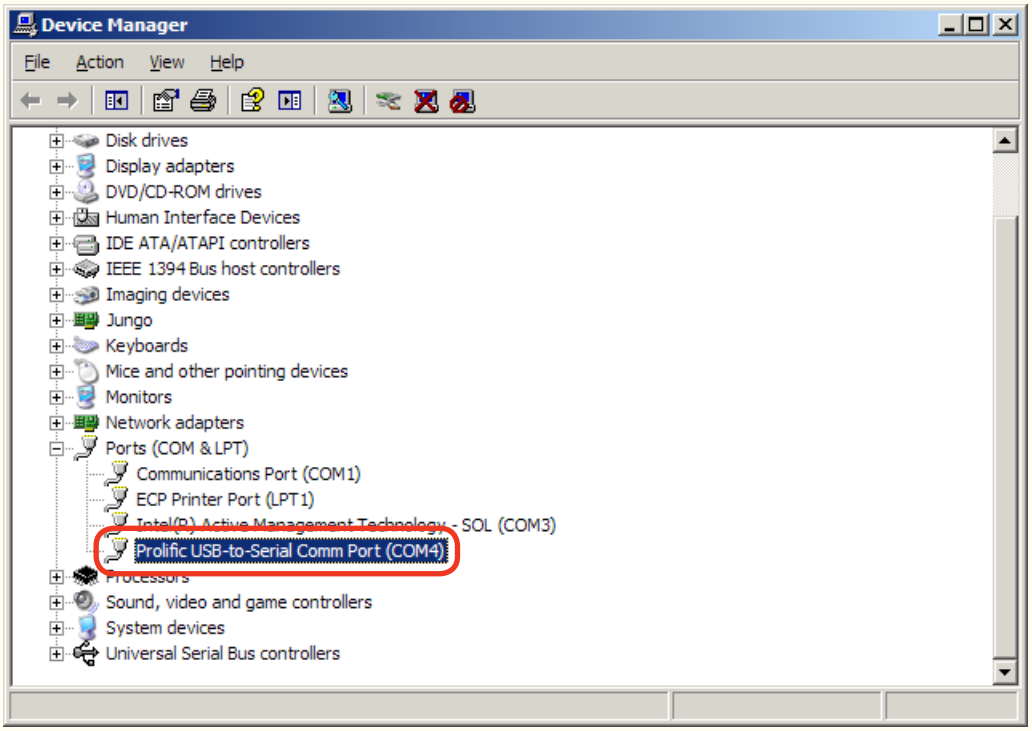


Note: The above graphic is only a sample, and may not reflect the port number that the Programming Kit is connected to on your computer. You are able to view which port number your computer is using using the *Windows Device Manager* (continue on for more details).

Firmware Inspection Using IFI Loader *(cont.)*

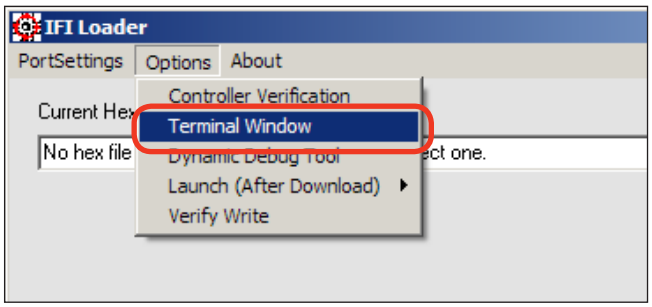
Information - Windows Device Manager

To open the Windows Device Manager right-click on "My Computer" and select "Properties". Then select the "Hardware" tab and choose "Device Manager".



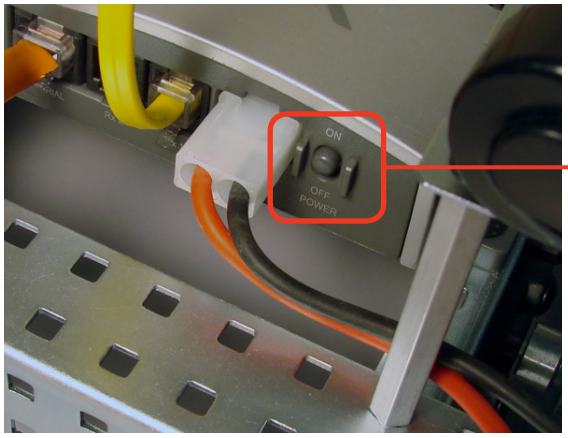
Click on the "+" sign next to "Ports (COM & LPT)" to expand it. Look for the menu item described as a USB-to-Serial Comm Port and make note of the COM number following it in parenthesis. This is the port number you will use in the IFI Loader software.

4. After you select the appropriate COM port under ***PortSettings***, go to the ***Options*** menu and select ***Terminal Window***.



Firmware Inspection Using IFI Loader *(cont.)*

5. Once the *Terminal Window* is open, turn the VEX Microcontroller on. If it is already turned on, turn it off, and then back on.

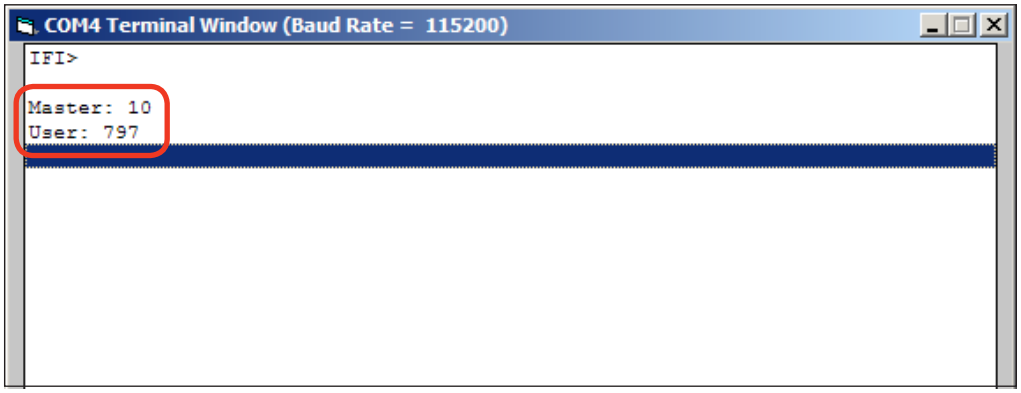


5. Power Cycle the VEX Microcontroller
Flip the small switch on your VEX Microcontroller to turn your robot on. If it is already on, turn it off, and then back on.

6. The *Terminal Window* will display both the master and ROBOTC user firmware.

   The VEX **Master** firmware version should be at least **10**.

   The ROBOTC **User** firmware version should be at least **7.97**.



Note: If either firmware is out of date, they can be downloaded using ROBOTC by going to the *Robot* menu and selecting *Download Firmare* for the ROBOTC firmware, or *Download IFI Master Firmware* for the master firmware.

If you download the master firmware, you must also download the ROBOTC firmware. After downloading firmware, you must also re-download the user program to the VEX Microcontroller.

Testing VEX PIC Robots with the 75 MHz Crystals

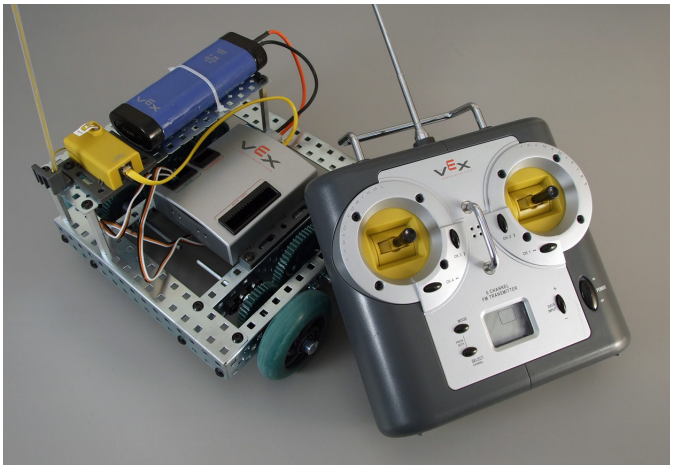
This document is an inspection guide for VEX v0.5 microcontroller-based robots. Use this document to test if a robot using the 75 MHz crystals is competition ready.

You will need:

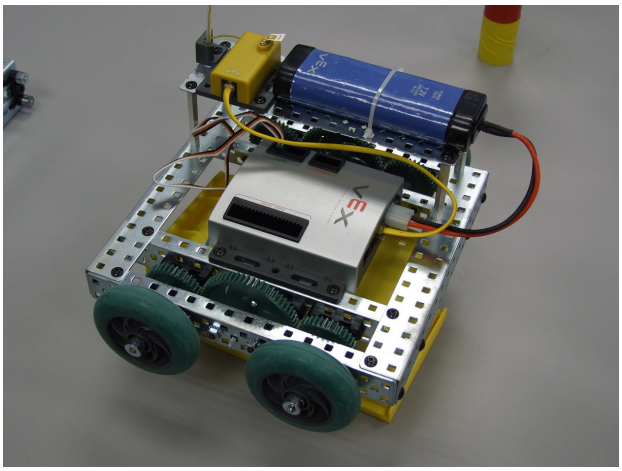
- A VEX robot and transmitter with matching 75 MHz crystals
- A stopwatch
- An object to prop the robot up, off of its wheels

---

1. Turn both the VEX Microcontroller and Radio Control Transmitter **OFF**.

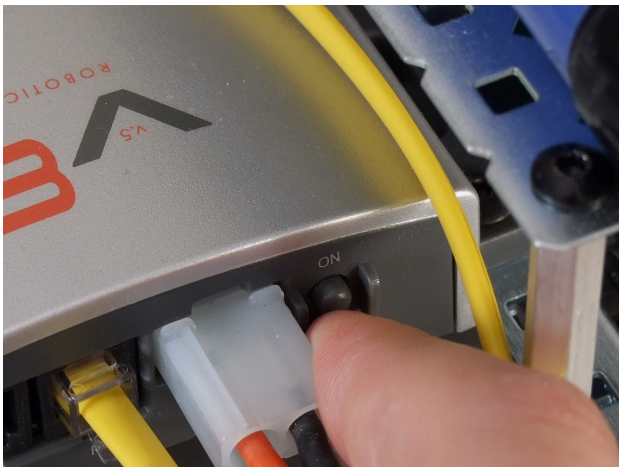


2. Prop the robot up, so that its wheels are no longer touching a surface.



Testing VEX PIC Robots with the 75MHz Crystals *(cont.)*

3. Turn on the VEX Microcontroller.



4. Turn on the Radio Control Transmitter and observe the robot. You will need to use the transmitter joysticks and buttons to test the user control period.

After turning on the transmitter, robots using the **Competition Template** will immediately run their autonomous code for the amount of time specified within the template (20 seconds by default). During this time, moving the transmitter joysticks should have no effect on the behavior of the robot.

After the autonomous period has elapsed, the robot will automatically switch into user control mode and enable radio control for the amount of time specified within the template (120 seconds by default). After the user control period has ended, radio control will cease and the robot will stop. A stopwatch may be used to confirm that the robot remains responsive to the transmitter controls for the desired amount of time.

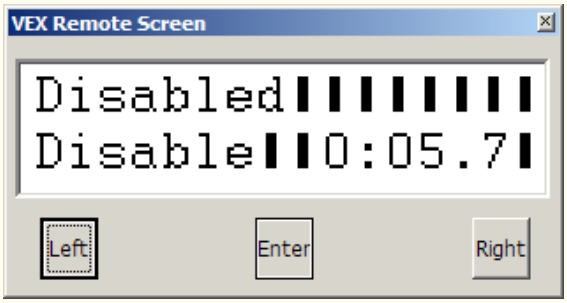
Robots using the **Driver Skills Template** will immediately run their user control mode, enabling radio control for the amount of time specified within the template (60 seconds by default). After the user control period has ended, radio control will cease and the robot will stop.

Note: In either scenario, the Radio Control Transmitter must be on the entire time. For best results, fully raise the antenna on the transmitter.

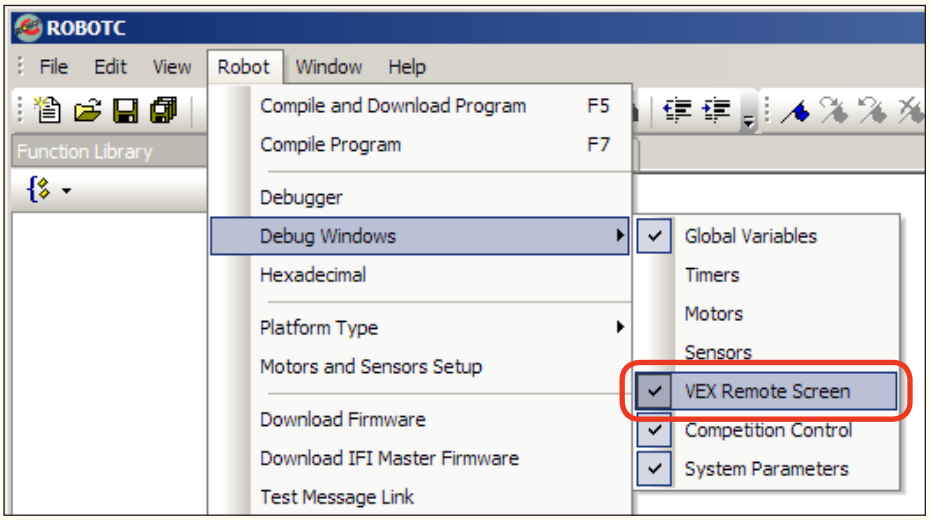
Testing VEX PIC Robots with the 75MHz Crystals *(cont.)*

Useful Information - The VEX Remote Screen

The ROBOTC Competition Templates are pre-programmed to display status information to the VEX LCD Screen. Even if you don't have the VEX LCD Screen attached to your robot, you can use the ROBOTC VEX Remote Screen to view the information (along with any other information you choose to display yourself).



*To open the **VEX Remote Screen**, first open the ROBOTC **Debugger**. Then go to **Robot** > **Debug Windows**, and select **VEX Remote Screen**.*



*Programming help for the VEX LCD Screen / VEX Remote Screen can be found in the **ROBOTC Help** documentation under **ROBOTC Functions** > **Display**.*

Testing VEX PIC ROBOTS with the VEXnet Upgrade

This document is an inspection guide for VEX v1.5 microcontroller-based robots. Use this document to test if a robot using the VEXnet Upgrade is competition ready.

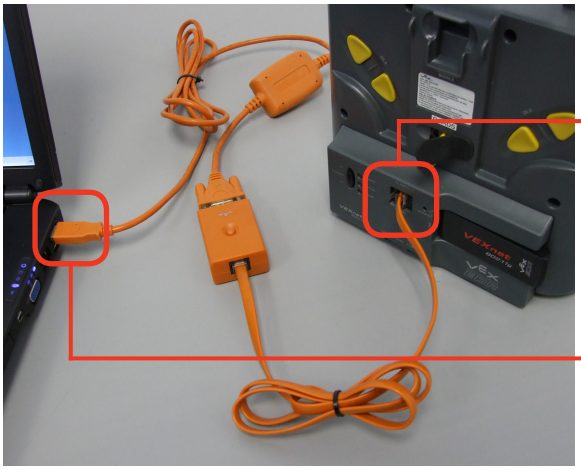
Method I. Using the ROBOTC Competition Debug Window

You will need:

- A VEX robot and transmitter with paired VEXnet Upgrades
- A computer with ROBOTC for Cortex and PIC 2.32 (or later) installed
- A VEX Programming Kit
- An object to prop the robot up, off of its wheels

---

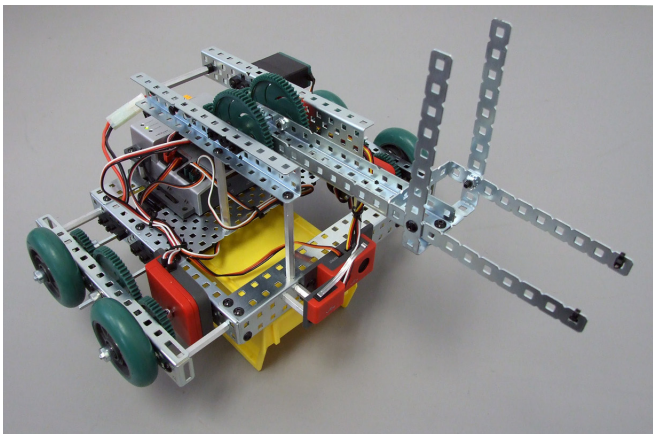
1. Connect the VEXnet Upgrade on the Radio Control Transmitter to the computer using the VEX Programming Kit.



1a. Connect to Transmitter
Plug the "phone cable" end of the Programming Kit into the SERIAL port of the VEXnet Upgrade on the Transmitter.

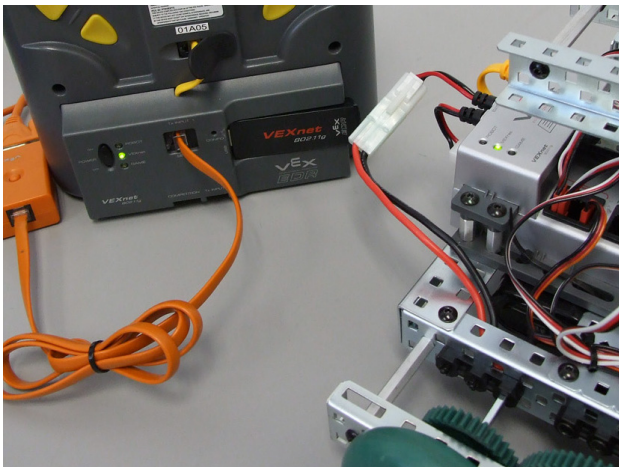
1b. Connect to PC
Plug the USB connector on the Programming Kit into the PC.

2. Prop the robot up, so that its wheels are no longer touching a surface.

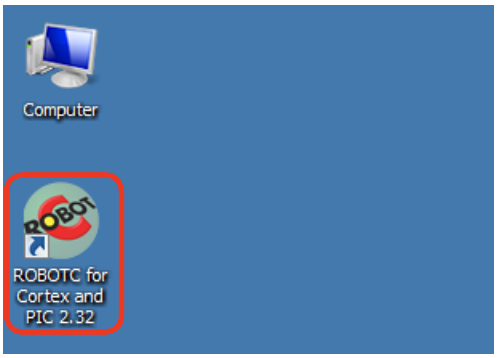


Testing VEX PIC Robots with the VEXnet Upgrade *(cont.)*

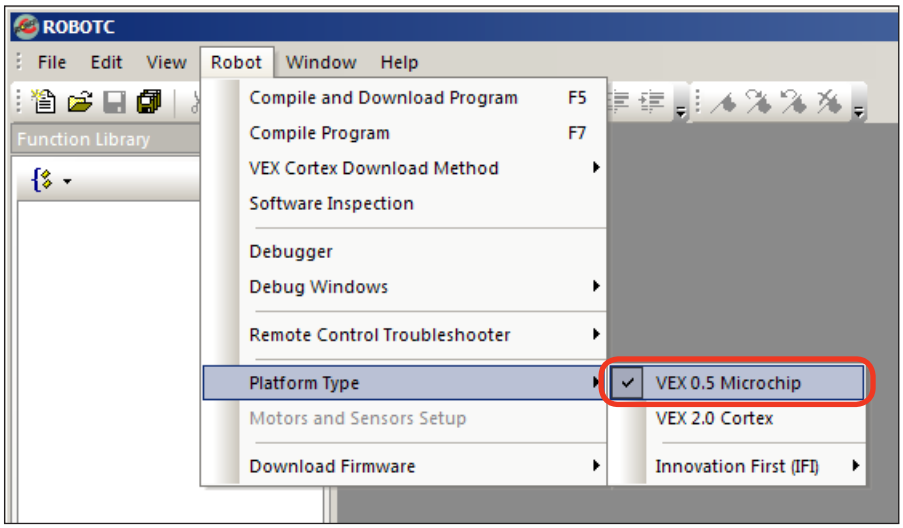
3. Turn on the VEX robot and transmitter. Allow the VEXnet Upgrades to pair.



4. Open ROBOTC for Cortex and PIC

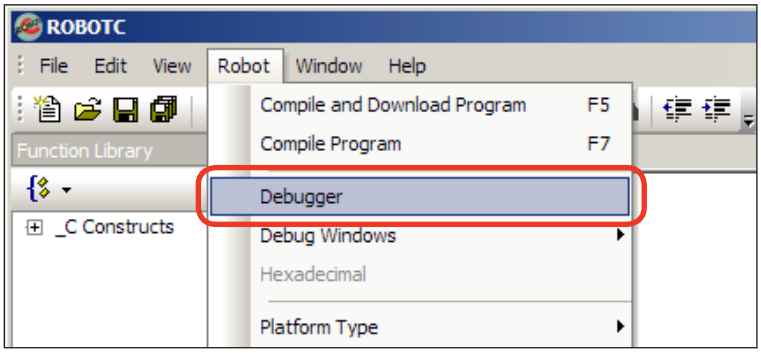


5. Verify that the Platform Type in ROBOTC is set to VEX 0.5 Microchip.

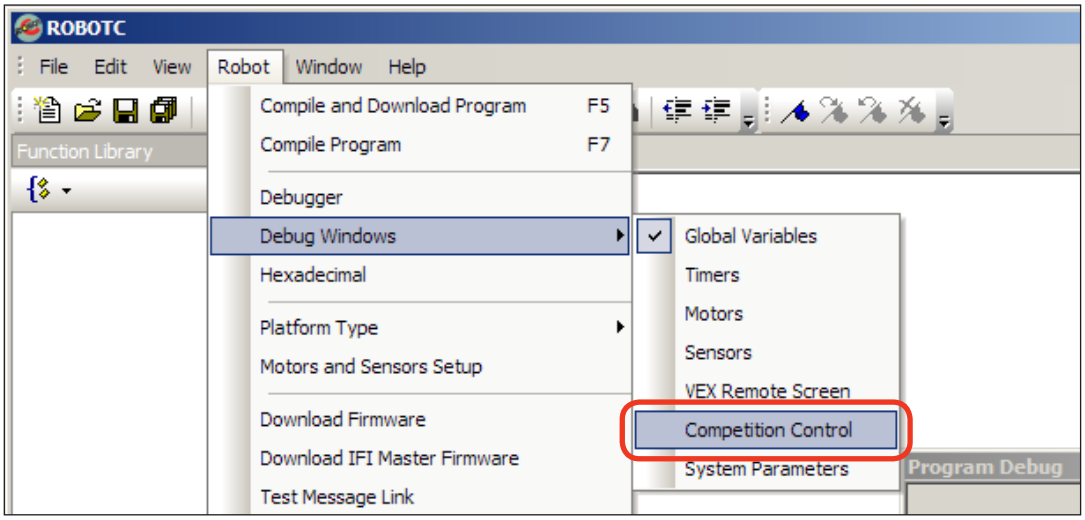


Testing VEX PIC Robots with the VEXnet Upgrade *(cont.)*

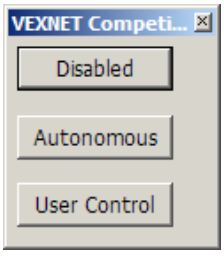
6. Establish a connection to the VEX Microcontroller by going to the ***Robot*** menu and selecting ***Debugger***.



