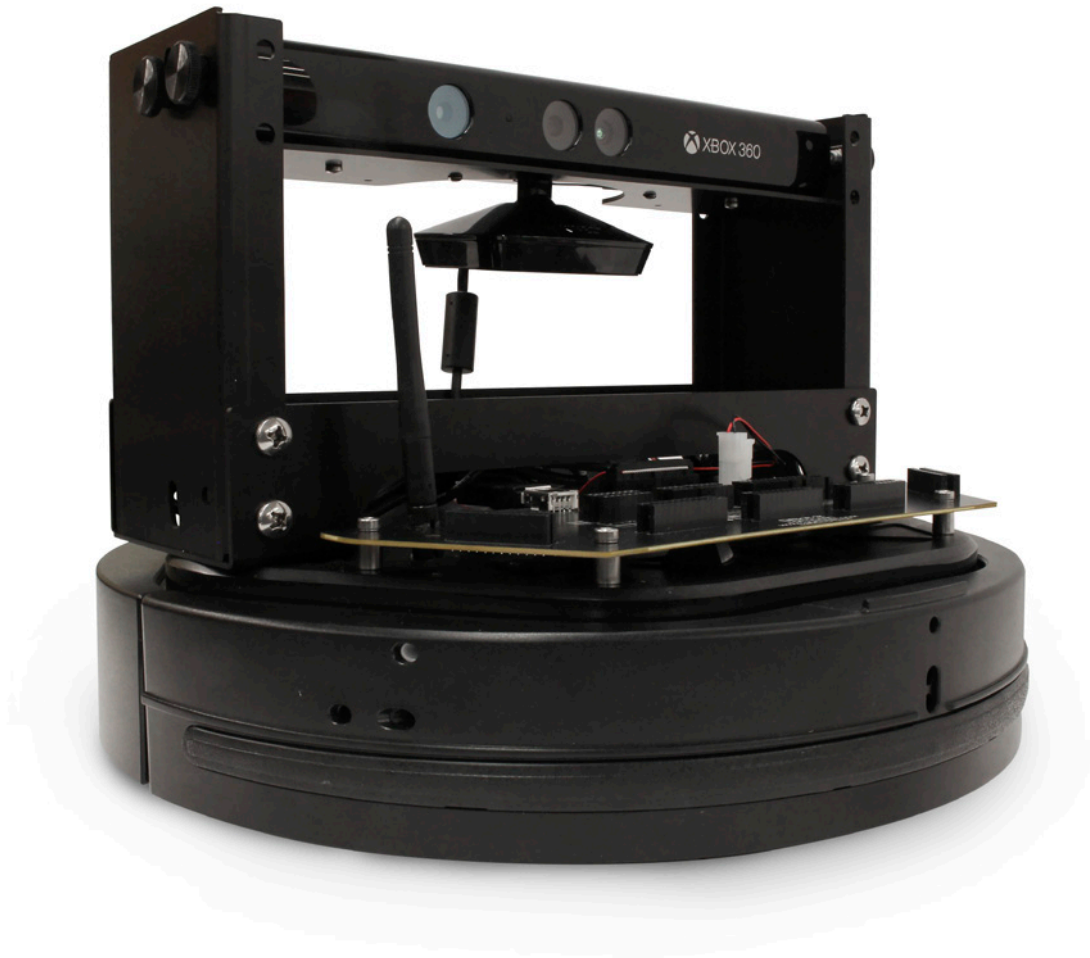




USER MANUAL

QBot 2 for QUARC

Set Up and Configuration



CAPTIVATE. MOTIVATE. GRADUATE.

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1 Introduction

The Quanser QBot 2 (Figure 1.1) is an innovative autonomous ground robot system incorporating a robust educational ground vehicle with the Microsoft Kinect and a Quanser® embedded target. The QBot 2 is comprised of a Yujin Robot Kobuki platform, a Microsoft Kinect RGB camera and depth sensor, and a Quanser® DAQ with a wireless embedded computer (also referred to as the target computer). The embedded computer system mounted on the vehicle uses the Gumstix DuoVero computer [1] to run QUARC®, Quanser®'s real-time control software, and interface with the QBot 2 data acquisition card (DAQ).