7. After a connection has been established and the ***Program Debug*** window appears, go to ***Robot*** > ***Debug Windows*** and select ***Competition Control***.

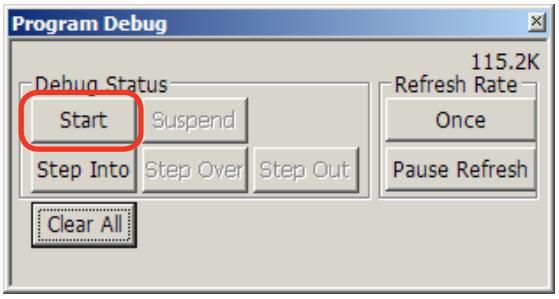


8. The ***VEXnet Competition Control*** debug window will appear.



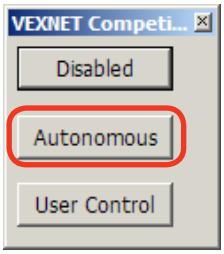
Testing VEX PIC Robots with the VEXnet Upgrade *(cont.)*

9. Press the ***Start*** button on the ***Program Debug*** window.



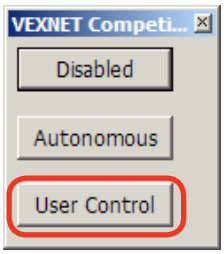
Note: After pressing the ***Start*** button, the robot will automatically go into User Control mode.

10. To test the robot's autonomous mode, press the ***Autonomous*** button on the ***VEXnet Competition Control*** window.



The code for autonomous mode will run once, until it is finished, or until you press the ***Disabled*** button on the ***VEXnet Competition Control window***. A stopwatch can be used to time the duration of the autonomous mode, if desired. To run the code for the autonomous period again, simply press the Autonomous button again.

11. To test the robot's user control mode, press the ***User Control*** button on the ***VEXnet Competition Control*** window.



The code for user control mode will run until you press the ***Disabled*** button on the ***VEXnet Competition Control window***. To restart the code for the user control period period, simply press the User Control button again.

Testing VEX PIC Robots with the VEXnet Upgrade *(cont.)*

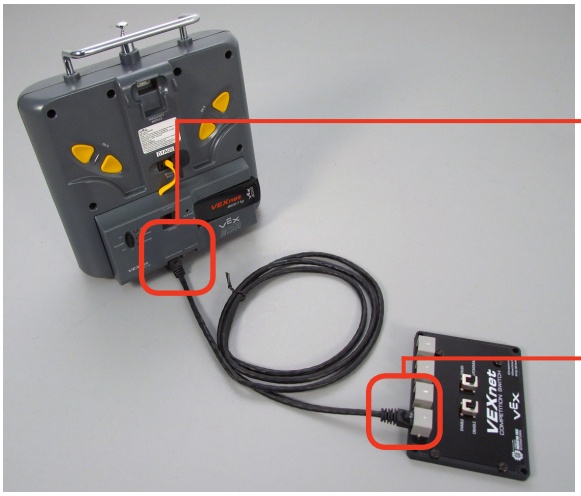
Method II. Using the VEXnet Competition Switch

You will need:

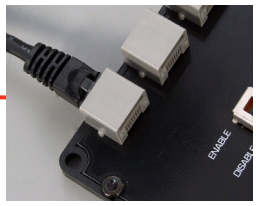
- A VEX robot and transmitter with paired VEXnet Upgrades
- A VEXnet Competition Switch
- An Ethernet Cable
- An object to prop the robot up, off of its wheels

---

1. Connect the VEXnet Upgrade on the Radio Control Transmitter to the VEXnet Competition Switch using the VEX ethernet cable.



1a. Connect to Transmitter
Plug one end of the ethernet cable into the COMPETITION port on the VEXnet Upgrade.

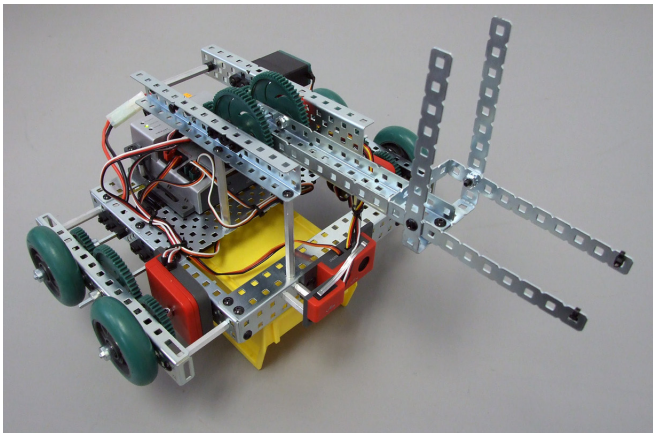


1b. Connect to Switch
Plug the the other end of the ethernet cable into one of the ports on the VEXnet Competition Switch.

2. Set the ENABLE/DISABLE switch to **DISABLE** and the DRIVER/AUTONOMOUS switch to **AUTONOMOUS**.

Testing VEX PIC Robots with the VEXnet Upgrade *(cont.)*

3. Prop the robot up, so that its wheels are no longer touching a surface.



4. Turn on the VEX robot and transmitter. Allow the VEXnet Upgrades to pair.

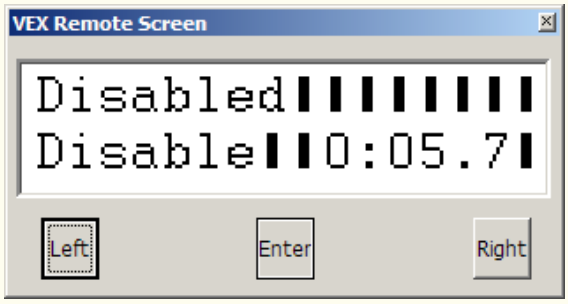
To test the robot's autonomous mode, verify that the DRIVER/AUTONOMOUS switch is set to **AUTONOMOUS** and change the ENABLE/DISABLE switch to **ENABLE**. The code for the autonomous period will run once, until it is finished, or until it is disabled on the VEXnet Competition Switch. A stopwatch can be used to time the duration of the autonomous mode, if desired. To run the code for the autonomous period again, toggle the ENABLE/DISABLE switch to DISABLE and then to ENABLE.

To test the robot's user control mode, first verify that the ENABLE/DISABLE switch is set to **DISABLE**. Then, set the DRIVER/AUTONOMOUS switch to **DRIVER** and change the ENABLE/DISABLE switch to **ENABLE.** The code for the user control period will run until it is disabled on the VEXnet Competition Switch. To restart the code for the user control period again, toggle the ENABLE/DISABLE switch to DISABLE and then to ENABLE.

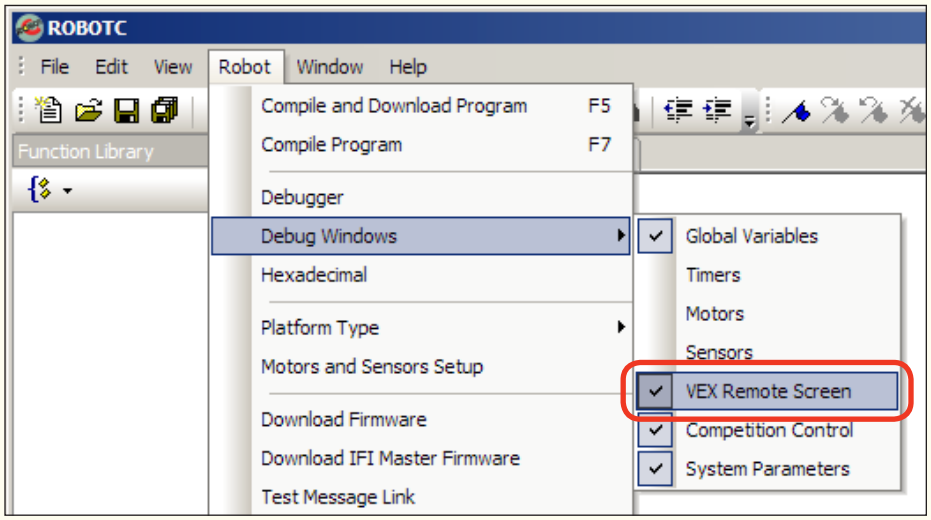
Testing VEX PIC Robots with the VEXnet Upgrade *(cont.)*

Useful Information - The VEX Remote Screen

The ROBOTC Competition Templates are pre-programmed to display status information to the VEX LCD Screen. Even if you don't have the VEX LCD Screen attached to your robot, you can use the ROBOTC VEX Remote Screen to view the information (along with any other information you choose to display yourself).



*To open the **VEX Remote Screen**, first open the ROBOTC **Debugger**. Then go to **Robot** > **Debug Windows**, and select **VEX Remote Screen**.*



*Programming help for the VEX LCD Screen / VEX Remote Screen can be found in the **ROBOTC Help** documentation under **ROBOTC Functions** > **Display**.*

ROBOTC Programming Competition Templates

This document is part of a software inspection guide for VEX based robots. Use this document to learn how to use the "Competition Template" or "Driver Skills Template" included with ROBOTC. ***For the most up-to-date versions of the templates (and ROBOTC) download the latest version of ROBOTC for Cortex and PIC at www.robotc.net.***

You will need:

- A computer with ROBOTC for Cortex and PIC 2.32 or later installed (available at www.robotc.net)

Normal Programming vs. Competition Programming

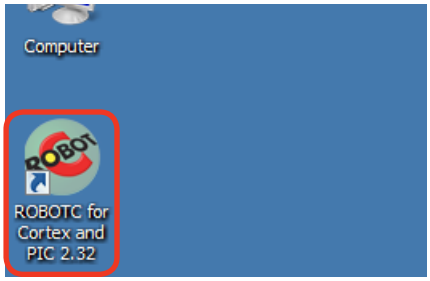
In ROBOTC, every program is usually based around **`task main()`**, as shown below:

```
task main()
{
  //User code goes here
}
```

In a VEX competition, however, the robots need to communicate with the field control system, so programming is a little different. To keep things simple, ROBOTC comes with built-in Competition and Driver Skills templates. The templates contains three main sections, each mapped to specific portions of the competition, where teams should place their code.

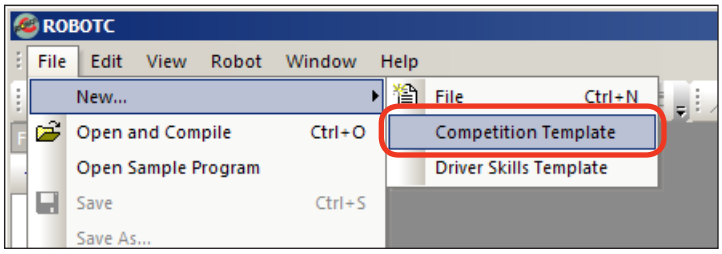
Part I. Using the ROBOTC Competition Template

1. Open *ROBOTC for Cortex and PIC*.



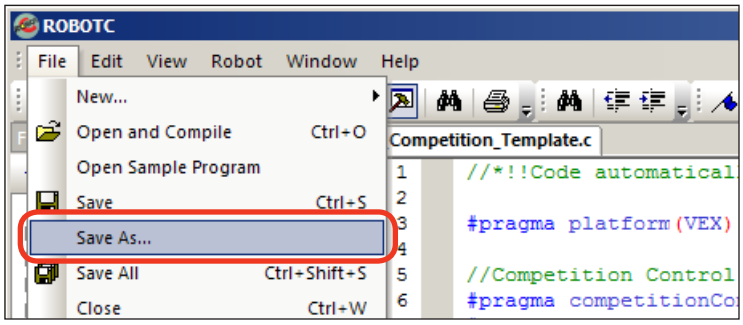
1. ***Open ROBOTC for Cortex and PIC***
   Open *ROBOTC for Cortex and PIC* from your Desktop or Start Menu.

2. To begin programming in a Competition Template, go to ***File*** > ***New...*** and select ***Competition Template***.



ROBOTC Programming Competition Templates *(cont.)*

3. A new file named ***Competition.c*** will appear. Before making any changes to the template, go to ***File***, select ***Save As...*** and save this program in a location and under a name you will remember.



Shown below are the contents of the ***Competition.c*** file with brief descriptions, but with the comments removed. Additional details are available throughout the document.

```
#pragma platform(VEX)
```

This **pragma** statement specifies the VEX as the platform type.

```
#pragma competitionControl(Competition)
```

This **pragma** statement enables competition control.

```
#pragma autonomousDuration(20)
#pragma userControlDuration(120)
```

These **pragma** statements specify the duration (20 and 120 second defaults) of the autonomous and user control modes for VEX PIC based robots using the 75 MHz Crystals. VEX Cortex and VEX 1.5 (VEXnet Upgraded PIC) based robots will ignore these lines; which mode they are in and the duration are controlled using the field control system.

```
#include "Vex_Competition_Includes.c"
```

This **include** file contains the functionality necessary for the robot to operate with the VEX field control. Do NOT modify the include file or remove this line of code.

```
void pre_autonomous()
{
  //Place pre-autonomous code here
}
```

Any initialization code, such as setting servo positions or clearing encoder values can be placed within the **pre_autonomous()** function.

```
task autonomous()
{
  //Place autonomous code here
  AutonomousCodePlaceholderForTesting();
}
```

All code for the autonomous portion of the competition should be placed within the **autonomous task**. The **AutonomousCodePlaceholderForTesting** function can be removed once you place your own code within the task.

```
task usercontrol()
{
  while(true)
  {
    //Place user control code here
    UserControlCodePlaceholderForTesting();
  }
}
```

All code for the user control portion of the competition should be placed within the **while()** loop of the **usercontrol task**. The while() loop repeats all commands within its curly brackets for the duration of the user control portion of the competition, ensuring that the transmitter data and any other values are up-to-date. The **UserControlCodePlaceholderForTesting** function can be removed once you place your own code within the task.

ROBOTC Programming Competition Templates *(cont.)*

Setting up Competition Control and Timing

In ROBOTC, competition programming is completely user customizable, so no jumpers are required for testing. By adjusting the following commands, the templates can be adapted to work in any VEX supported competition.

```
#pragma competitionControl(Competition)
#pragma autonomousDuration(20)
#pragma userControlDuration(120)
```

`#pragma competitionControl(competition_mode)` - Controls the competition mode that the VEX is in. There are two different competition modes that you can pass:

`OFF` - No competition control.

`Competition` - The VEX will respond to field control commands and switch between Autonomous and User Control modes at the competition-specified times. Use this mode for competitions.

`#pragma autonomousDuration(time_in_seconds)` -
Defines the duration of the autonomous phase of a VEX competition for VEX PIC robots using the 75 MHz crystals. To use the competition template in a User Control-only competition, you can set the duration to zero. This line can be deleted or commented-out if you are using the VEX Cortex or a VEX 1.5 (VEXnet Upgraded PIC) based robot.

`#pragma userControlDuration(time_in_seconds)` -
Defines the duration of the user control phase of a VEX competition for robots using the 75 MHz crystals. To use the competition template in an Autonomous-only competition, you can set the duration to zero. This line can be deleted or commented-out if you are using the VEX Cortex or a VEX 1.5 (VEXnet Upgraded PIC) based robot.

Important Information - Timing Tips

For robots using the 75MHz crystals, the user control duration can be increased beyond the actual length of the round to compensate for any possible delays in the system. For example, changing **`userControlDuration(120)`** to **`userControlDuration(180)`** would ensure that the robot remains active until the Field Control system ends the user control period.

The durations of VEX Cortex and VEX 1.5 based robots are determined solely by the Field Control system. When programming VEX Cortex or VEX 1.5 based robots, so you can comment-out or delete the **`autonomousDuration()`** and **`userControlDuration()`** pragma statements.

ROBOTC Programming Competition Templates *(cont.)*

Pre-Autonomous Period

Place your initialization code inside this function. During the pre-autonomous period, code can be executed to configure your robot before the actual competition begins. Valid code for this section includes tasks such as clearing encoders, reflecting motors, and setting initial servo positions.

```
void pre_autonomous()
{
  //Place pre-autonomous code here
}
```

Note: This code executes only once and runs before the competition begins.

Autonomous Period

Place your autonomous code inside this task. During the autonomous period, the robot performs the pre-programmed actions once, or until it is disabled by the field control system (or for the length of time specified in the **`autonomousDuration(time)`** pragma statement, for VEX PIC based robots using the 75 MHz Cystals). The **`AutonomousCodePlaceholderForTesting();`** function is only a placeholder and **should be replaced** with your own code.

```
task autonomous()
{
  //Place autonomous code here
  AutonomousCodePlaceholderForTesting();
}
```

Important Information - Transmitter Signal

VEX PIC based robots using the 75 MHz Crystals cannot accept commands from the Radio Control Transmitter during the autonomous period, but they require that the signal be present as a safety precaution. The autonomous period during a competition cannot be skipped by shutting the transmitter off; doing so with a robot using the 75 MHz crystals will pause the VEX's internal timers, potentially causing the robot to enter the User Control period later than it should.

Also note that the **`AutonomousCodePlaceholderForTesting();`** function contains a **`while(true)`** loop that can prevent user-written autonomous code from executing. Remove this function to avoid any unexpected behavior during the autonomous period.

ROBOTC Programming Competition Templates *(cont.)*

User Control Period

Place your user control code inside this task. During the user controlled period, the robot accepts commands from the VEXnet Joysticks (VEX Cortex based robots) or the Radio Control Transmitter (VEX PIC based robots). This segment of code typically executes immediately after the autonomous period ends. The **`UserControlCodePlaceholderForTesting();`** function is only a placeholder and should be removed once you place your own code inside of the **`while(true)`** loop.

```
task usercontrol()
{
 while(true)
 {
    //Place user control code here
    UserControlCodePlaceholderForTesting();
 }
}
```

Important Information - while(true) loop

When programming for the user control period, place all commands inside of the **`while(true)`** loop. Failing to do so will result in the commands only running once, preventing you from remotely controlling your robot. The field control system determines and controls the maximum length of the user control period.

ROBOTC Programming Competition Templates *(cont.)*

Sample Competition Template with User Code

```
#pragma config(Sensor, in1, bumper, sensorTouch)
//*!!Code automatically generated

#pragma platform(VEX)

#pragma competitionControl(Competition)

#pragma autonomousDuration(20)
#pragma userControlDuration(120)

#include "Vex_Competition_Includes.c"

void forwardUntilTouch()
{
 while(SensorValue[bumper] == 0)
 {
    motor[port2] = 63;
    motor[port3] = 63;
 }
 motor[port2] = 0;
 motor[port3] = 0;
}

void pre_autonomous()
{
 bMotorReflected[port2] = true;
}

task autonomous()
{
 forwardUntilTouch();
 motor[port6] = 31;
 wait1Msec(250);
 motor[port6] = 0;
}

task usercontrol()
{
 while(true)
 {
    motor[port2] = vexRT[Ch2];
    motor[port3] = vexRT[Ch3];
    motor[port6] = vexRT[Ch6]/4;
 }
}
```

Motors and Sensors configured using the ROBOTC *Motors and Sensors* setup window will automatically be added as **`pragma`** statements at the top of the program.

While it's not technically required, it's good programming practice to place user-defined functions and/or global variables below the pragma and include statements, and above the template-included functions and tasks.

This sets the motor connected to VEX Port 2 to spin in reverse.

Commands in the autonomous period are executed once (assuming there are no loops in the code). Also, notice that the **`AutonomousCodePlaceholderForTesting`** function has been removed.

Commands in the while(true) loop of the user control period are executed until the end of the match. Also, notice that the **`UserControlCodePlaceholderForTesting`** function has been removed from the loop.

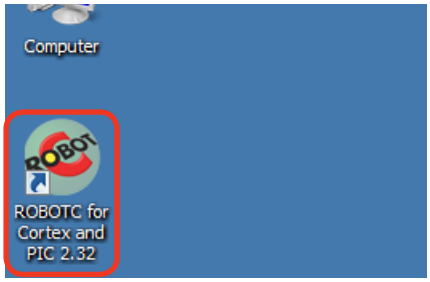
ROBOTC Programming Competition Templates *(cont.)*

Part II. Using the ROBOTC Driver Skills Template

Using the ROBOTC Driver Skills Template is very similar to using the ROBOTC Competition Template. The two templates are nearly identical; the only difference between the two are comments in the code, the autonomous duration is set to zero seconds by default, the user control duration is set to sixty seconds by default, and basic remote control commands are already placed within the while(true) loop of the user control section of the program.

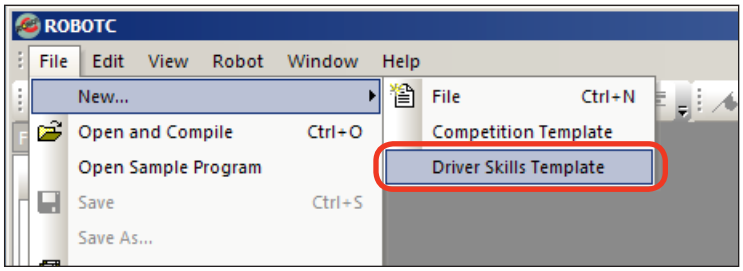
---

1. Open *ROBOTC for Cortex and PIC*.

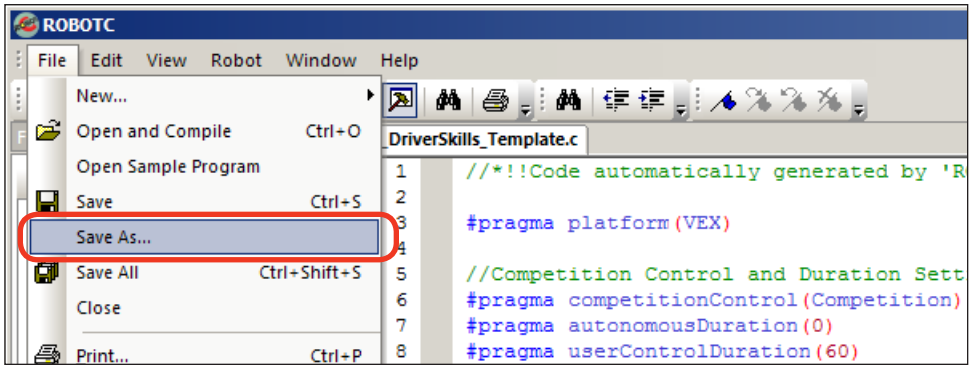


1. Open ROBOTC for Cortex and PIC
Open *ROBOTC for Cortex and PIC* from your Desktop or Start Menu.

2. To begin programming in a Driver Skills Template, go to ***File*** > ***New...*** and select ***Driver Skills Template***.



3. A new file named ***DriverSkills.c*** will appear. Before making any changes to the template, go to ***File***, select ***Save As...*** and save this program in a location and under a name you will remember.



ROBOTC Programming Competition Templates *(cont.)*

Shown below are the contents of the ***DriverSkills.c*** file with brief descriptions, but with the comments removed and additional spacing added. Additional details can be found in **Part I** of this document.

```
#pragma platform(VEX)

#pragma competitionControl(Competition)

#pragma autonomousDuration(0)
#pragma userControlDuration(60)




#include "Vex_Competition_Includes.c"

void pre_autonomous()
{
  //Place pre-autonomous code here
}

task autonomous()
{
  //Leave this section alone
  AutonomousCodePlaceholderForTesting();
}

task usercontrol()
{
  while(true)
  {
     //Place user control code here
     UserControlCodePlaceholderForTesting();
     motor[port2] = vexRT[Ch1];
     motor[port3] = vexRT[Ch4];
  }
}
```

These **`pragma`** statements specify the duration of the autonomous and user control portions of the competition (0 and 60 second defaults)for VEX PIC based robots using the 75 MHz Crystals.

If your robot is using the 75 MHz crystals, do NOT remove these lines of code. If you are using a VEX Cortex or VEX 1.5 (VEXnet Upgraded PIC) based robot, you can comment these lines out or delete them.

Any initialization code, such as setting servo positions or clearing encoder values can be placed within the **`pre_autonomous()`** function.

The **`autonomous task`** can be ignored when programming for a Driver Skills competition, but do NOT delete it.

All code for the user control portion of the competition should be placed within the **`while()`** loop of the **`usercontrol task`**. The while() loop repeats all commands within its curly brackets for the duration of the user control portion of the competition, ensuring that the remote control values sent to the robot are continually updated.

The pre-existing code within the loop can be replaced with your own code. The **`UserControlCodePlaceholderForTesting`** function should also be removed.

Driver Installation

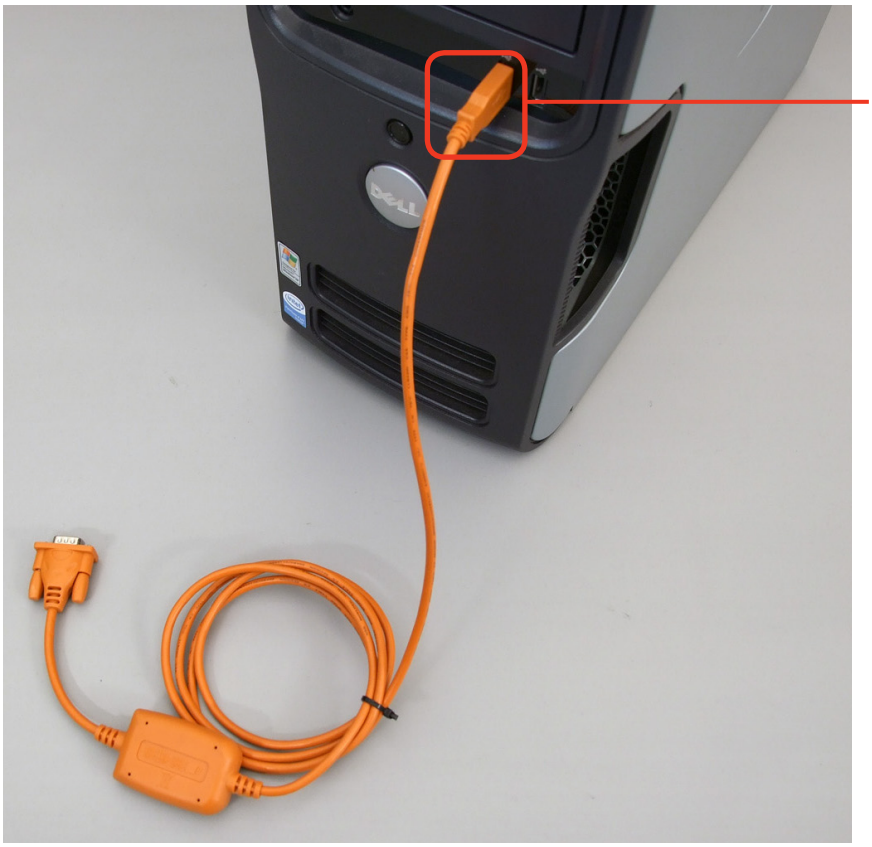
In this lesson, you will learn how to install the USB-to-Serial Cable driver. Make sure you have sufficient security privileges to install drivers on the computer before you begin.

You will need:

1. A ROBOTC for IFI Installation CD or an Internet connection
2. A VEX USB-to-Serial cable

---

1. Plug the USB connector end into your computer.

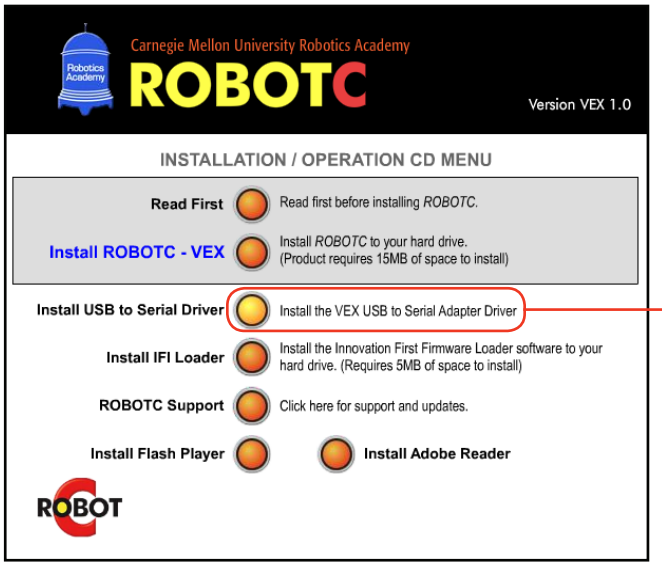


1. Connect the cable
Plug the USB end of the cable into the computer.

Driver Installation

2. Cancel any automatic installation prompts that may appear, such as the "Found New Hardware Wizard" Window. Instead, run the driver installation program manually from the ROBOTC for IFI CD-ROM or download and run the driver from the ROBOTC.net website. For downloading instructions, see step 3.

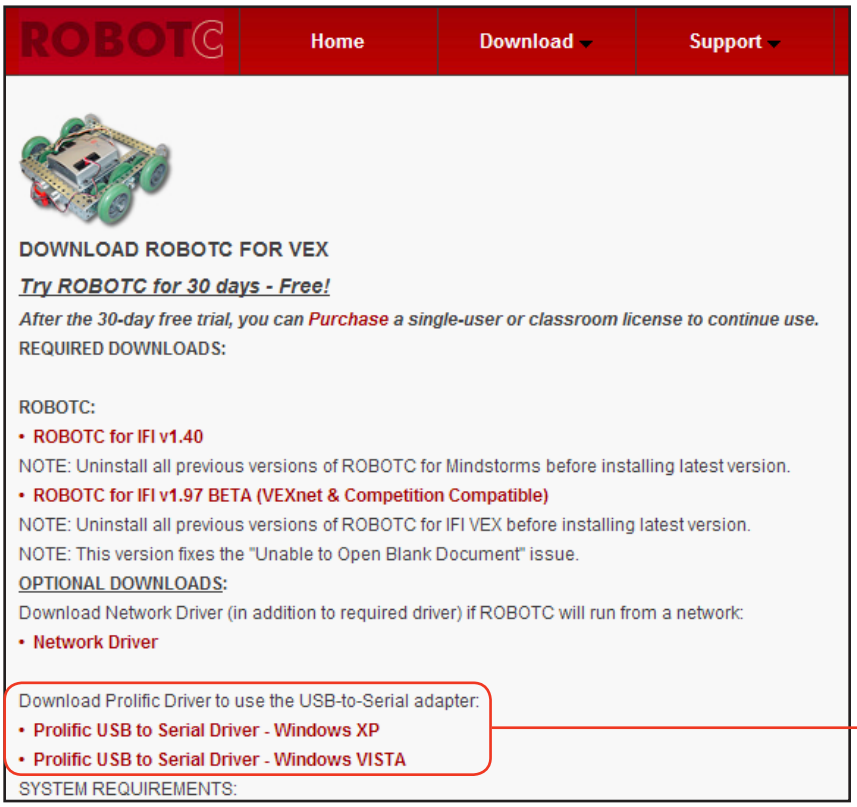
2a. Cancel any installation wizard
The driver installation does not require the use of the "Found New Hardware Wizard".



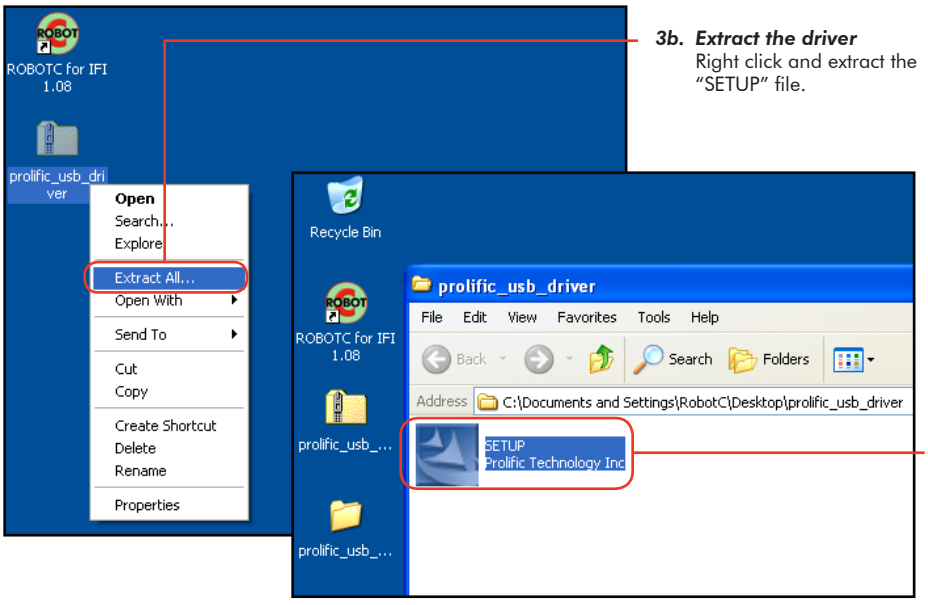
2b. Run the Driver
The USB-to-Serial driver installation can be run from the ROBOTC for IFI installation CD.

Driver Installation

3. If you download the driver from ROBOTC.net, the installation file will need to be extracted before you can start the installation process. Extract the "prolific_usb_driver" file by right-clicking its icon, selecting "Extract All...", and proceeding through the following steps. Once complete, run the "SETUP" file and follow the its instructions to finish installing the USB-to-Serial driver.



3a. Download driver
If you do not have the CD, you can download the driver from the VEX "Download" page of ROBOTC.net.

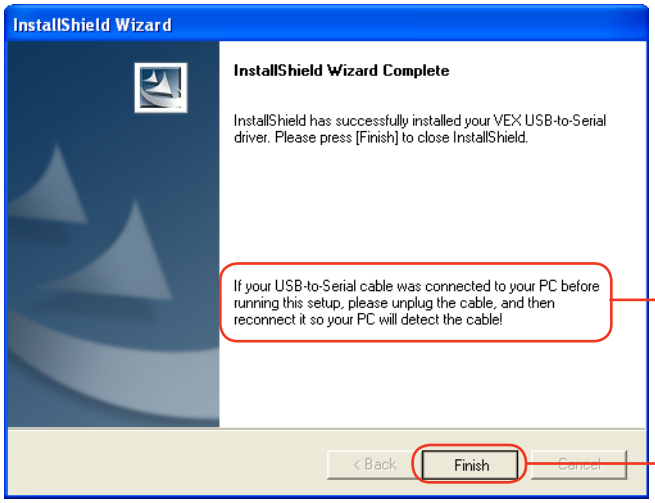


3b. Extract the driver
Right click and extract the "SETUP" file.

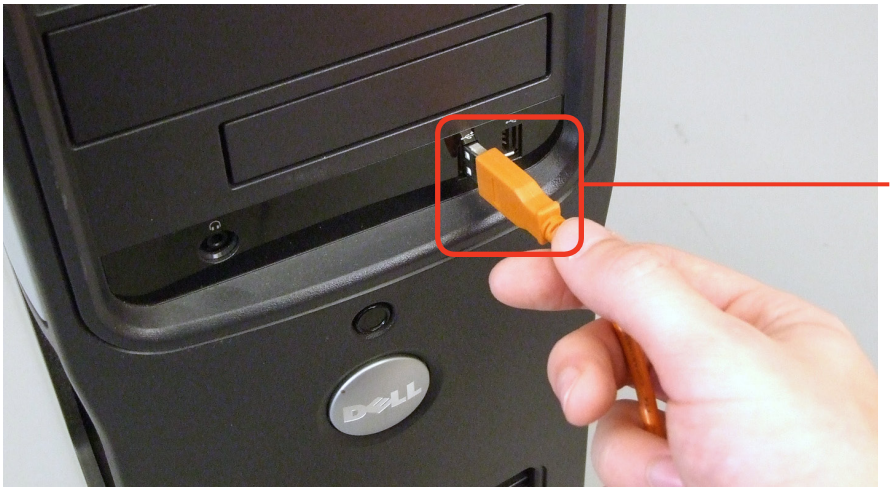
3c. Install the driver
Double click the "SETUP" file to begin the installation.

Driver Installation

4. Follow the installation prompts to complete the installation.



4a. Follow prompts
Complete the installation according to the onscreen instructions.



4b. Finish the installation
Unplug the USB-to-Serial cable and plug it back in to complete the installaton.

VEX Cortex Configuration over USB

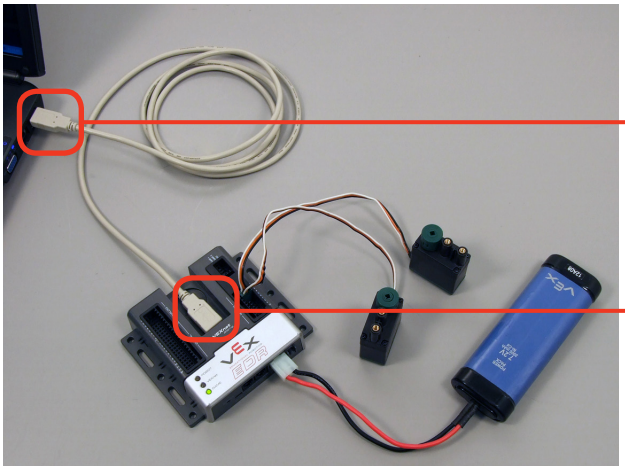
The VEX Cortex is a fully programmable device, and is what enables you to incorporate motors, sensors, an LCD screen, and remote control signals all in one robot. Inside of the Cortex, there are two separate processors; a user processor handles all of the ROBOTC programming instructions, and a master processor controls lower-level operations, like motor control and VEXnet communication. This document is a guide for downloading the Master CPU firmware and ROBOTC firmware to the VEX Cortex using the USB A-to-A cable.

You will need:

- 1 VEX Cortex Microcontroller with one 7.2V Robot Battery
- A computer with ROBOTC for Cortex and PIC installed
- 1 USB A-to-A Cable

---

1. Leaving the POWER switch in the OFF position, connect your Cortex to the computer using the USB A-to-A cable. Once the cable is attached, move the POWER switch to the ON position.



1a. Connect the Cortex to your PC
Use the USB A-to-A cable to connect your Cortex to your PC.

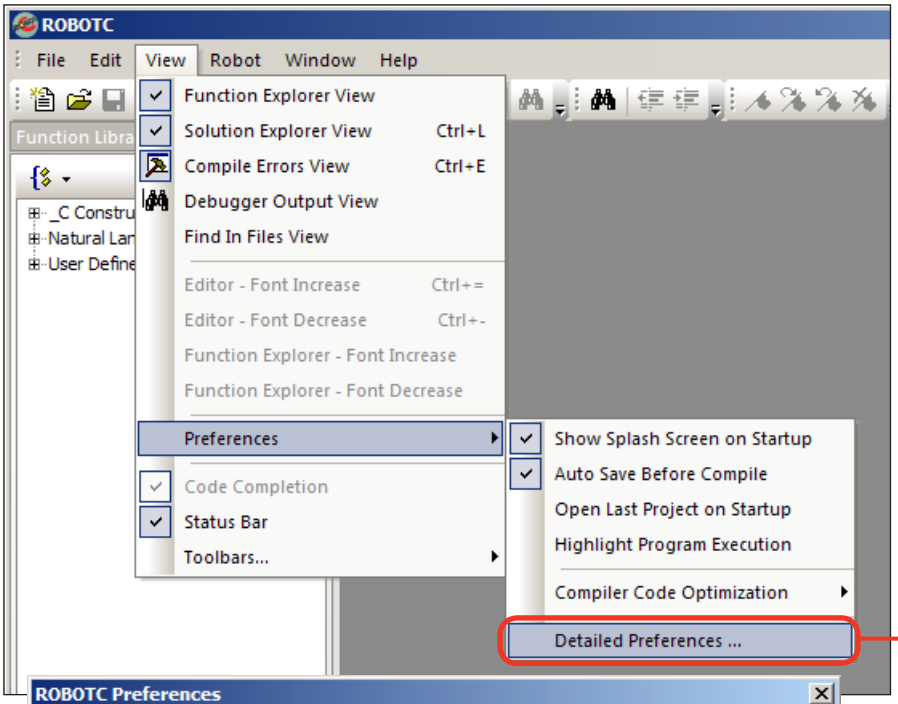
Note: The order detailed in this step is crucial. When the Cortex is powered on, it immediately tries to determine how it is connected (over VEXnet, USB, or no connection). Some power is provided to the Cortex over USB, which will allow it to determine that it is connected to your computer.

1b. Turn the Cortex ON
Make sure a 7.2V Robot battery is connected and move the POWER switch on the Cortex to the ON position.

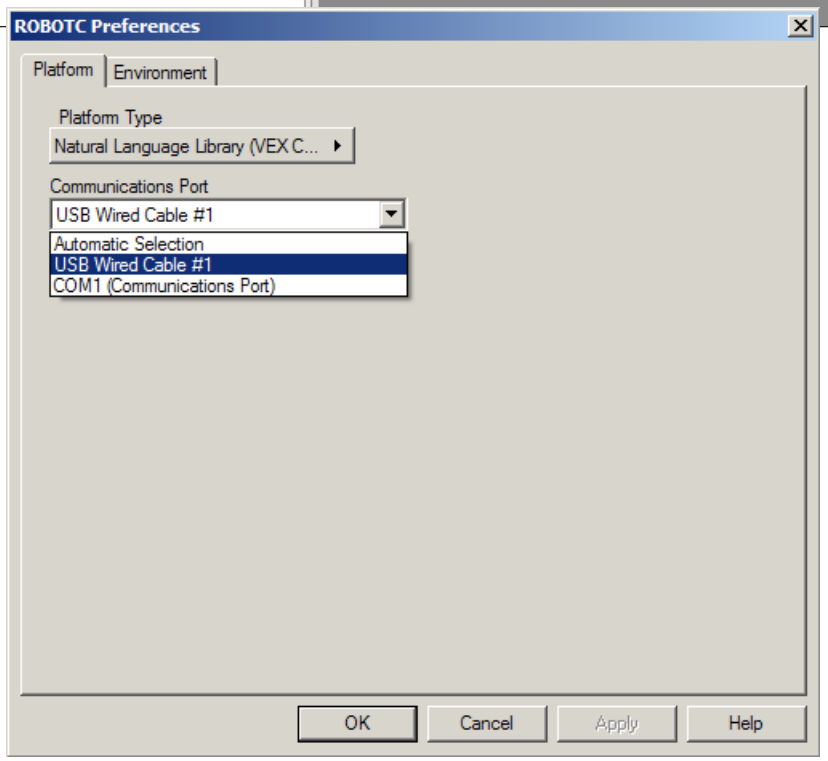
Note: If your Cortex is connected to a mobile robot, it's recommended that you prop the robot up to prevent its wheels from making contact with a surface. The motors may turn on and off during the firmware download process.

VEX Cortex Configuration over USB *(cont.)*

2. Specify that you are using the Cortex and how it is connected to your computer in ROBOTC.



2a. Detailed Preferences...
Go to *View* > *Preferences* and select *Detailed Preferences...*



2b. Platform Settings
Make sure that the *Platform* tab is selected on the *ROBOTC Preferences* window.

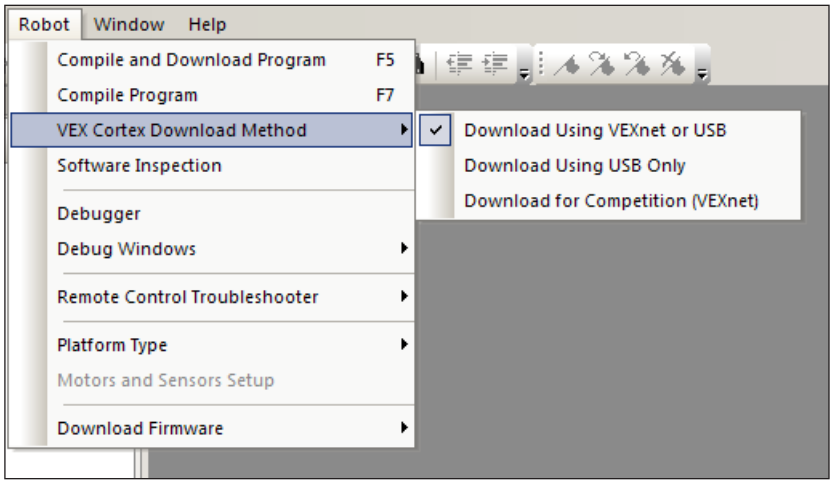
Next, specify the *Natural Language (VEX Cortex)* as your *Platform Type*.