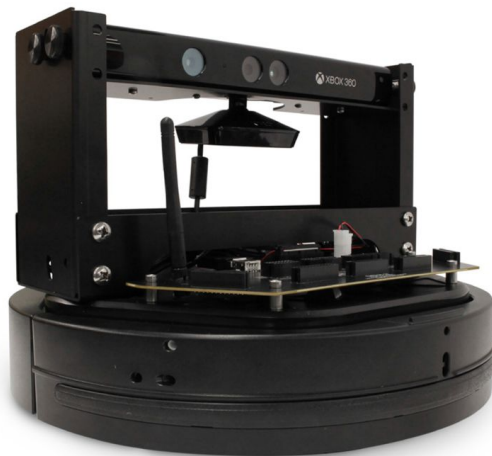


Figure 1.1: The Quanser QBot 2

The interface to the target computer is Matlab® Simulink® with QUARC®. The QBot 2 is accessible through three different block sets: the Quanser® Hardware-In-the-Loop (HIL) block set to read from sensors and/or write to outputs, the Quanser® Stream API blockset to perform communications over wired and wireless communication channels, the Quanser® Multimedia blockset to read RGB and depth image data from the Kinect sensor, and The MathWorks® Computer Vision System toolbox to perform image processing. Controllers are developed in Simulink® with QUARC® on the host computer, and these models are cross-compiled and downloaded to the target (Gumstix [1]) seamlessly. A diagram of this configuration is shown in Figure 1.2.

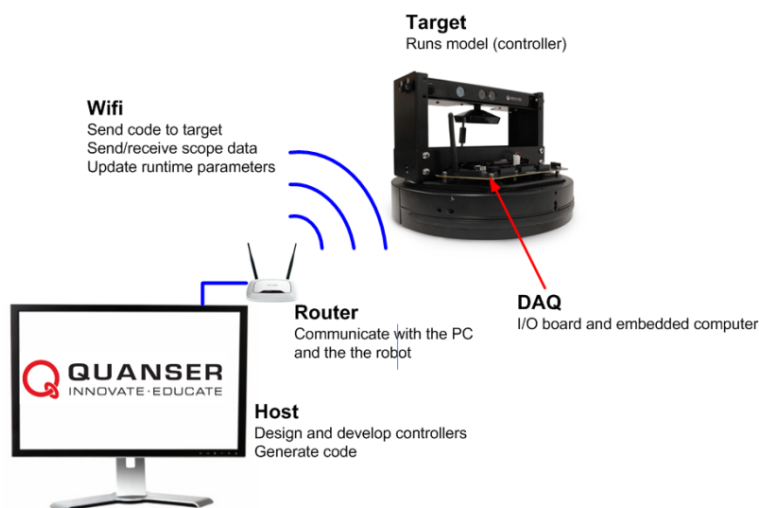


Figure 1.2: Communication Hierarchy

The general system description, component nomenclature, specifications, and model parameters are all given in Section 2. Section 3 goes into detail on how to setup the QBot 2. Lastly, Section 4 contains a troubleshooting guide.

1.1 Prerequisites

To successfully operate the QBot 2, the prerequisites are:

1. To be familiar with the components of the QBot 2.
2. To have **QUARC**[®] version 2.5 or later installed and properly licensed.
3. **The MathWorks**[®] Computer Vision System toolbox: <http://www.mathworks.com/products/computer-vision/>
4. Microsoft Kinect SDK v1.8 installed: <http://www.microsoft.com/en-ca/download/details.aspx?id=40278>
5. Microsoft Kinect for Windows Developer Toolkit v1.8 installed:
<http://www.microsoft.com/en-ca/download/details.aspx?id=40276>
6. To be familiar with using **QUARC**[®] control and monitor the vehicle in real-time, and in designing a controller through **Simulink**[®]. See Reference [2] for more details.

1.2 References

- [1] Gumstix: <http://gumstix.com/>
[2] QUARC User Manual (type doc quarc in Matlab to access)

2 Components

The QBot 2 is made up of four main components: the Kobuki robot platform, the QBot 2 data acquisition card (DAQ), the Gumstix DuoVero embedded computer, and the Kinect sensor. This section outlines these components in more detail.

2.1 The Kobuki Robot Platform

The QBot 2 uses an Kobuki mobile robot platform (Figure 2.1). The QBot 2 follows the **Quanser[®]** standard for body frame axes, where the x-axis is in the forward direction, the y-axis is to the left, and the z-axis is up. The diameter of the vehicle is 34 cm, and its height (without attachments) is 10 cm. The Kobuki is driven by two differential drive wheels with built-in encoders. The Kobuki comes with a bumper sensor as well as a built-in gyroscope and cliff sensors. The embedded computer target can access data from these sensors.