Finally, to program directly over the USB A-to-A cable, select the option that specifys the *USB Wired Cable*. Press *OK* to finalize your settings.

Note: The Platform Type can also be modified by going to the *Robot* menu in ROBOTC, selecting *Platform Type*, and choosing one of the available options. Also, the *Automatic Selection* option should be used if you will be switching between VEXnet using the USB-to-Serial Programming Cable, and the USB A-to-A Cable.

VEX Cortex Configuration over USB *(cont.)*

3. The *VEX Cortex Download Method* controls how ROBOTC downloads firmware and programs to your Cortex, as well as what types of connections your Cortex checks for when it is powered on. Confirm that your *VEX Cortex Download Method* is set to *Download Using VEXnet or USB* or *Download Using USB Only*.



Option 1: Download Using VEXnet or USB

With this option selected, ROBOTC will download ROBOTC firmware and programs to your Cortex using a VEXnet or USB connection. In this mode, when the Cortex is powered ON it will look for a VEXnet or USB connection for up to 10 seconds before running your program. (The Automatic Selection option in the ROBOTC Preferences should be selected if you plan on switching between VEXnet and USB as your download method.)

Option 2: Download Using USB Only

With this option selected, ROBOTC will download firmware and programs to your Cortex using only the USB connection. In this mode, when the Cortex is powered ON it will immediately run your program. This option is NOT recommended if you are using the VEXnet Joysticks to download to the Cortex, or remotely control it.

Option 1: Download for Competition (VEXnet)

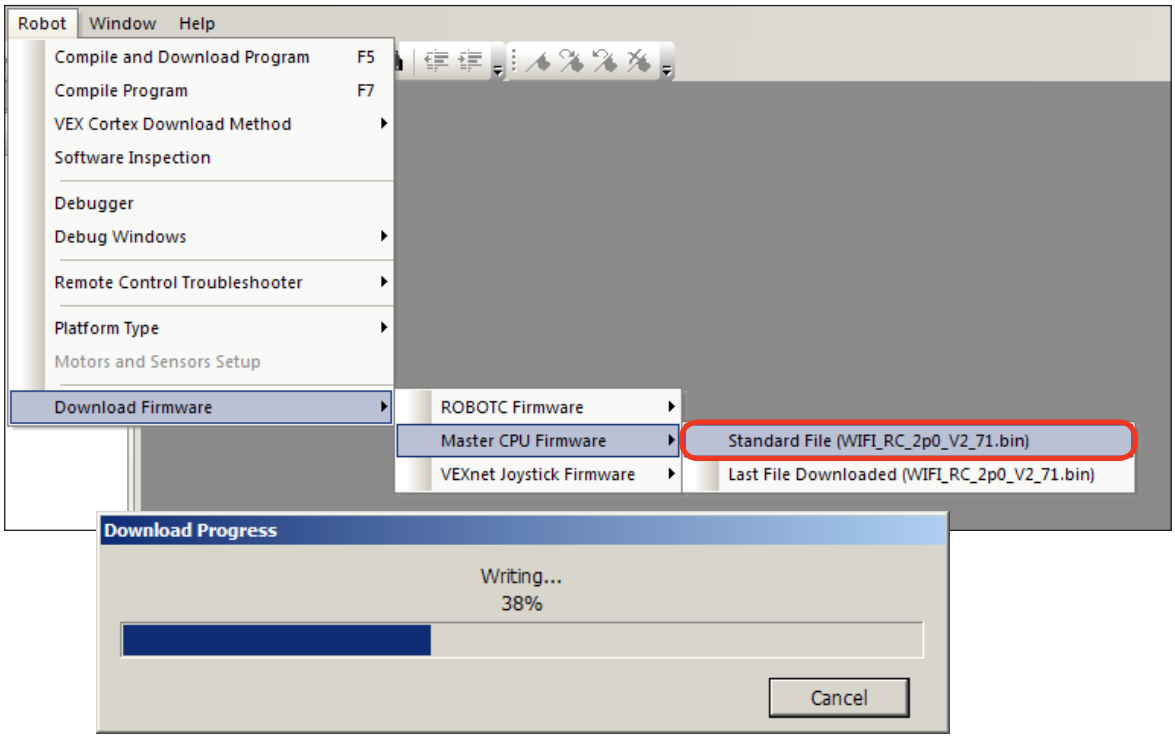
This option disables the ROBOTC debugger, and is not recommended for classroom use.

Important Note: Restarting the Cortex

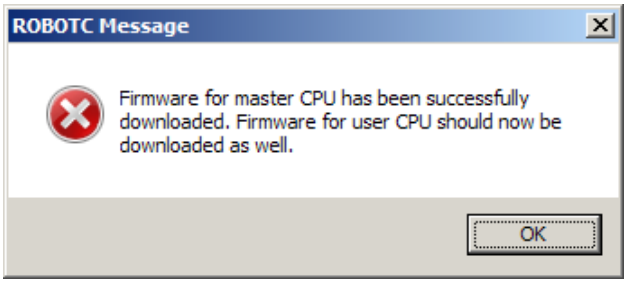
The VEX Cortex Download Method setting is stored in ROBOTC and on the Cortex. If you change the setting, the Cortex must be power cycled (turned fully off, and then back on) before the change will take effect.

VEX Cortex Configuration over USB *(cont.)*

4. Go to ***Robot*** > ***Download Firmware*** > ***Master CPU Firmware*** and select ***Standard File*** to download the latest Master CPU Firmware to your robot.



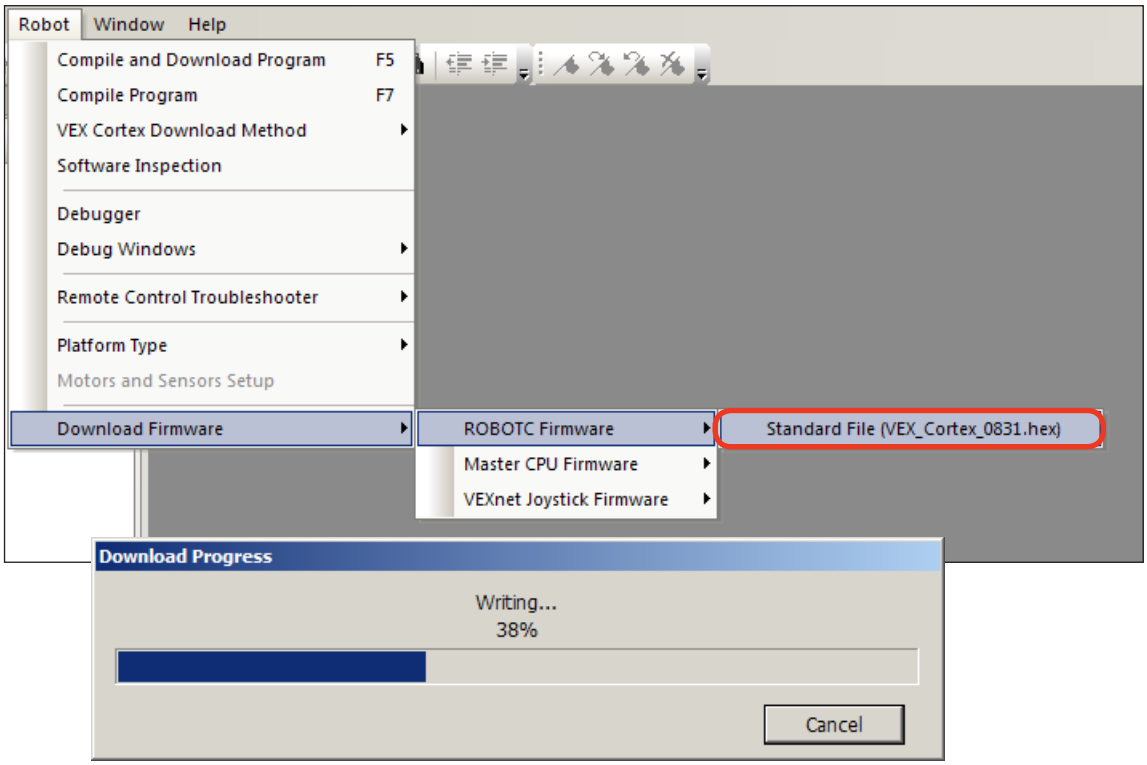
4. ***Download Progress***
A ***Download Progress*** window will appear and begin the download process. When the window closes, the firmware download is complete. A ROBOTC Message will appear, and remind you to also download the ROBOTC Firmware.



Note: You only need to download the Master CPU Firmware once, when you first start using a VEX Cortex with ROBOTC, or when you upgrade to a newer version of ROBOTC. Switching programs or download methods does not require a re-download.

VEX Cortex Configuration over USB *(cont.)*

5. The ROBOTC Firmware enables you to download ROBOTC programs to your robot and utilize the various debug windows. Go to ***Robot*** > ***Download Firmware*** > ***ROBOTC Firmware*** and select ***Standard File*** to download the ROBOTC Firmware to your robot.



5. ***Download Progress***
   A ***Download Progress*** window will appear and begin the download process. When the window closes, the firmware download is complete.

   Note: You only need to download the ROBOTC Firmware once, when you first start using a VEX Cortex with ROBOTC, or when you upgrade to a newer version of ROBOTC.

End of Lesson

Once the Download Progress window closes, the ROBOTC Firmware download is complete. *Your VEX Cortex is now ready to be programmed in ROBOTC.*

If you are also using the VEXnet Joysticks, you can follow the provided instructions in the VEXnet Joysticks Setup document. Otherwise, move on to the Downloading Sample Programs over USB guide to learn how to download sample code, and verify that your setup is fully functional.

VEXnet Joystick Configuration in ROBOTC

The VEXnet Joystick enables more than just the remote control of your robot. It also provides the wireless communication link between your computer and the VEX Cortex, enabling you to wirelessly download firmware, programs and run the ROBOTC debugger. In this document, you will learn how to configure VEXnet Joystick using ROBOTC.

This document is broken into 3 sections:

1. Downloading Firmware to the VEXnet Joystick
2. Creating a Wireless Link Between the VEXnet Joystick and VEX Cortex
3. Calibrating the VEXnet Joystick Values

You will need:

- 1 VEXnet Joystick with 6 AAA Batteries
- 1 Small Phillips Screwdriver
- A computer with ROBOTC for Cortex and PIC installed
- 1 USB A-to-A Cable
- 1 USB-to-Serial Programming Cable

Section 1: Downloading Firmware to the VEXnet Joystick

1. Begin by installing 6 AAA batteries in the VEXnet Joystick. You will need a small Phillips screwdriver to remove the battery cover.

1a. Install 6 AAA Batteries
Remove the battery cover using a small Phillips screwdriver and install 6 AAA batteries, being careful to align them as indicated.

1b. Verify Correct Installation
Turn the VEXnet Joystick ON to verify that you correctly installed the batteries. If any of the LED's on the front turn on, you installed the batteries correctly. Turn the controller OFF and secure the battery cover using the Philips screwdriver.

VEXnet Joystick Configuration in ROBOTC *(cont.)*

2. Connect the VEXnet Joystick to your computer using the USB A-to-A cable and turn it ON.

2a. Connect the VEXnet Joystick
Use the USB A-to-A cable to connect your VEXnet Joystick to your computer.

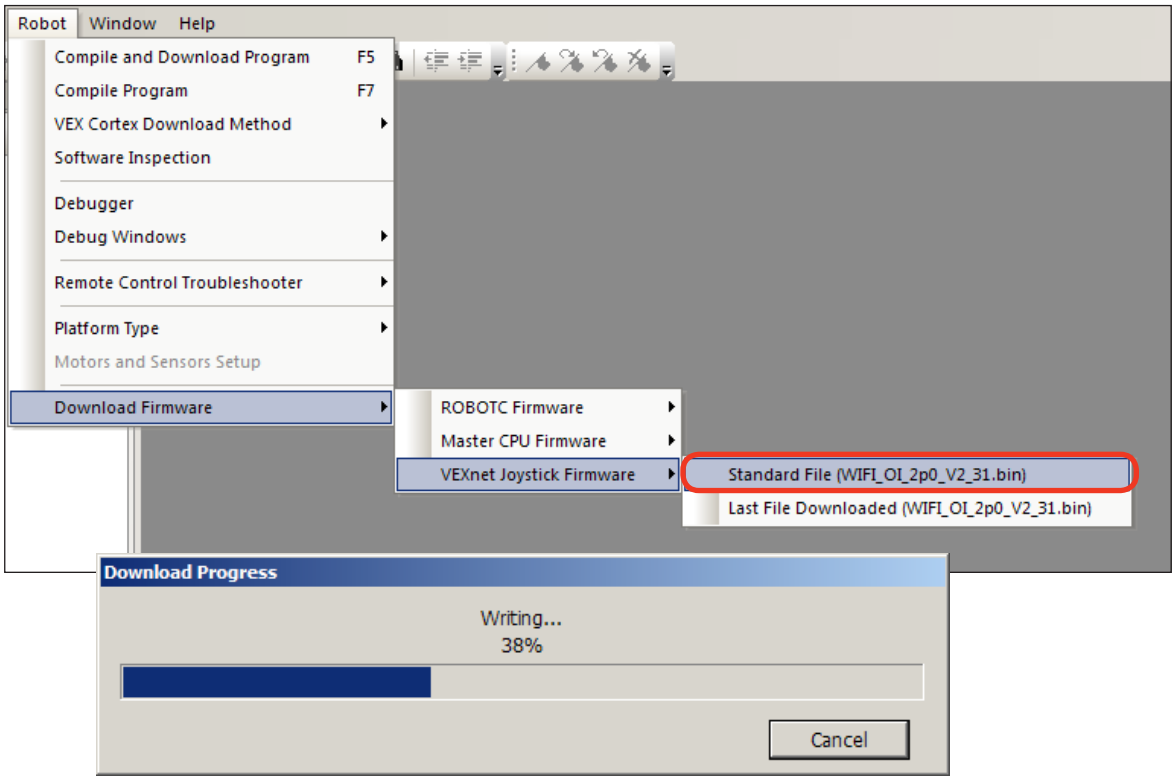
Note: The VEXnet light should turn green.

2b. Turn the VEXnet Joystick ON
Switch the VEXnet Joystick to the ON postion.

Note: The Joystick light should turn green.

VEXnet Joystick Configuration in ROBOTC *(cont.)*

3. Go to ***Robot*** > ***Download Firmware*** > ***VEXnet Joystick Firmware*** and select ***Standard File*** to download the latest VEXnet Joystick Firmware to the controller.



3. ***Download Progress***
   A ***Download Progress*** window will appear and begin the download process. When the window closes, the firmware download is complete.

   Note: You only need to download the VEXnet Joystick Firmware once, when you first start using a VEX Cortex with ROBOTC, or when you upgrade to a newer version of ROBOTC.

End of Section: Downloading Firmware to the VEXnet Joystick

Once the Download Progress window closes, the VEXnet Joystick Firmware download is complete.

Move on to the next section to learn how to create a wireless link between the VEXnet Joystick and VEX Cortex.

VEXnet Joystick Configuration in ROBOTC *(cont.)*

Section 2: Creating a wireless link betwen the VEXnet Joystick and VEX Cortex

In this section, you will learn how to pair a VEX Cortex Microcontroller to a VEXnet Joystick, allowing them to communicate over VEXnet. This section assumes that you have already updated the master firmware on the VEX Cortex and VEXnet Remote Control.

VEXnet is an 802.11 WiFi communication system between the VEX Cortex and VEXnet Remote Control.

VEXnet features include:

- Easy to connect (No IP addresses, MAC addresses, passwords, or special security modes)
- Multiple layers of security built-in and always on
- No wireless access point needed; each VEXnet pair makes its own private network
- Hundreds of robots can operate at once; every VEXnet robot has a hidden unique ID
- Optional tether for wired communication
- Optional 9V battery backup to maintain wireless link during a main 7.2V power loss
- LED scheme displays the status of the Robot, VEXnet link, and Game (Competition Mode)

---

1. Begin by verifying that both the Cortex and VEXnet Joystick are connected to charged batteries.

1a. Connect a Battery to the Cortex
Connect a 7.2V robot battery to the Cortex, but do not power it ON.

1b. Install Batteries in the VEXnet Remote Control
Remove the battery cover plate on the remote control. Install 6 AAA batteries, and replace the battery cover plate. Do not power the remote control ON.

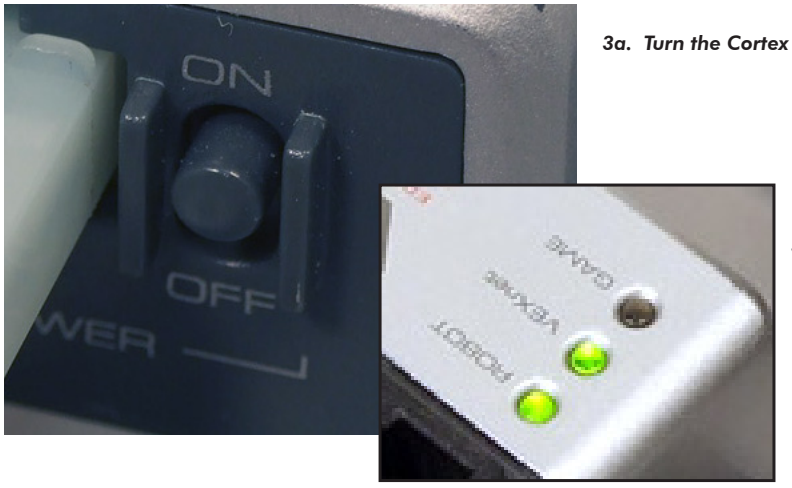
VEXnet Joystick Configuration in ROBOTC *(cont.)*

2. Tether the USB port on the VEXnet Joystick to the USB port on the Cortex using a USB A-to-A cable.

2a. VEXnet Joystick USB Port
Plug one end of the USB A-to-A cable into the USB port on the VEXnet Joystick.

2b. VEX Cortex USB Port
Plug the other end of the USB A-to-A cable into the USB port on the VEX Cortex.

3. Power the Cortex ON. After a few seconds, ROBOT and VEXnet LEDs will blink green, indicating that the Cortex and VEXnet Joystick have successfully paired.

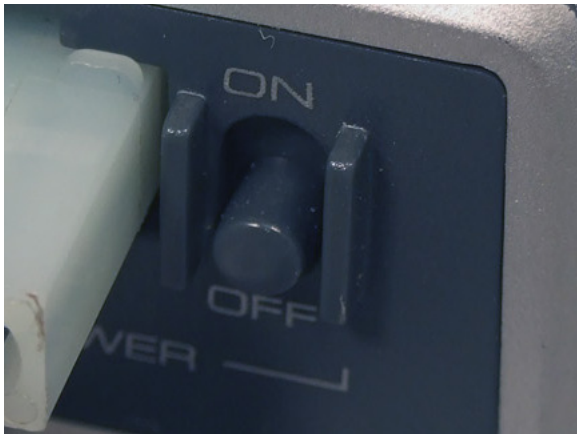


3a. Turn the Cortex ON

3b. Status LEDs
The ROBOT and VEXnet LEDs will blink green once the Cortex and VEXnet Joystick have successfully paired. The GAME LED will also blink green if a program is stored on your Cortex.

VEXnet Joystick Configuration in ROBOTC *(cont.)*

4. Turn the Cortex OFF.



5. Remove the USB A-to-A cable from the VEXnet Joystick and Cortex.

6. Insert VEXnet USB Keys into both the VEXnet Joystick and Cortex.

6. VEXnet USB Keys
Insert VEXnet USB Keys into the VEXnet Joystick and Cortex.

> ***Note:***
> It does not matter which VEXnet USB Key you insert into the Cortex versus the VEXnet Joystick. Pairing the Cortex and VEXnet Joystick establishes the link; the VEXnet USB Keys simply act as antennas for the link.

VEXnet Joystick Configuration in ROBOTC *(cont.)*

7. Power the Cortex and Joystick ON. After roughly 15 seconds, the ROBOT and VEXnet LED's will blink green, indicating that the VEXnet communication link has been established.

7a. Turn the Cortex ON

7b. Turn the VEXnet Joystick ON

7c. Status LEDs
After roughly 15 seconds, the ROBOT and VEXnet status LEDs will start quickly blinking green. With the VEXnet link established, you should power OFF your Cortex and VEXnet Joystick to preserve battery.

End of Section: Creating a Wireless Link between the VEXnet Joystick and VEX Cortex

Your VEXnet Joystick and VEX Cortex can now communicate over the VEXnet USB Keys. Move on to the next section to calibrate the values your VEXnet Joystick sends out.

VEXnet Joystick Configuration in ROBOTC *(cont.)*

Section 3: Calibrating the VEXnet Joystick Values

This section contains the procedure for calibrating the VEXnet Remote Control joysticks. Some steps are time-sensitive, so it's recommended that you read through the instructions once before following along.

The VEXnet Remote Control includes two joysticks (each having an X and Y-axis), 8 buttons on the front, and 4 additional trigger buttons on the top. Inside, there is also 3-Axis accelerometer, capable of providing X-Y-Z acceleration values. Values from the joysticks, buttons, and accelerometer are sent as a constant stream of information over VEXnet to the robot, enabling a user to control the robot in real-time.

To ensure that the VEXnet Joystick sends out accurate joystick values, the joysticks must be calibrated before their first use, and after any firmware updates are applied.

You will need:

- A VEXnet Joystick with batteries
- A VEX Cortex with robot battery
- A small Allen wrench (1/16" or smaller) or paper clip

---

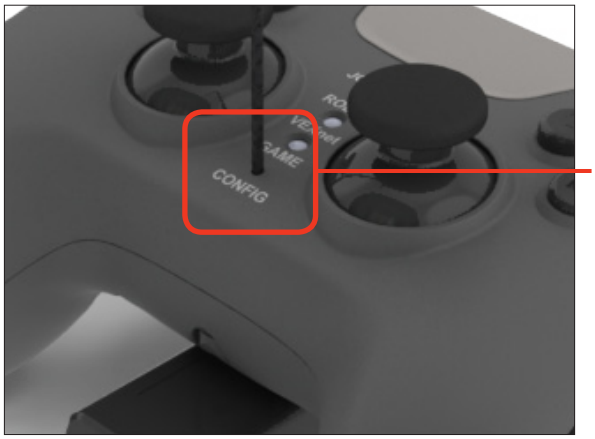
1. Power on the VEXnet Joystick and VEX Cortex. Allow them to sync over VEXnet.

VEXnet Joystick Configuration in ROBOTC *(cont.)*

2. Press and hold the **6U** trigger button.

2. Press and hold the 6U trigger button

3. While keeping the **6U** trigger button pressed in, use your Allen wrench or paper clip to press in the internal **CONFIG** button until the **JOYSTICK** LED blinks red and green.



3a. Press and the CONFIG button
While still pressing in the 6U trigger button, use an Allen wrench or paper clip to press in the CONFIG button.

3b. JOYSTICK LED
Once the JOYSTICK LED begins to blink red and green, release both the 6U and CONFIG buttons.

VEXnet Joystick Configuration in ROBOTC *(cont.)*

> ***Important - Time Sensitive Instructions***
> There is a 10 second time limit to complete steps 4 and 5. If they are not completed in time, the calibration process will timeout and the **VEXnet** LED will blink red briefly.

4. Move both joysticks through their full ranges of motion. When the remote control detects that the joysticks have been fully rotated, the **JOYSTICK** LED stops blinking red and green, and switches to a solid green.

4a. Move the Joysticks
Move the joysticks through their full ranges of motion - Up, Down, Left, Right, and in a circle.

4b. JOYSTICK LED
Once the remote control detects that the joysticks have been fully rotated, the JOYSTICK LED switches to solid green, indicating that you can stop moving the joysticks.

VEXnet Joystick Configuration in ROBOTC *(cont.)*

5. Press the **8U** button to save the new calibration.

5. Save
Press the 8U button to save the joystick calibration on your remote control. The JOYSTICK LED will blink green for a few seconds.

Additional Information

- If the calibration is not saved, the process will timeout after 10 seconds and the **VEXnet** LED will blink red.
- To cancel a calibration, press the **7U** button. The calibration process will be discontinued and the **VEXnet** LED will blink red.
- Once the calibration is discontinued or saved, all of the remote control LEDs will resume their normal function.
- The joysticks must be calibrated any time the firmware on the remote control is downloaded.

End of Section: Calibrating the VEXnet Joystick Values
The joysticks on your VEXnet Joystick are now properly calibrated and ready to be used to remote control your robot. If you had any issues during the process, troubleshooting tips can be found on the following page.

VEXnet Joystick Configuration in ROBOTC *(cont.)*

Troubleshooting

Issue: Slow blinking green ROBOT light on the Cortex
Solution: Download the Cortex Master Firmware using ROBOTC.

Issue: Slow blinking ROBOT green light on the VEXnet Joystick
Solution: Push and hold CONFIG button for about 5 seconds, until the status LEDs starts blinking green. Release it, wait for another 5 seconds, and then turn the VEXnet Joystick OFF and then back ON. If that fails, download the VEXnet Joystick Firmware using ROBOTC.

Issue: Yellow or red ROBOT light on the Cortex
Solution: Make sure you are using fully charged Robot battery.

Issue: Yellow or red ROBOT light on the VEXnet Joystick, even though they are both green on the Cortex.
Solution: Power cycle both the VEXnet Joystick and CORTEX.

Master Firmware Download Instructions

In this document, you will learn how to download the IFI Master CPU Firmware to the VEX Microcontroller.

What is the Master Firmware?

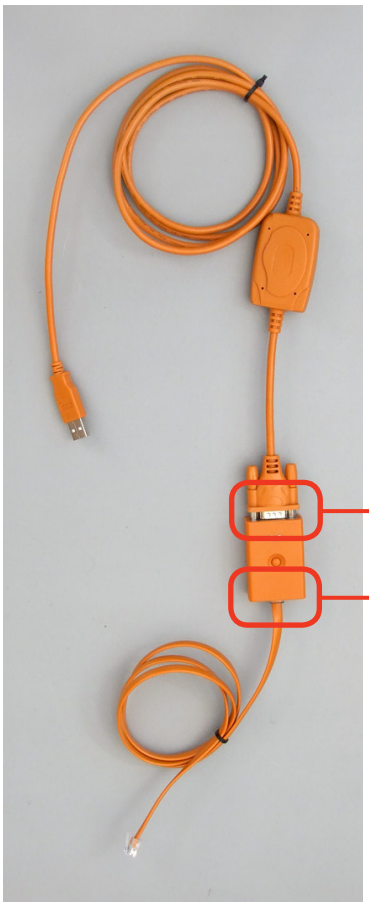
The VEX Microcontroller contains two processors: a user processor that handles all of the ROBOTC instructions, and a **master processor** that handles lower-level operations like motor control and radio communication. The **IFI Master CPU Firmare**, or master firmware, is a program that allows the master processor to complete the lower-level operations. Every VEX Microcontroller is preloaded with a version of the master firmware, but downloading the latest version will ensure that your robot is compatible with the latest hardware available.

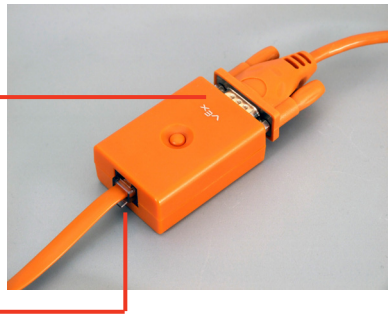
Before you begin, make sure:

- Your VEX is connected to a charged battery
- You have an orange USB-to-Serial programming cable
- ROBOTC 2.0 or later is installed on your computer

---

1. Plug the Robot Interface ("telephone") Cable and the USB-to-Serial cable into the Programming Module.





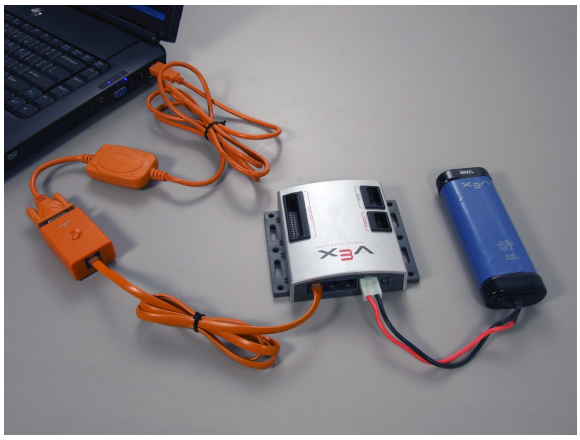
1a. Connect USB-to-Serial Cable to Programming Module
Plug the 9-pin Serial end of the USB-to-Serial Cable into the matching port on the Programming Module.

1b. Connect Robot Interface Cable to Programming Module
Plug the end of the RJ25 "telephone" cable into the matching port on the Programming Module.

Master Firmware Download Instructions *(cont.)*

2. Power the VEX Microcontroller and connect it to your computer using the orange USB-to-Serial programming cable.

2a. Power the VEX Microcontroller
Connect the VEX Microcontroller to a charged 7.2V battery and turn it ON.



2b. Connect the VEX to the Computer
Use the orange USB-to-Serial programming cable to connect the VEX to your computer. If you are using the VEXnet Microcontroller Upgrade, temporarily unplug it from the SERIAL port.

Note: You must have the driver for the USB-to-Serial programming cable installed on your computer. You can download the driver at www.ROBOTC.net.

Drivers Needed

When you plug in the **USB-to-Serial Cable**, your computer may prompt you to **install new hardware**.

If this happens, it is because your computer does not have the proper **drivers** installed to operate the USB-to-Serial Cable.

Complete the steps in the **Driver Installation Guide** to install the drivers, then continue with this lesson.

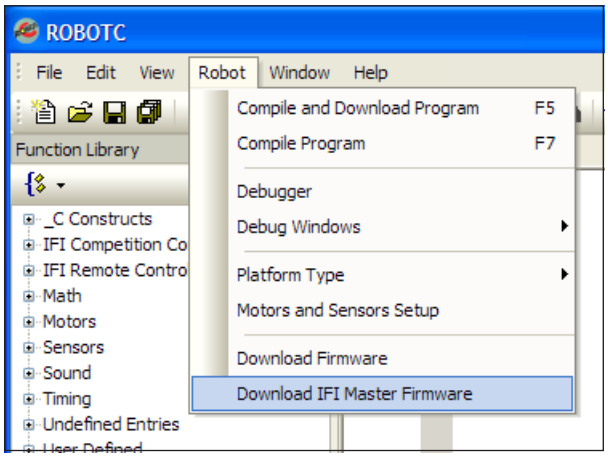
Master Firmware Download Instructions *(cont.)*

3. Open ROBOTC for IFI.

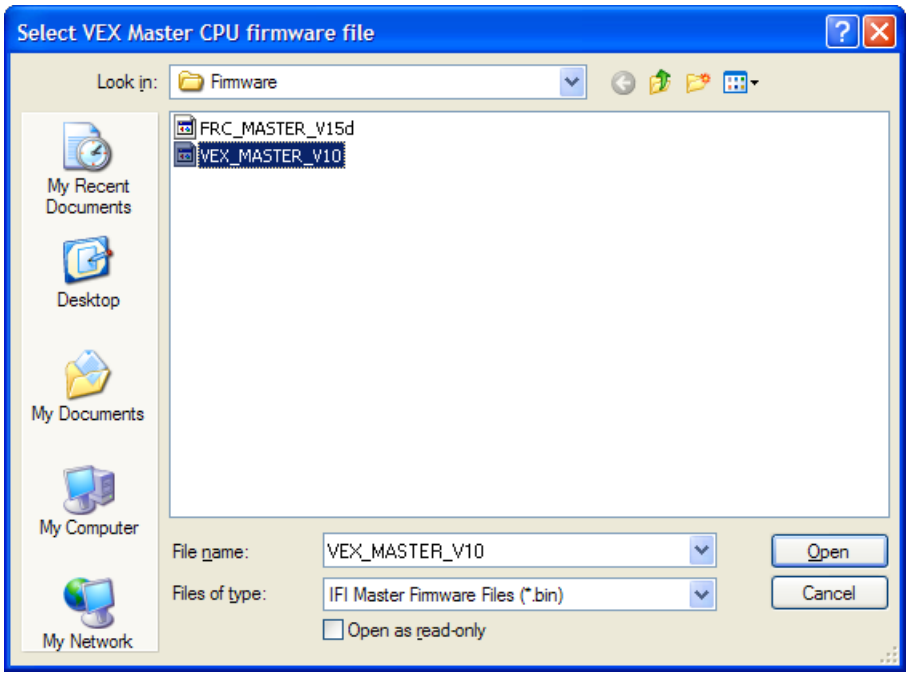
3. Open ROBOTC for IFI
Open *ROBOTC for IFI* from your Desktop or Start Menu.

---

4. Download the master firmware to the VEX Microcontroller.



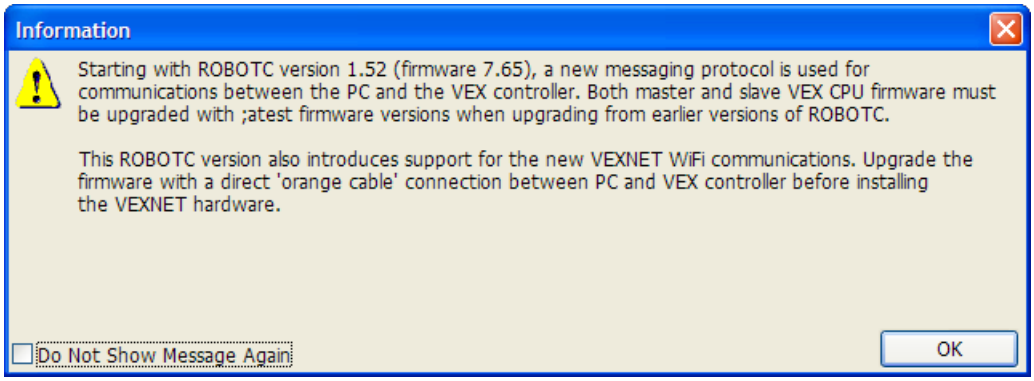
4a. Download IFI Master CPU Firmware
Go to *Robot* and select *Download IFI Master CPU Firmware*.



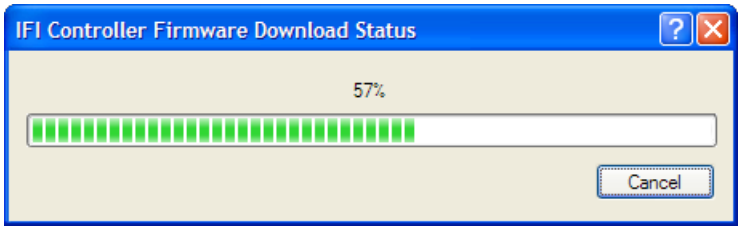
4b. Select the Master Firmware File
Choose the file that begins with *VEX_MASTER* and has the highest version number available.

Press *Open* to start the download.

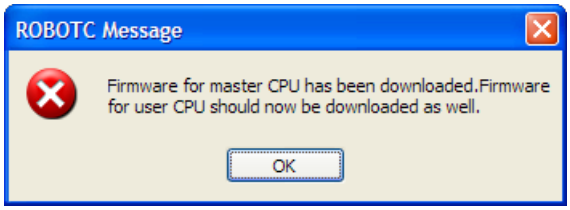
Master Firmware Download Instructions *(cont.)*



4c. OK the Information Window
An information window may appear with details about the VEXnet communication system. Press ***OK*** to close it.



4d. IFI Controller Firmware Download Status
The ***IFI Controller Firmware Download Status*** will appear and begin the download.



4e. ROBOTC User Firmware Reminder
Once the master firmware is finished downloading, a ROBOTC Message window will appear, reminding you to download the ROBOTC user firmware.

End of Section

Your robot now has the latest master firmware. Move on to the next lesson to download the ROBOTC user firmware to your robot.

Download ROBOTC User Firmware

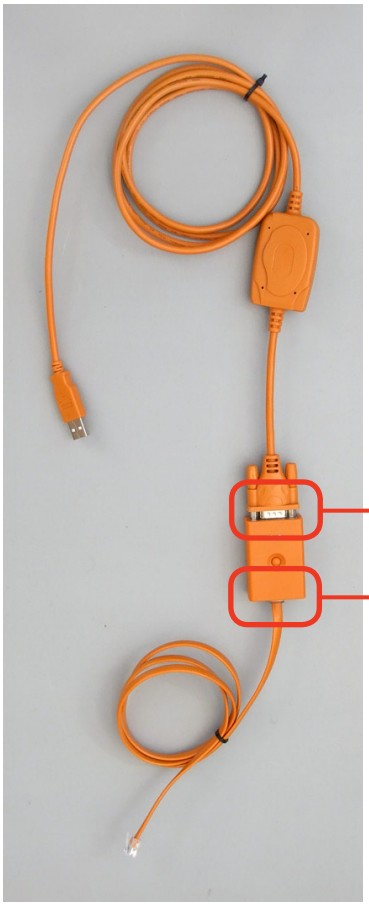
In this lesson, you will learn how to connect your VEX Microcontroller to the PC and load the ROBOTC User firmware onto it, allowing the robot to run ROBOTC programs.

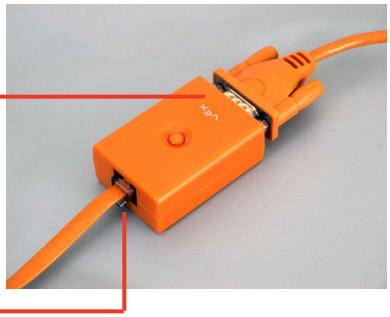
You will need:

- Your VEX Microcontroller
- A computer with *ROBOTC for IFI* 2.0 or later installed
- A VEX Programming Kit (1 USB-to-Serial cable, 1 VEX Robot Interface ("telephone") Cable, 1 VEX Programming Module)

---

1. Plug the Robot Interface ("telephone") Cable and the USB-to-Serial cable into the Programming Module.



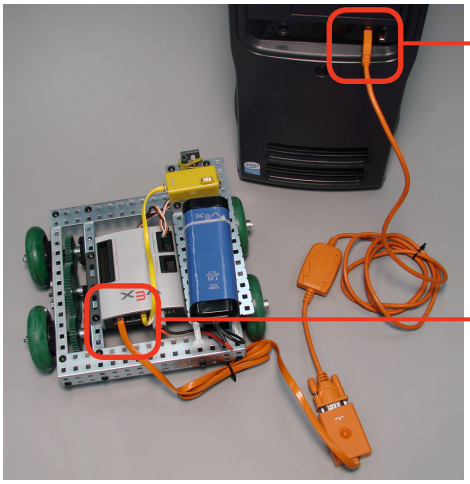


1a. Connect USB-to-Serial Cable to Programming Module
Plug the 9-pin Serial end of the USB-to-Serial Cable into the matching port on the Programming Module.

1b. Connect Robot Interface Cable to Programming Module
Plug the end of the RJ25 "telephone" cable into the matching port on the Programming Module.

Download ROBOTC User Firmware *(cont.)*

2. Plug the free USB connector end of the Programming cable into a USB port on your computer. Plug the other unconnected end of the cable into the "SERIAL" port of your VEX Microcontroller.



2a. Connect USB to PC
Plug the remaining USB connector on the USB-to-Serial Cable into the PC.

2b. Connect "phone" to VEX
Plug the loose RJ25 "phone" connector into the SERIAL port on the VEX Microcontroller.

Drivers Needed Error

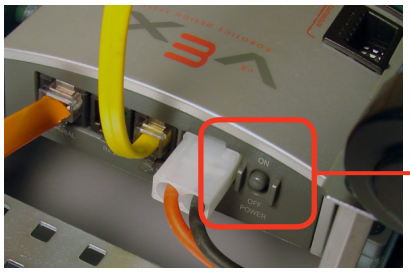
When you plug in the **USB-to-Serial Cable**, your computer may prompt you to **install new hardware**.

If this happens, it is because your computer does not have the proper **drivers** installed to operate the USB-to-Serial Cable.

Complete the steps in the **Driver Installation Guide** to install the drivers, then continue with this lesson.

Download ROBOTC User Firmware *(cont.)*

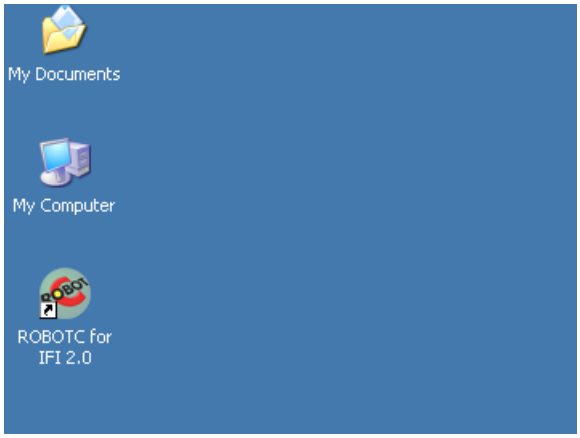
3. If the VEX Microcontroller is not already turned on, turn it on now.



3. Turn the VEX Microcontroller on
Flip the small switch on your VEX Microcontroller to turn your robot on, if it is not on already. Make sure that a charged battery pack is connected.

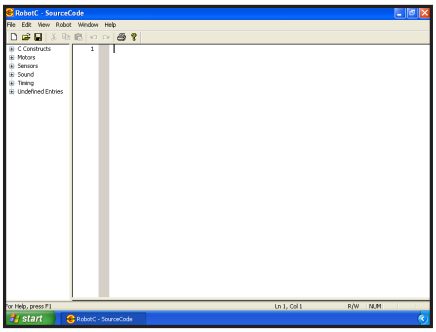
---

4. Open ROBOTC for IFI and make sure it is configured to work with the VEX Microcontroller.



4a. Open ROBOTC for IFI
Open *ROBOTC for IFI* from your Desktop or Start Menu.

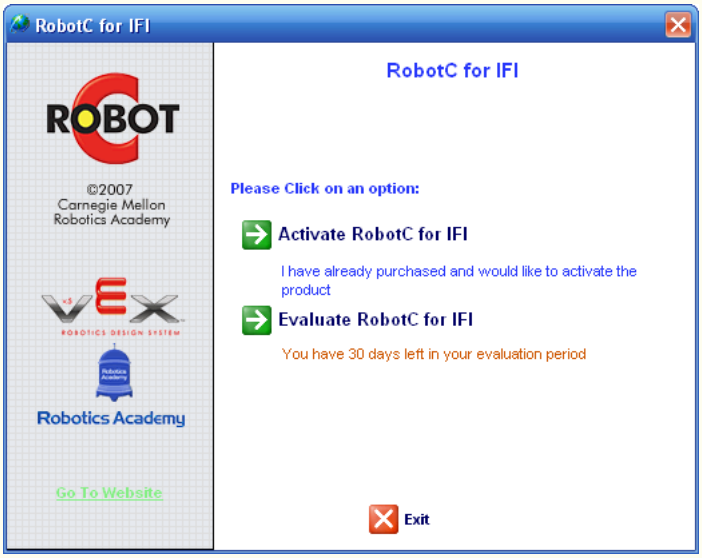
Checkpoint. Your screen should like like one of the screens below. The ROBOTC dialog box (left) will disappear after a few seconds. What is left is the main ROBOTC window (right).



Download ROBOTC User Firmware *(cont.)*

ROBOTC Registration

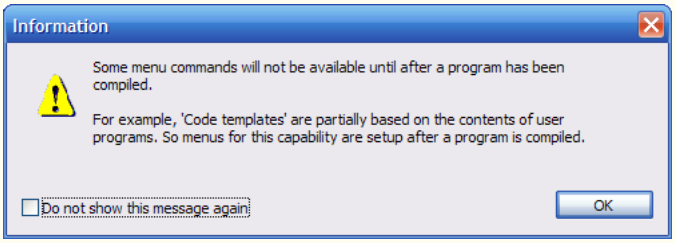
If you have not yet registered your copy of ROBOTC, the window below will appear when you run ROBOTC.