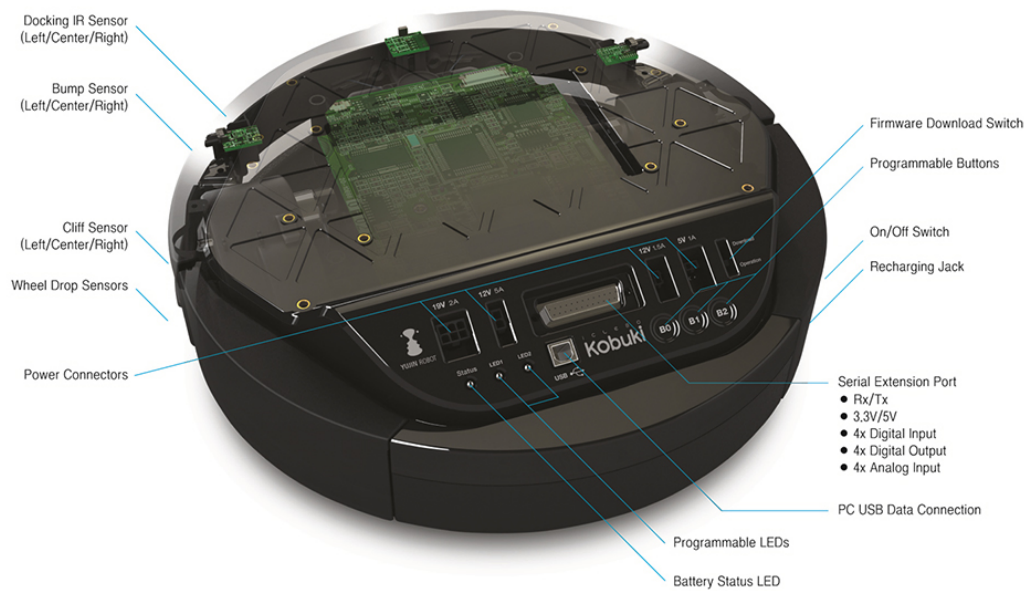
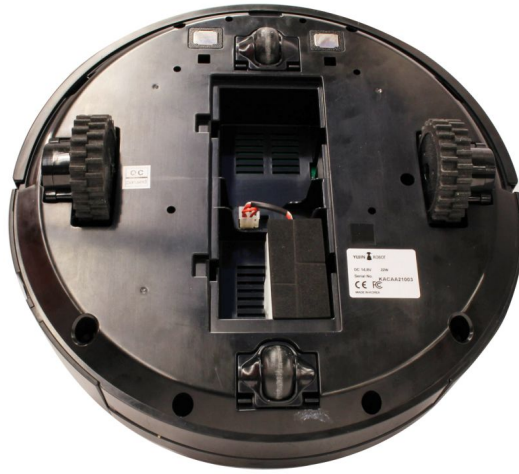


Figure 2.1: The Kobuki mobile robot platform

The QBot 2 is powered by a Lithium ion battery pack (Figure 2.2a) provided by Yujin Robot. The battery fits underneath the QBot 2, and can last continuously for about 3 hours after a full charge. The battery takes less than 3 hours to charge. While charging, the power light pulses slowly with an orange colour. A battery charger is provided (Figure 2.2b). To recharge the QBot 2, plug in the battery charger and connect it to the charger input port on the QBot 2 next to the *ON/OFF* switch (Figure 2.2c).



(a) The QBot 2 battery



(b) The QBot 2 charger



(c) The QBot 2 charger input

Figure 2.2: The QBot 2 battery and charger input

2.2 System Specifications and Model Parameters

Table 2.1 lists the main parametrs associated with the QBot 2.

| Symbol | Description | Value | Unit |
|-------------|--|-------|------|
| D | Diameter of the QBot 2 | 0.35 | m |
| d | Distance between the left and right wheels | 0.235 | m |
| h | Height of the QBot 2 (with Kinect mounted) | 0.27 | m |
| ν_{max} | Maximum speed of the QBot 2 | 0.7 | m/s |
| m | Total mass of the QBot 2 | 3.79 | kg |

Table 2.1: QBot 2 specifications

2.3 The QBot 2 Data Acquisition Card (DAQ)

The QBot 2 DAQ contains the wiring and circuitry integrating the DuoVero embedded computer, Kobuki robot, Kinect sensor, and additional input/output (I/O) components connected to the DAQ. Figure 2.3 shows the QBot 2 DAQ with

accessible I/O headers for the user including SPI, I2C, UART, digital I/O, analog input, encoder input, and PWM output. More details on accessing the QBot 2 I/O is found in 2.6. The QBot 2 DAQ connects to the Kinect sensor via a USB port (see Figure 2.4). The QBot 2 DAQ connects to the Kobuki via a ribbon cable (see Figure 2.4). The QBot 2 DAQ is powered via a cable connected to the Kobuki 12 V, 5 A power source (see Figure 2.4).