Follow the instructions printed on your CD case or online at www.robotc.net to activate your copy of ROBOTC.

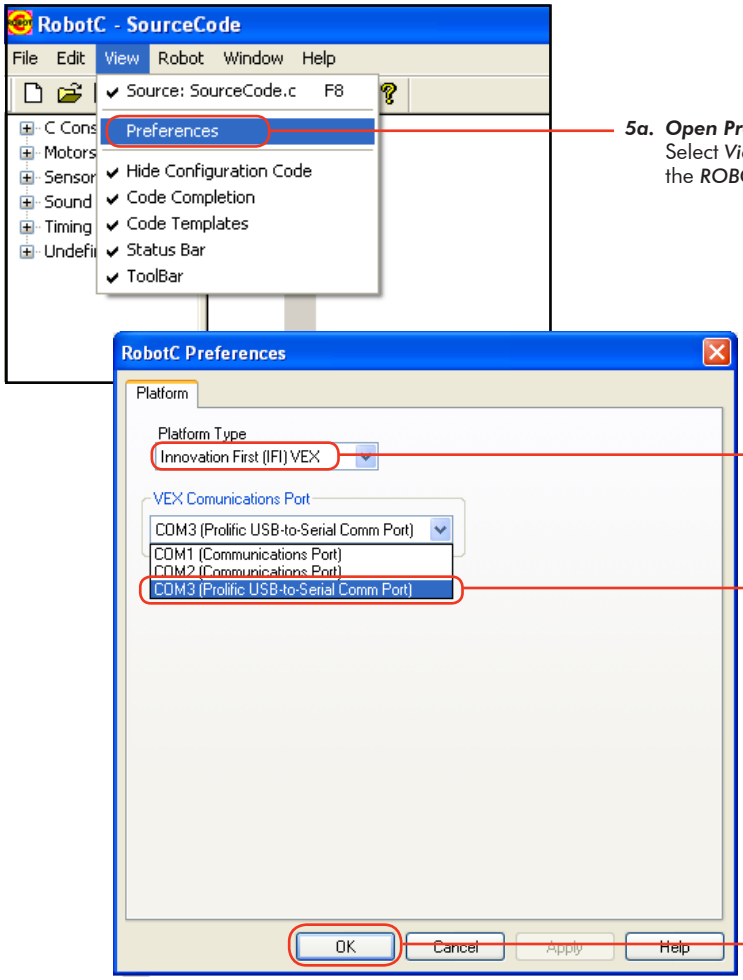
Information Box

A message that ROBOTC commands are unavailable may also appear. This is normal. Click OK to acknowledge and dismiss the message.



Download ROBOTC User Firmware *(cont.)*

5. Now that ROBOTC is open, go to the ***View menu*** and select ***Preferences***. A new window with a ***Platform*** tab appears. Select the platform type and COM port for your robot.



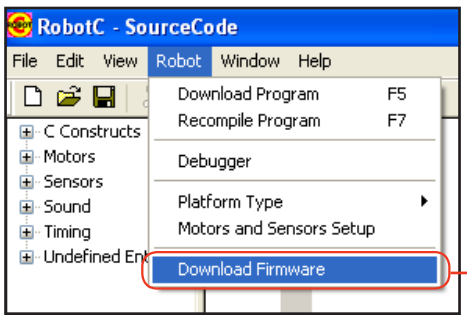
5a. Open Preferences window
Select *View* > *Preferences* to open the *ROBOTC Preferences* window.

5b. Choose Platform Type
Select *Innovation First (IFI) VEX* as the *Platform Type*.

5c. Choose VEX Communications Port
Select the correct COM port. The port with the USB-to-serial cable will contain the phrase: *"Prolific USB-to-Serial Comm Port"*.

5d. Save your preferences
Choose *OK* to save your changes and exit the *RobotC Preferences* dialog box.

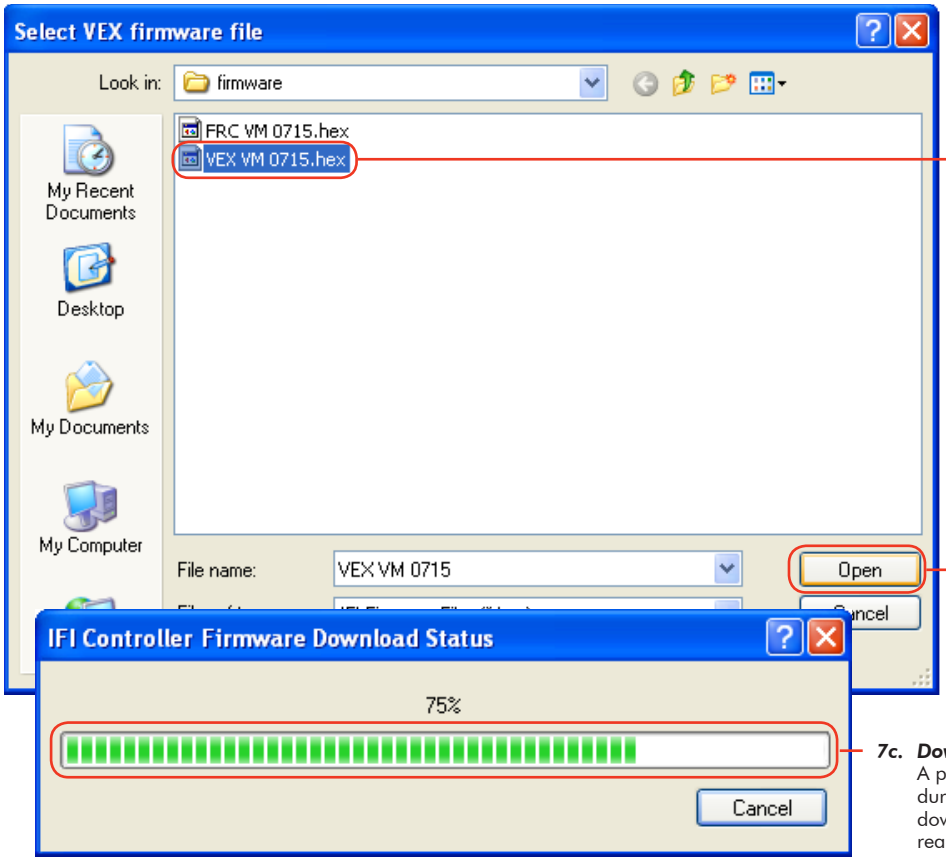
6. From the ***Robot*** menu, select ***Download Firmware***.



6. Download Firmware
Select *Robot* > *Download Firmware* to open up the *Select VEX firmware file* window.

Download ROBOTC User Firmware *(cont.)*

7. The ***Select VEX firmware file*** window appears. The VEX firmware file starts with "VEX" and has a number. If more than one file starts with "VEX", choose the one with the highest number. Choose ***Open*** to start downloading the VEX firmware.

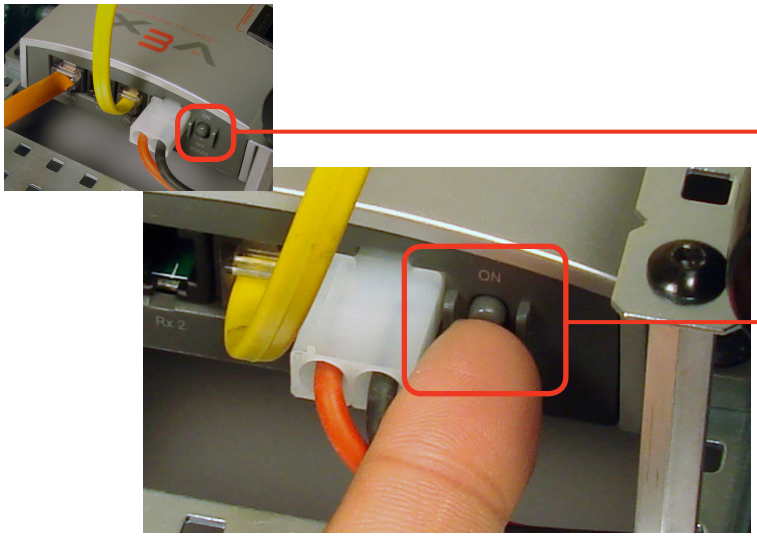


7a. Select the firmware
Choose the VEX firmware file with the highest number following it.

7b. Open the file
Click ***Open*** to begin downloading the firmware file you selected.

7c. Download the firmware
A progress bar will appear during the download. The download has completed after it reaches 100% and closes.

8. Restart your VEX Microcontroller to complete the download firmware process.



8a. Turn the power off
Flip the small switch on the the VEX Microcontroller to the "Off" position to turn off the power to your robot.

8b. Turn the power on
Flip the switch to the "On" position to turn the power to your robot back on. You should now be able to program your robot using ROBOTC.

Download ROBOTC User Firmware *(cont.)*

End of Section

Your robot is now ready to run ROBOTC programs. The **firmware** you downloaded in this lesson tells the robot how to **"speak" ROBOTC**. Any time you want to switch programming languages, you may be required to load the appropriate firmware for that language.

In the next lesson, you will download a **program** to the robot. Whereas the firmware tells the robot how to "speak" a certain programming language, the program gives it an actual set of instructions to follow.

VEXnet Upgrade Installation Instructions

In this document, you will learn how to install the VEXnet Upgrades on both the VEX Microcontroller and the Radio Control Transmitter. This document assumes that you have already downloaded the Master Firmware to your VEX Microcontroller.

What is VEXnet?

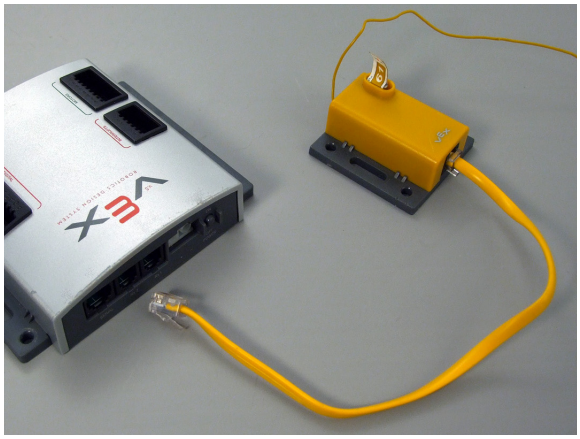
VEXnet is an 802.11 WiFi replacement for the crystal-based communication system between the VEX Microcontroller and Radio Control Transmitter. The **VEXnet Upgrade** enables users to convert existing Microcontrollers and Transmitters to the VEXnet communication system.

Additional VEXnet features include:

- Easy to connect (No IP addresses, MAC addresses, passwords, or special security modes)
- Multiple layers of security built-in and always on
- No wireless access point needed; each VEXnet pair makes its own private network
- Hundreds of robots can operate at once; every VEXnet robot has a hidden unique ID
- Optional tether for wired communication
- Two user selectable channels and one private channel for competitions
- Optional 9V battery backup to maintain wireless link during a main 7.2V power loss
- LED scheme displays the status of the Robot, VEXnet link, and Game (Competition Mode)

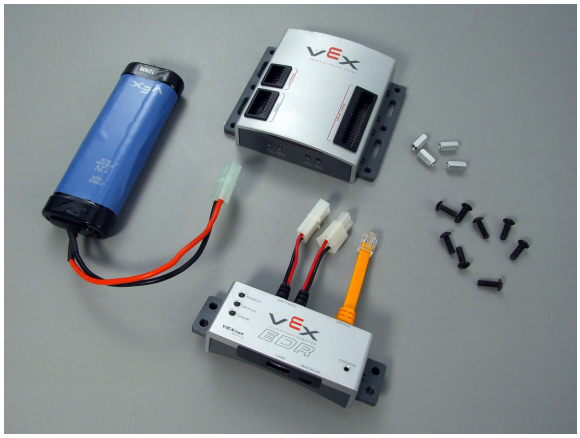
Part I. Installing the VEXnet Upgrade on the Microcontroller

1. Begin by removing any of the 75MHz crystal receivers from your Microcontroller.



VEXnet Upgrade Installation Instructions *(cont.)*

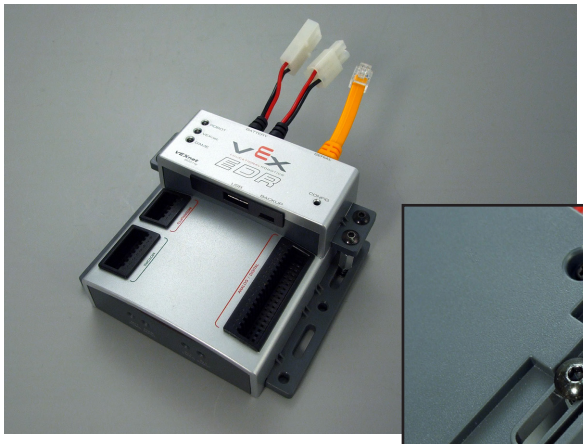
2. Attach the VEXnet Upgrade to the top of the Microcontroller.



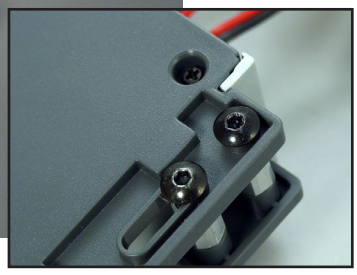
2a. Collect the Parts
Gather the following parts before moving on:

- **1** Microcontroller
- **1** VEXnet Microcontroller Upgrade
- **8** 3/4″ 8-32 Screws
- **4** 1/2″ Standoffs
- **1** 7.2V Battery

2b. Secure Components to the VEXnet Upgrade
Use four of the screws to attach the 1/2″ standoffs to the VEXnet upgrade.



2c. Place the VEXnet Upgrade
Align the back of the VEXnet Upgrade with the back of the Microcontroller.

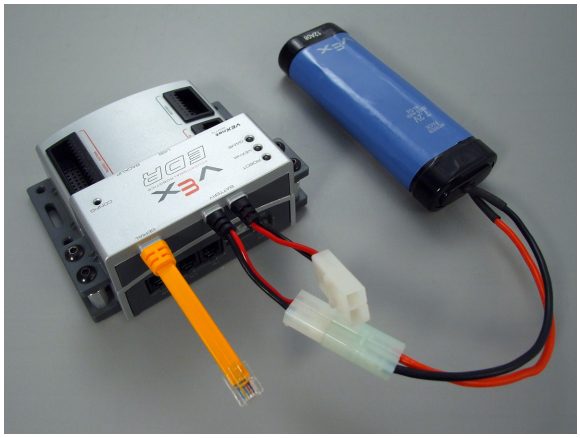


2d. Secure the VEXnet Upgrade
Use the four remaining screws to attach the VEXnet Upgrade to the Microcontroller.

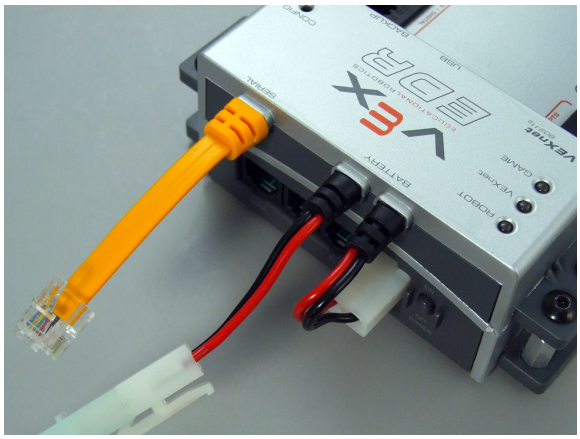
Note: When securing the VEXnet Upgrade and Microcontroller assembly to your robot, the bottom four screws can be removed, inserted through a section of the robot chassis, and then reconnected to the bottom of the assembly.

VEXnet Upgrade Installation Instructions *(cont.)*

3. Power the Microcontroller and VEXnet upgrade with the 7.2V battery.

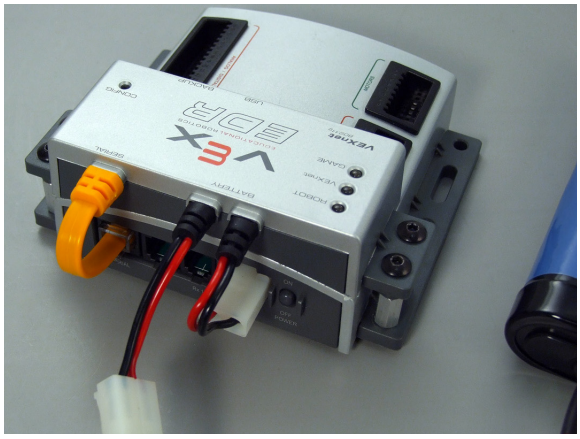


3a. Power the VEXnet
Connect the battery to the VEXnet Upgrade.



3b. Power the Microcontroller
Connect the battery wire coming from the VEXnet Upgrade to the Microcontroller. The ON/OFF switch on the Microcontroller controls the power to the Microcontroller and the VEXnet Upgrade.

4. Connect the yellow VEXnet cable to the SERIAL port on the Microcontroller.



VEXnet Upgrade Installation Instructions *(cont.)*

5. Connect a VEXnet USB adapter to the VEXnet Microcontroller Upgrade.

5a. Apply the Velcro
Attach the Velcro loop piece (fuzzy) to the USB adapter and the hook piece (bristly) to the Microcontroller so they will align once the USB adapter is inserted into the VEXnet Upgrade. This will ensure that the adapter will not get disconnected while the robot is running.

Note: It does not matter which VEXnet USB adapter you use.

5b. Insert the USB Adapter
If you are connecting a VEXnet Microcontroller Upgrade that was packaged with the Transmitter Upgrade, insert the USB adapter now. If not, or if you are unsure, you can wait to insert the USB adapter until you manually pair the Transmitter and Microcontroller Upgrades (Part III of this document).

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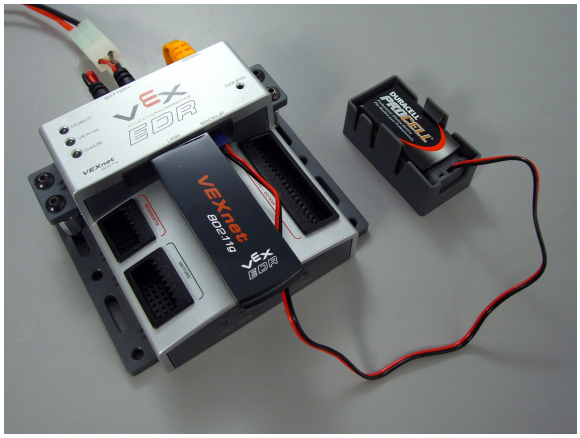
6. (Optional) Connect the 9V backup battery to the VEXnet Upgrade.

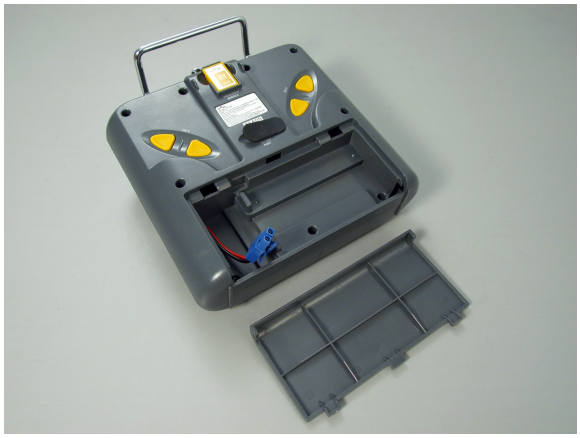


6. Connect the 9V Backup Battery
The backup battery maintains VEXnet communication in the event of a main power loss and is mandatory during official VEX competitions, but optional in classroom use. Connect the backup battery to the front of the VEXnet Upgrade. (The battery is not included with kit.)

VEXnet Upgrade Installation Instructions *(cont.)*

Part II. Installing the VEXnet Upgrade on the Transmitter

1. Begin by removing the battery door and crystal on the back of the Transmitter.



1a. Remove the Battery Door
Slide the battery door down to remove it from the Transmitter. The VEXnet Upgrade will replace it.

1b. Remove the Crystal
Pull the crystal from the back of the Transmitter to remove it.

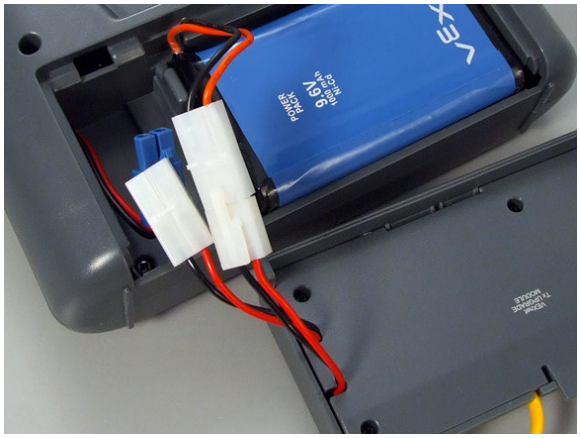
---

2. Place the 9.6V rechargeable battery in the battery compartment.

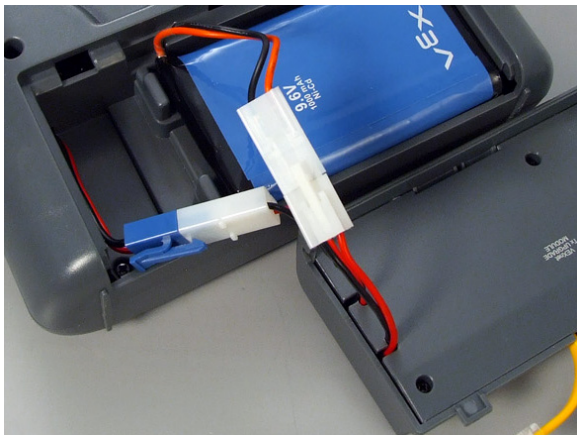
2. Place the Battery
Place the 9.6V rechargeable battery in the battery compartment, but **DO NOT connect it to the Transmitter**. Note that the VEXnet upgrade will not work with the AA battery holder.

VEXnet Upgrade Installation Instructions *(cont.)*

3. Power the Transmitter and VEXnet upgrade with the 9.6V battery.



3a. Power the VEXnet
Connect the battery to the VEXnet Upgrade.



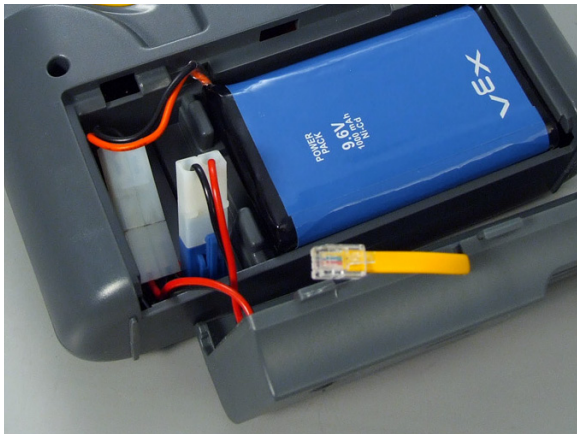
3b. Power the Transmitter
Connect the battery wire coming from the VEXnet Upgrade to the Transmitter.

3c. Controlling the Power
The ON/OFF switch on the VEXnet Upgrade controls the power to the Transmitter and the VEXnet Upgrade, but the Transmitter must also be turned on to send and receive data.

You can leave the Transmitter ON/OFF switch in the ON position at all times, but remember to power down the VEXnet upgrade to conserve battery power.

VEXnet Upgrade Installation Instructions *(cont.)*

4. Install the VEXnet Transmitter Upgrade in place of the battery door.



4a. Use Caution...
Be careful to route the wires so they won't get pinched.

4b. Install the VEXnet Upgrade
Slide the VEXnet Upgrade into the Transmitter to secure it.

5. Connect the short yellow wire on the VEXnet Upgrade to the TETHER PORT on the Transmitter.

VEXnet Upgrade Installation Instructions *(cont.)*

6. Connect a VEXnet USB adapter to the VEXnet Transmitter Upgrade.

6a. Apply the Velcro
Attach the Velcro loop side (fuzzy) to the USB adapter and insert the hook side (bristly) into the slot on the the VEXnet adapter so they will align once the USB adapter is inserted.

Note: It does not matter which VEXnet USB adapter you use.

6b. Insert the USB Adapter
If you are connecting a VEXnet Transmitter Upgrade that was packaged with the Microcontroller Upgrade, insert the USB adapter now. If not, or if you are unsure, you can wait to insert the USB adapter until we manually pair the Transmitter and Microcontroller Upgrades (Part III of this document).

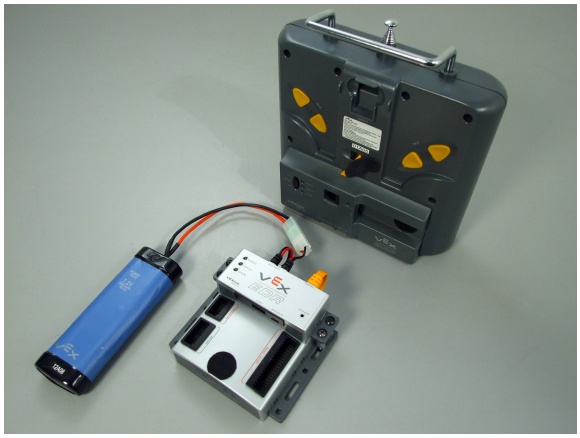
VEXnet Upgrade Installation Instructions *(cont.)*

Part III. Manually Pairing the Microcontroller and Transmitter VEXnet Upgrades

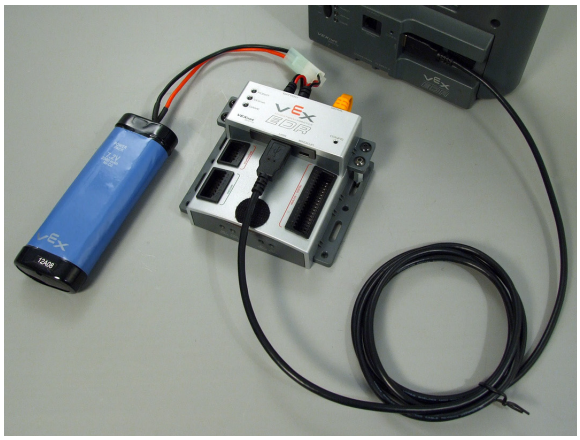
Important Note:

Bundled Microcontroller and Transmitter VEXnet Upgrades are preconfigured to automatically establish a link with each other. Only follow the steps to manually pair your VEXnet Upgrades if you are having trouble establishing a connection between them, or if you are using a Microcontroller VEXnet Upgrade that was NOT bundled with a corresponding Transmitter VEXnet Upgrade.

1. Remove the USB adapters from the Microcontroller and Transmitter VEXnet Upgrades.



2. Connect the Microcontroller and Transmitter VEXnet Upgrades using the USB cable.

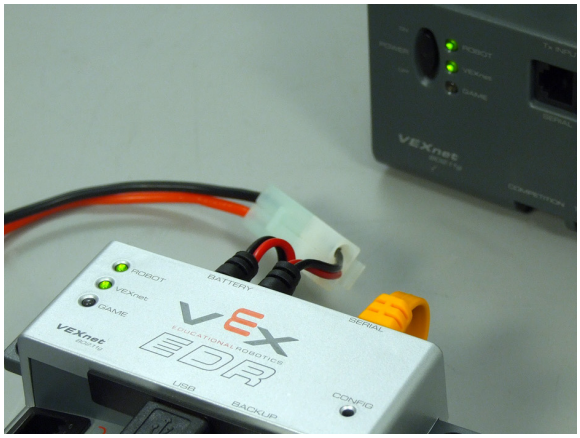


2. Connect the VEXnet Upgrades
Use the USB A-to-A cable to connect the Microcontroller and Transmitter VEXnet Upgrades.

VEXnet Upgrade Installation Instructions *(cont.)*

3. Turn on the Transmitter VEXnet Upgrade and allow them to pair.

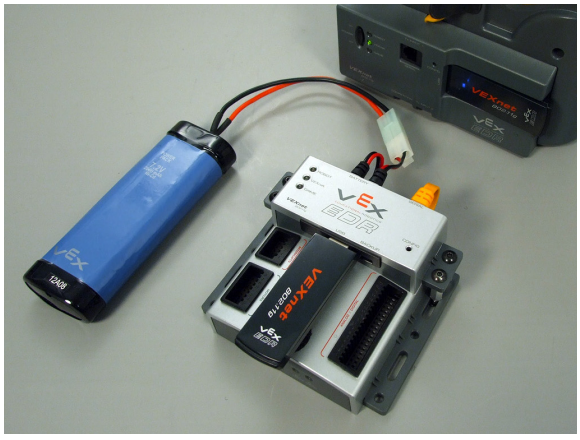
3a. Turn on the Transmitter VEXnet Upgrade
Slide the POWER switch of the VEXnet Upgrade to the ON position. Do NOT power the Microcontroller VEXnet Upgrade. Power from the Transmitter will turn on the Microcontroller VEXnet Upgrade.



3b. Allow the VEXnet Upgrades to Pair
The ROBOT and VEXnet status lights will blink yellow and red. When both lights turn green, the Transmitter and Microcontroller VEXnet Upgrades have successfully paired.

---

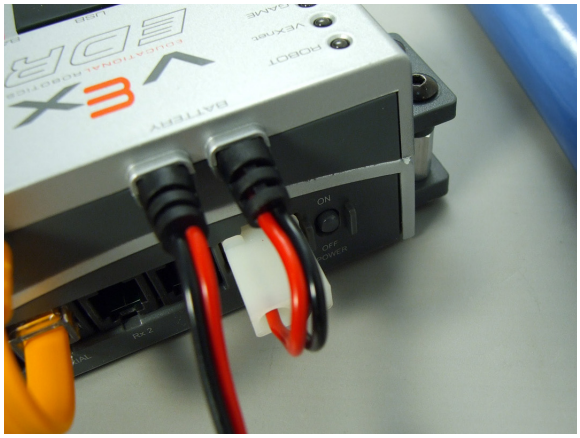
4. Remove the USB cable from the VEXnet Upgrades and replace both USB adapters.



VEXnet Upgrade Installation Instructions *(cont.)*

Part IV. Linking the Microcontroller and Transmitter VEXnet Upgrades

1. Begin turning on both of the VEXnet Upgrades.

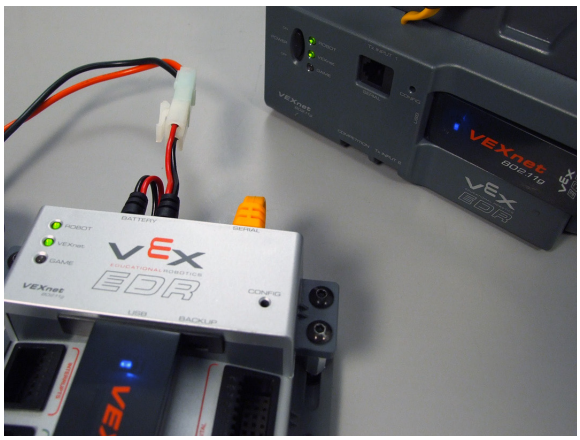


1a. Turn on the Microcontroller
Slide the POWER switch on the Microcontroller to the ON position to power it and the VEXnet Upgrade.

1b. Turn on the Transmitter
Slide both POWER switches on the Transmitter (front and back) to the ON position. (If your Transmitter was already on from Part III, turn it OFF and then back ON.)

---

2. Wait for the ROBOT and VEXnet status lights to turn green. When they turn green, the VEXnet Upgrades are finished linking.



2. Allow the VEXnet Upgrades to Link
The VEXnet status light will blink yellow while the link is being established. When the linking is complete, both the ROBOT and VEXnet status lights will be green.

Reserved Words

Motors

Motor control and some fine-tuning commands.

`motor[output] = power;`
This turns the referenced VEX motor output either on or off and simultaneously sets its power level. The VEX has 8 motor outputs: `port1`, `port2`... up to `port8`. The VEX supports power levels from -127 (full reverse) to 127 (full forward). A power level of 0 will cause the motors to stop.

```
motor[port3]= 127;    //port3 - Full speed forward
motor[port2]= -127;   //port2 - Full speed reverse
```

`bMotorReflected[output] = 1;` (or `0;`)
When set equal to one, this code reverses the rotation of the referenced motor. Once set, the referenced motor will be reversed for the entire program (or until bMotorReflected[] is set equal to zero).

This is useful when working with motors that are mounted in opposite directions, allowing the programmer to use the same power level for each motor.

There are two settings: `0` is normal, and `1` is reverse. You can use "true" for `1` and "false" for `0`.

Before:

```
motor[port3]= 127;     //port3 - Full speed forward
motor[port2]= 127;     //port2 - Full speed reverse
```

After:

```
bMotorReflected[port2]= 1;  //Flip port2's direction
motor[port3]= 127;          //port3 - Full speed forward
motor[port2]= 127;          //motorA - Full speed forward
```

Timing

The VEX allows you to use Wait commands to insert delays into your program. It also supports Timers, which work like stopwatches; they count time, and can be reset when you want to start or restart tracking time elapsed.

`wait1Msec(wait_time);`
This code will cause the robot to wait a specified number of milliseconds before executing the next instruction in a program. "wait_time" is an integer value (where 1 = 1/1000th of a second). Maximum wait_time is 32768, or 32.768 seconds.

```
motor[port3]= 127;      //port3 - full speed forward
wait1Msec(2000);        //Wait 2 seconds
motor[port3]= 0;        //port3 - off
```

Reserved Words

`wait10Msec(wait_time);`
This code will cause the robot to wait a specified number of hundredths of seconds before executing the next instruction in a program. "wait_time" is an integer value (where 1 = 1/100th of a second). Maximum wait_time is 32768, or 327.68 seconds.

```
motor[port3]= 127;      //port3 - full speed forward
wait10Msec(200);        //Wait 2 seconds
motor[port3]= 0;        //port3 - off
```

`time1[timer]`
This code returns the current value of the referenced timer as an integer. The resolution for "time1" is in milliseconds (1 = 1/1000th of a second).

The maximum amount of time that can be referenced is 32.768 seconds (~1/2 minute)

The VEX has 4 internal timers: `T1`, `T2`, `T3`, and `T4`

```
int x;          //Integer variable x
x=time1[T1];    //Assigns x=value of Timer 1 (1/1000 sec.)
```

`time10[timer]`
This code returns the current value of the referenced timer as an integer. The resolution for "time10" is in hundredths of a second (1 = 1/100th of a second).

The maximum amount of time that can be referenced is 327.68 seconds (~5.5 minutes)

The VEX has 4 internal timers: `T1`, `T2`, `T3`, and `T4`

```
int x;          //Integer variable x
x=time10[T1];   //Assigns x=value of Timer 1 (1/100 sec.)
```

`time100[timer]`
This code returns the current value of the referenced timer as an integer. The resolution for "time100" is in tenths of a second (1 = 1/10th of a second).

The maximum amount of time that can be referenced is 3276.8 seconds (~54 minutes)

The VEX has 4 internal timers: `T1`, `T2`, `T3`, and `T4`

```
int x;          //Integer variable x
x=time100[T1];  //assigns x=value of Timer 1 (1/10 sec.)
```

Reserved Words

`ClearTimer(timer);`
This resets the referenced timer back to zero seconds.

The VEX has 4 internal timers: `T1`, `T2`, `T3`, and `T4`

```
ClearTimer(T1); //Clear Timer #1
```

`SensorValue(sensor_input)`
SensorValue is used to reference the integer value of the specified sensor port. Values will correspond to the type of sensor set for that port.

The VEX has 16 analog/digital inputs: `in1`, `in2...` to `in16`

```
if(SensorValue(in1) == 1) //If in1 (bumper) is pressed
{
  motor[port3] = 127;     //Motor Port 3 full speed forward
}
```

Type of Sensor	Digital/Analog?	Range of Values
Touch	Digital	0 or 1
Reflection (Ambient)	Analog	0 to 1023
Rotation (Older Encoder)	Digital	0 to 32676
Potentiometer	Analog	0 to 1023
Line Follower (Infrared)	Analog	0 to 1023
Sonar	Digital	-2, -1, and 1 to 253
Quadrature Encoder	Digital	-32678 to 32768
Digital In	Digital	0 or 1
Digital Out	Digital	0 or 1

Sounds

The VEX can play sounds and tones using an external piezoelectric speaker attached to a motor port.

`PlayTone(frequency, duration);`
This plays a sound from the VEX internal speaker at a specific frequency (1 = 1 hertz) for a specific length (1 = 1/100th of a second).

```
PlayTone(220, 500); //Plays a 220hz tone for 1/2 second
```

Reserved Words

Radio Control

ROBOTC allows you to control your robot using input from the Radio Control Transmitter.

`bVexAutonomousMode`
Set the value to either `0` for radio enabled or `1` for radio disabled (autonomous mode). You can also use "true" for `1` and "false" for `0`.

```
bVexAutonomousMode = 0;   //enable radio control

bVexAutonomousMode = 1;    //disable radio control
```

`vexRT[joystick_channel]`
This command retrieves the value of the specified channel being transmitted.

If the RF receiver is plugged into Rx 1, the following values apply:

Control Port	Joystick Channel	Possible Values
Right Joystick, X-axis	Ch1	-127 to 127
Right Joystick, Y-axis	Ch2	-127 to 127
Left Joystick, Y-axis	Ch3	-127 to 127
Left Joystick, X-axis	Ch4	-127 to 127
Left Rear Buttons	Ch5	-127, 0, or 127
Right Rear Buttons	Ch6	-127, 0, or 127

If the RF receiver is plugged into Rx 2, the following values apply:

Control Port	Joystick Channel	Possible Values
Right Joystick, X-axis	Ch1Xmtr2	-127 to 127
Right Joystick, Y-axis	Ch2Xmtr2	-127 to 127
Left Joystick, Y-axis	Ch3Xmtr2	-127 to 127
Left Joystick, X-axis	Ch4Xmtr2	-127 to 127
Left Rear Buttons	Ch5Xmtr2	-127, 0, or 127
Right Rear Buttons	Ch6Xmtr2	-127, 0, or 127

```
bVexAutonomousMode = false;  //enable radio control
while(true)
{
  motor[port3] = vexRT[Ch3]; //right joystick, y-axis
                             //controls the motor on port 3
  motor[port2] = vexRT[Ch2]; //left joystick, y-axis
                             //controls the motor on port 2
}
```

Reserved Words

Miscellaneous

Miscellaneous useful commands that are not part of the standard C language.

`srand(seed);`
Defines the integer value of the "seed" used in the random() command to generate a random number. This command is optional when using the random() command, and will cause the same sequence of numbers to be generated each time that the program is run.

```
srand(16);   //Assign 16 as the value of the seed
```

`random(value);`
Generates random number between 0 and the number specified in its parenthesis.

```
random(100);   //Generates a number between 0 and 100
```

Control Structures

Program control structures in ROBOTC enable a program to control its flow outside of the typical top to bottom fashion.

`task main(){}`
Creates a task called "main" needed in every program. Task main is responsible for holding the code to be executed within a program.

`while(condition){}`
Used to repeat a {section of code} while a certain (condition) remains true. An infinite while loop can be created by ensuring that the condition is always true, e.g. "1==1" or "true".

```
while(time1[T1]<5000)//While the timer is less than 5 sec...
{
 motor[port3]= 127;//...motor port3 runs at 100%
}
```

`if(condition){}/else{}`
With this command, the program will check the (condition) within the if statement's parentheses and then execute one of two sets of code. If the (condition) is true, the code inside the if statement's curly braces will be run. If the (condition) is false, the code inside the else statement's curly braces will be run instead. The else condition is not required when using an if statement.

```
if(sensorValue(bumper) ==1)//the bumper is used as...
{                          //...the condition
 motor[port3]= 0;   //if it's pressed port3 stops
}
else
{
  motor[port3]= 127; //if it's not pressed port3 runs
}
```

Reserved Words

Data Types

Different types of information require different types of variables to hold them.

`int`
This data type is used to store integer values ranging from -32768 to 32768.

```
int x;   //Declares the integer variable x
x = 765; //Stores 765 inside of x
```

The code above can also be written:

```
int x = 765;  //Declares the integer variable x and...
              //...initializes it to a value of 765
```

`bool`
This data type is used to store boolean values of either 1 (also true) or 0 (also false).

```
bool x;       //Declares the bool variable x
x = 0;        //Sets x to 0
```

`char`
This data type is used to store a single ASCII character, specified between a set of single quotes.

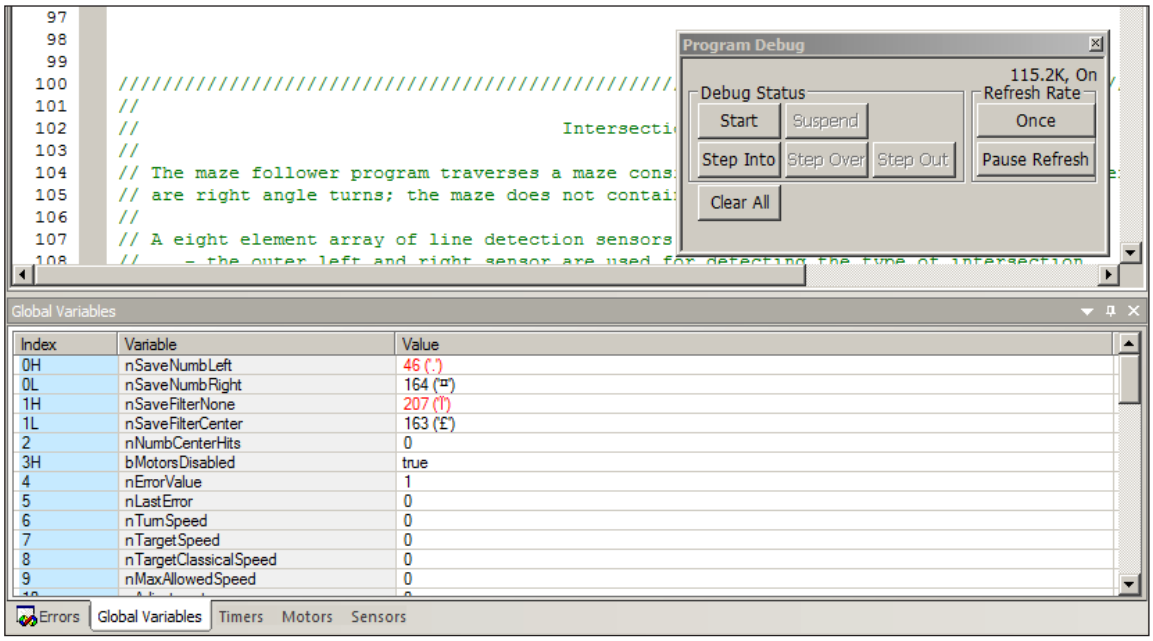
```
char x;       //Declares the char variable x
x = 'J';      //Stores the character J inside of x
```

The ROBOTC Debugger Overview

A "debugger" is a programming tool that enables you to quickly write and correct code, and allows you to interact with all of the inputs (sensors, timers, ect.) and ouputs (motors, LED's, ect.) connected to your VEX microcontroller.

ROBOTC has a debugging capability that enables unparalleled, interactive access to the robot as your program is running. Using the debugger will significantly reduce the time it takes to write programs and find erros in your code. With ROBOTC's real-time debugger you can:

- Start and stop your program from the computer
- "Single step" through your program, running one line of code at a time and examine the results (the values of variables, sensors, ect.) and the flow of execution
- Read and write the values of all the variables defined in your program
- Read the write the values of all the motors and sensors configured on your microcontroller



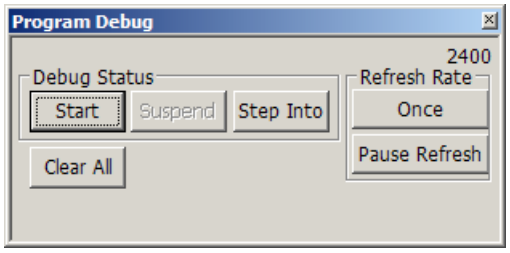
Note: Traditional Debugging Techniques
Debugging a program (finding the errors and correcting them) can be a slow process without a real-time debugger. Without a debugger you may have to resort to other techniques:

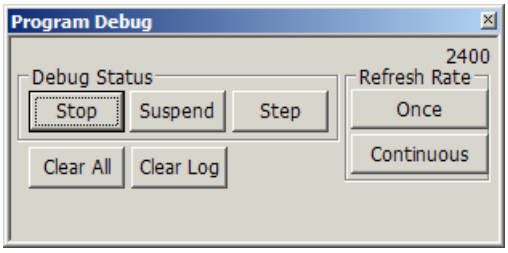
- Adding code to turn on different LED's as the microcontroller executes different sections of code. You then try to determine from the LED's what is being executed within your program.
- Adding "print" statements to your code at various points in the program, if your microcontroller has a display device. By examining the display, you can (hopefully) determine what is happening in your program.