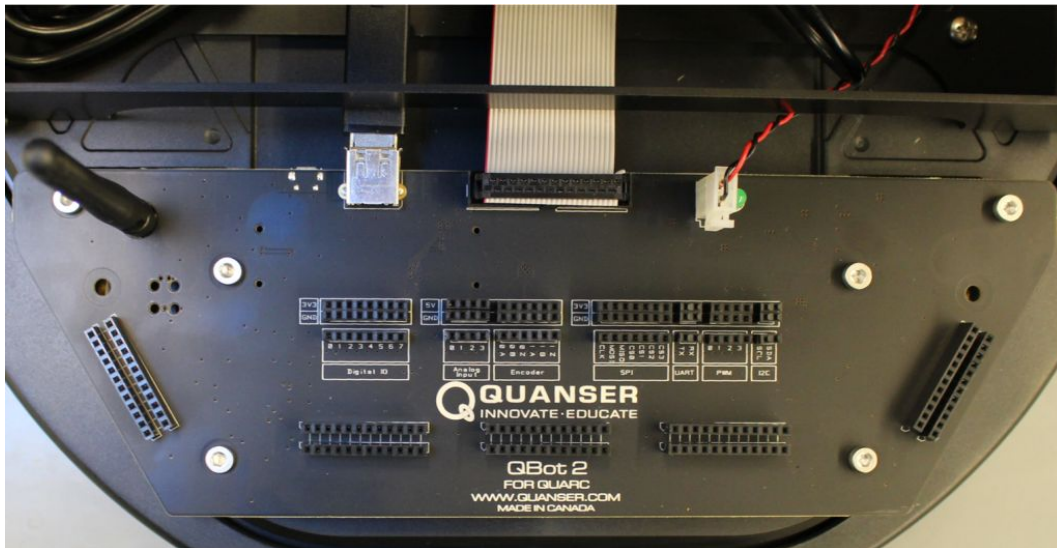


Figure 2.3: The QBot 2 DAQ

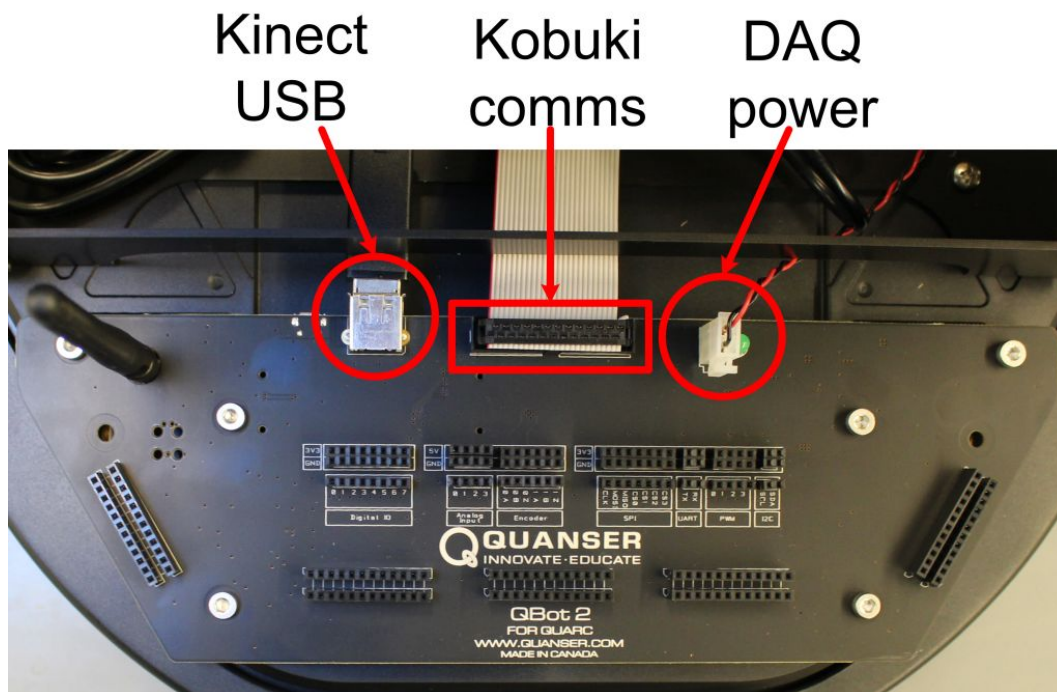


Figure 2.4: The QBot 2 DAQ connectors

The QBot 2 DAQ also provides five headers for users to use when integrating additional I/O components. Each header is a double row where each pin in the first row is electrically connected to the pin in the second row directly opposite. This allows users to connect a sensor to one row and map the connection from the DAQ I/O to the pins in the mating row similar to a breadboard. Figure 2.5 shows the location of the headers.