Both of the above techniques are available in ROBOTC, but a real-time debugger eliminates the need to resort to them. There's no need to add code to debug your program!

The ROBOTC Debugger Program Debug Window

The Program Debug window appears every time you download a program to your VEX microcontroller, and is in control of the connection between your computer and robot controller. Closing it will terminate the connection between your computer and the robot controller, along with any other open debug windows.





Start / Stop
Pressing the Start button will start the program execution on your robot controller, and the text on button will change to "Stop". Pressing the Stop button will stop the program execution.

Suspend
Pressing the Suspend button will suspend (pause) the program execution on your robot controller.

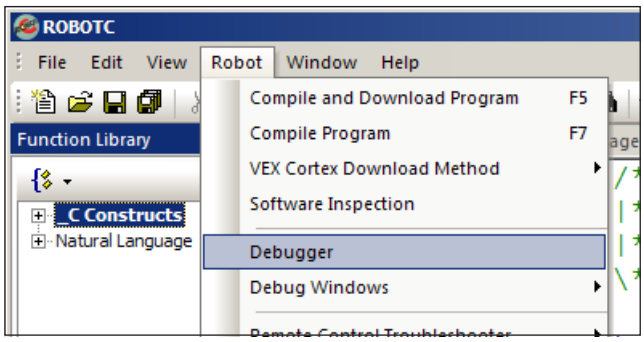
Step Into
Pressing the Step Into button will execute the next command in your program.

Clear All
The Clear All button will reset all of the values being displayed by the other debug windows.

Once
Pressing the Once button will update the values in the other debugger windows once.

Pause Refresh / Continuous
Pressing the Pause Refresh button will cause the values in the debugger windows to stop updating. Pressing it will also cause the text to change to "Continuous". Pressing the Continuous button will cause the values in the debugger windows to update continuously. Pressing it will also cause the text to change to "Pause Refresh".

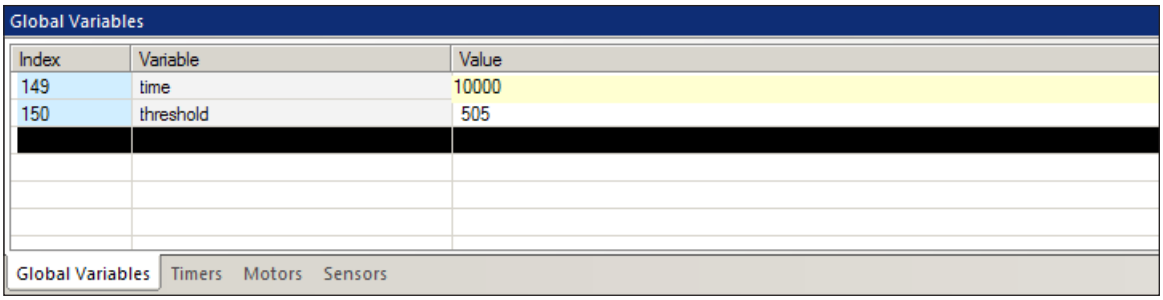
Note: For continuous value updates on the other debug windows, make sure the button says Pause Refresh, and not Continuous.



The recommended method of opening the Program Debug window, and establishing a connection with the robot is by downloading a program to the robot. However, the debugger can also be launched by selecting "Debugger" from the Robot menu in ROBOTC.

The ROBOTC Debugger Global Variables

The Global Variables window displays the current values of every variable declared in your program. Using the ROBOTC debugger, not only can you view the variable's names and values, you can also change their values in real-time. To change the value of one of the variables, select the Value box of the variable you'd like to change, type in the new value, and press Enter on your keyboard.

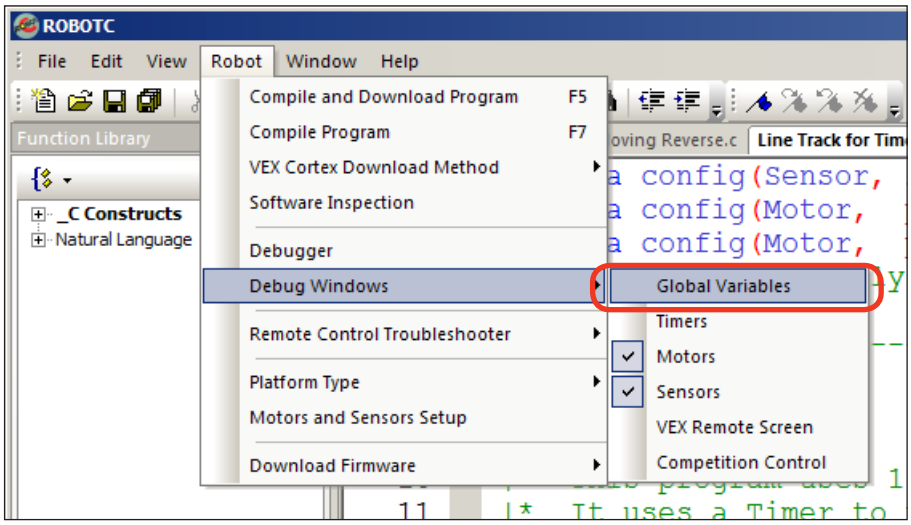


Index
The index of the variable, in memory.

Variable
The name of the variable, defined in the program.

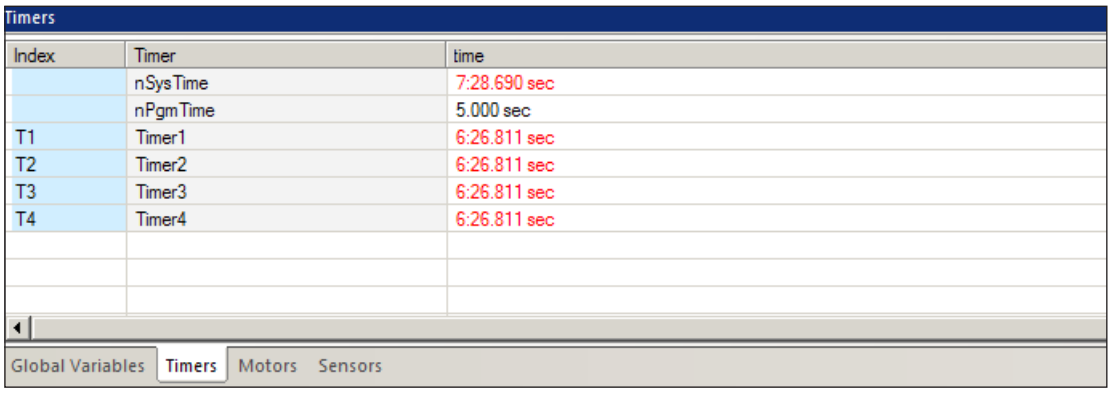
Value
The value of the variable during program execution. Values will update automatically if the Program Debug window is set to update continuously.

The Global Variables window can be opened by going to the Robot menu, Debug Windows, and selecting Global Variables.



The ROBOTC Debugger Timers

The Timers debug window provides access to current values of the timers built-in to your microcontroller. On the VEX Cortex, there are 4 user-accessible timers (T1, T2, T3, and T4), and two system timers (nSysTime and nPgrmTime). The 4 user-accessible timers can be modified in real-time using the Timers debug window, but the two system timers cannot.

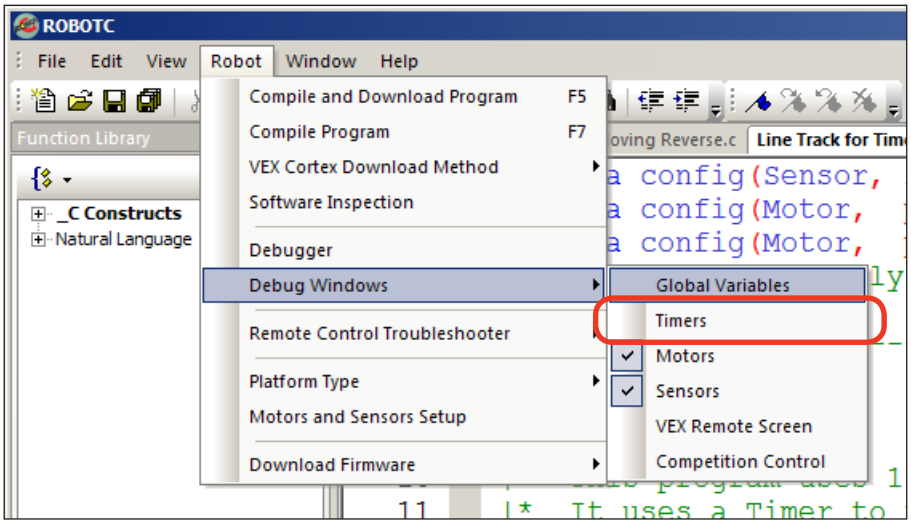


Index
The index of the timer (T1-T4).

Timer
Name of the timer. "nSysTime" is the amount of time the controller has been powered on. "nPgmTime" is the amount of time the current program has run. Timer1 through Timer4 can be reset and monitored in your programs.

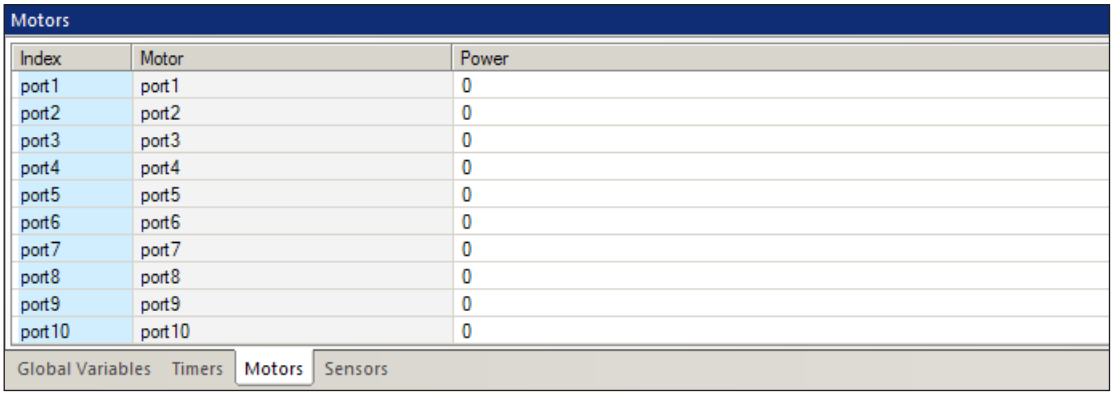
Time
Displays the elapsed time.

The Timers window can be opened by going to the Robot menu, Debug Windows, and selecting Timers.



The ROBOTC Debugger Motors

The Motors debug window provides access to the current values of the motors, servos and flashlights on your microcontroller. Motor, servo and flashlight power levels can be viewed and changed using this window.

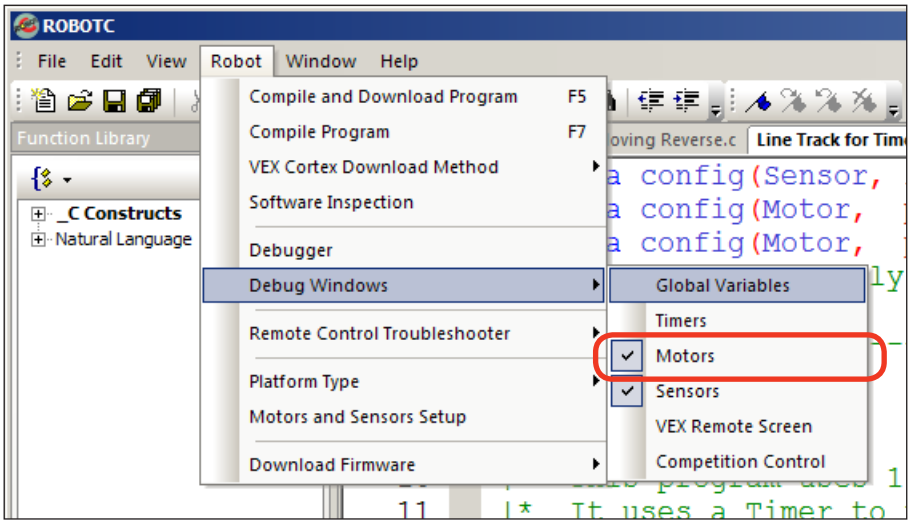


Index
The index of where the current device is located (port1-port10).

Motor
Current name of the motor. These names can be customized through the Motors and Sensor Setup window.

Value
Displays the current power level of the motor.

The Motors window can be opened by going to the Robot menu, Debug Windows, and selecting Motors.



The ROBOTC Debugger Sensors

The Sensors debug window provides access to the current values of all sensors, digital inputs and digital outputs configured on your microcontroller. Sensor values can be viewed and changed using this window, but you must first use the Motors and Sensors Setup menu to tell ROBOTC what types of sensors are connected to which ports. Different sensors are interpreted differently by ROBOTC and and the microcontroller, and appropriate values will not be displayed if they are not properly configured.

Sensors

Index	Sensor	Type	Value
in1	in1	Line Follower	2928
in2	in2	Line Follower	2963
in3	in3	Line Follower	2903
in4	in4	No Sensor	1668
in5	in5	No Sensor	125
in6	in6	Potentiometer	2160
in7	in7	No Sensor	2303
in8	in8	No Sensor	2067
dgtl1	dgtl1	Quadrature Enc...	0
dgtl2	dgtl2	Quad Encoder 2...	1
dgtl3	dgtl3	Quadrature Enc...	0
dgtl4	dgtl4	Quad Encoder 2...	1
dgtl5	dgtl5	No Sensor	1
dgtl6	dgtl6	Touch	0
dgtl7	dgtl7	Touch	0
dgtl8	dgtl8	SONAR (cm)	49
dgtl9	dgtl9	SONAR 2nd Port	0
dgtl10	dgtl10	No Sensor	1
dgtl11	dgtl11	No Sensor	1
dgtl12	dgtl12	No Sensor	1

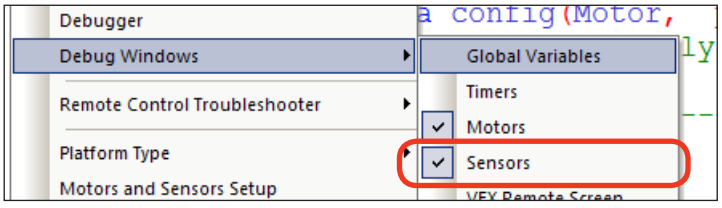
Global Variables | Timers | Motors | Sensors

Index
The index of where the current device is located (in1 - in8 for ANALOG Ports 1 - 8, and dgtl1 - dgtl12 for DIGITAL Ports 1 - 12).

Device
Current name of the sensor. These names can be customized through the Motors and Sensor Setup window.

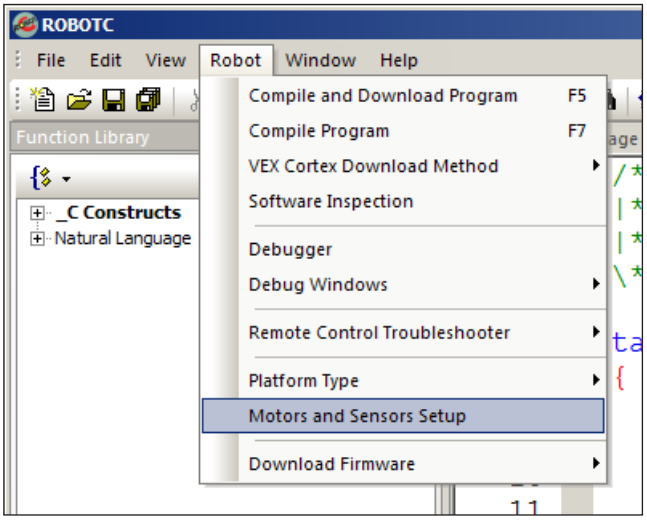
Type
Displays the type of the current sensor. The type must be set using the Motors and Sensor Setup window.

Value
Displays the current value of the sensor.



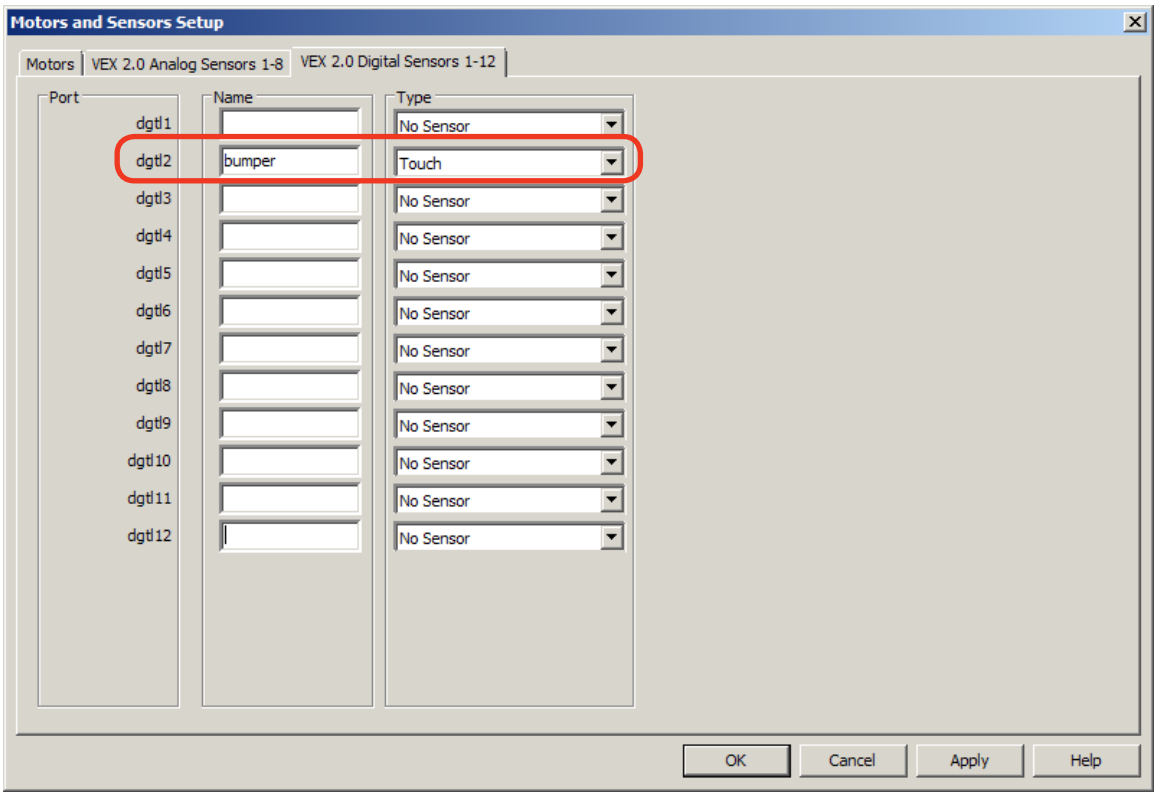
The Sensors window can be opened by going to the Robot menu, Debug Windows, and selecting Sensors.

The ROBOTC Debugger Sensors



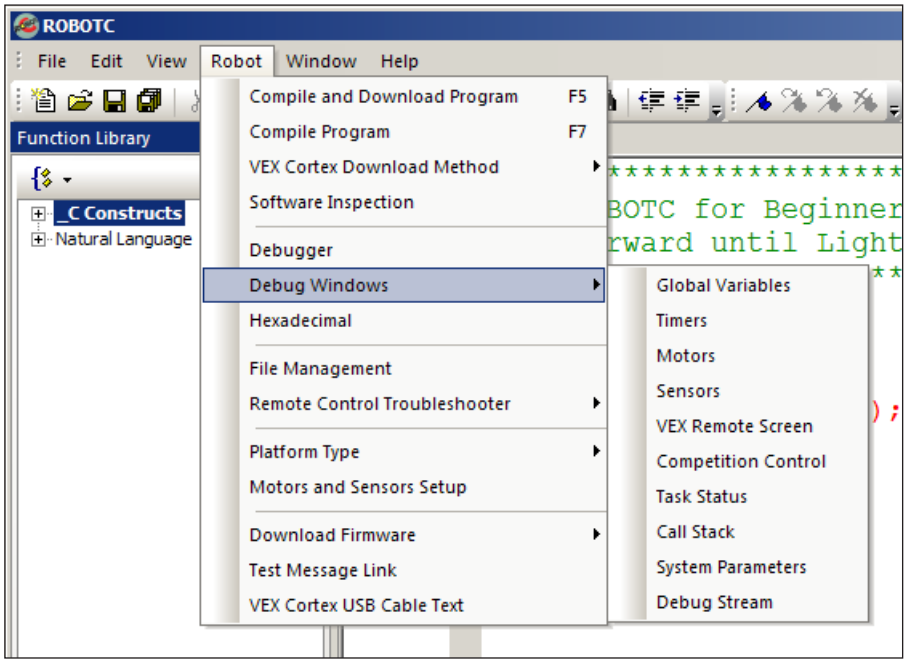
To configure the sensors connected to your microcontroller, open the Motors and Sensors Setup from the Robot menu in ROBOTC.

Digital sensors (Bumper, Limit, Encoder, Ultrasonic) can be configured on the "VEX 2.0 Digital Sensors 1-12" tab, and analog sensors (Light, Line Follower, Potentiometer, Accelerometer) can be configured on the "VEX 2.0 Analog Sensors 1-8" tab. To configure a sensor, first locate the row that aligns with where the sensor is plugged in on the Cortex. For example, "dgtl2" is short for DIGITAL Port 2 on the Cortex. Next, give the sensor a custom name and define its sensor type in the dropdown menu. After applying your chages, redownload your program to the microcontroller to have the changes take effect in the Sensor debug window.



The ROBOTC Debugger Miscellaneous

There are several additional debug windows available in the "Expert" and "Super User" modes of ROBOTC. To unlock these windows, change your Menu Level, by going to Window > Menu Level, and selecting one of the other modes. The additional debug windows are very powerful, and can be very helpful in advanced applications.



For additional information on these debug windows, along with the ones covered in this document, view the ROBOTC Debugger section of the built-in ROBOTC Help documentation.