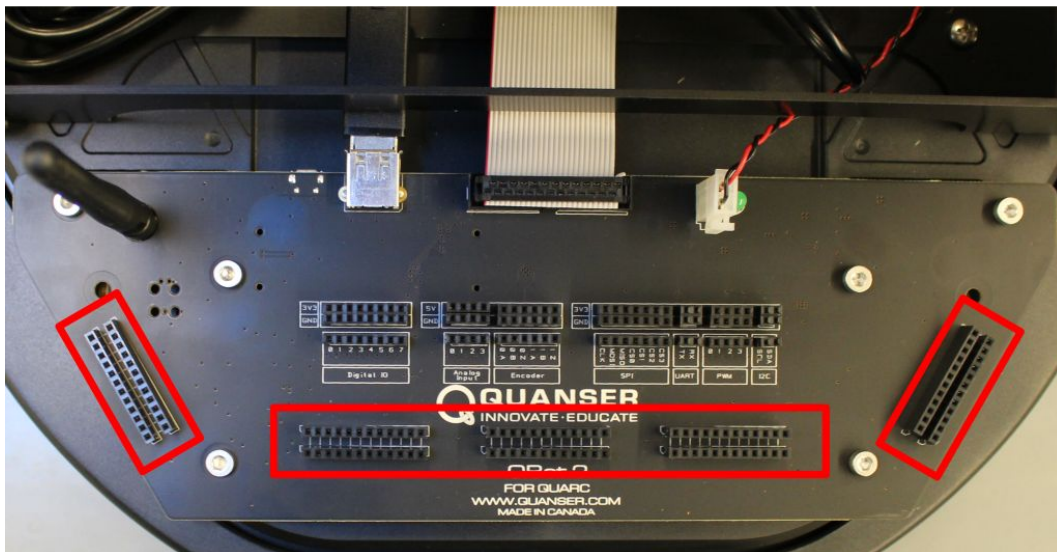
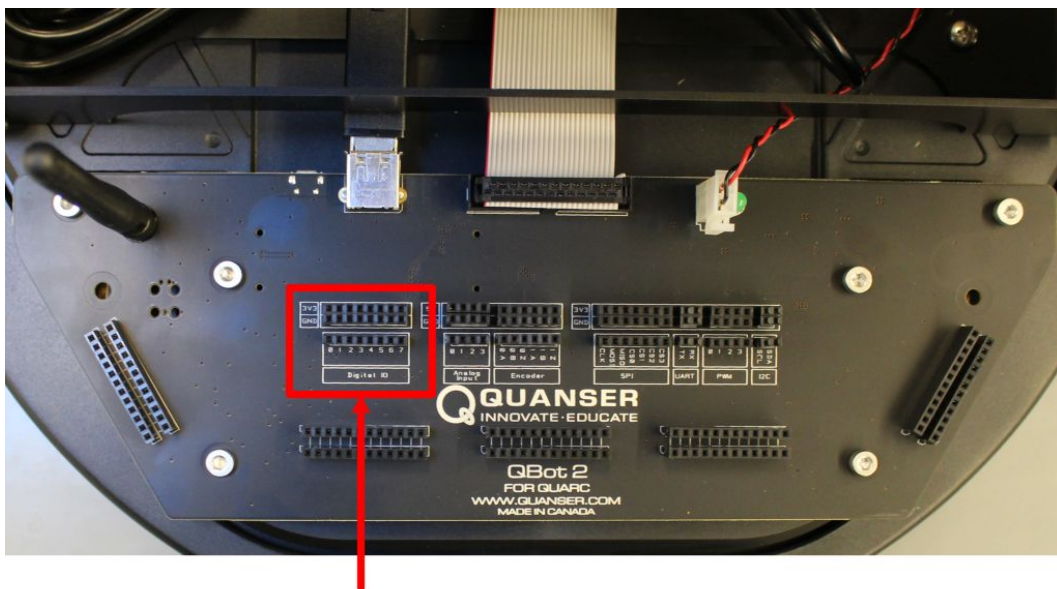


Figure 2.5: The QBot 2 DAQ sensor mounting rows

2.3.1 Digital Input/Output Pins (DIO)

The user DIO channels (Figure 2.6) are set as inputs by default. The DIO channels need to be configured as either inputs (or outputs, but not both) using the HIL Initialize block. Also, if an output needs to be in a known state on power up, it is recommended that a 10k resistor is put from the I/O to 5 V or GND as needed. The DIO channels are accessed through the HIL API.

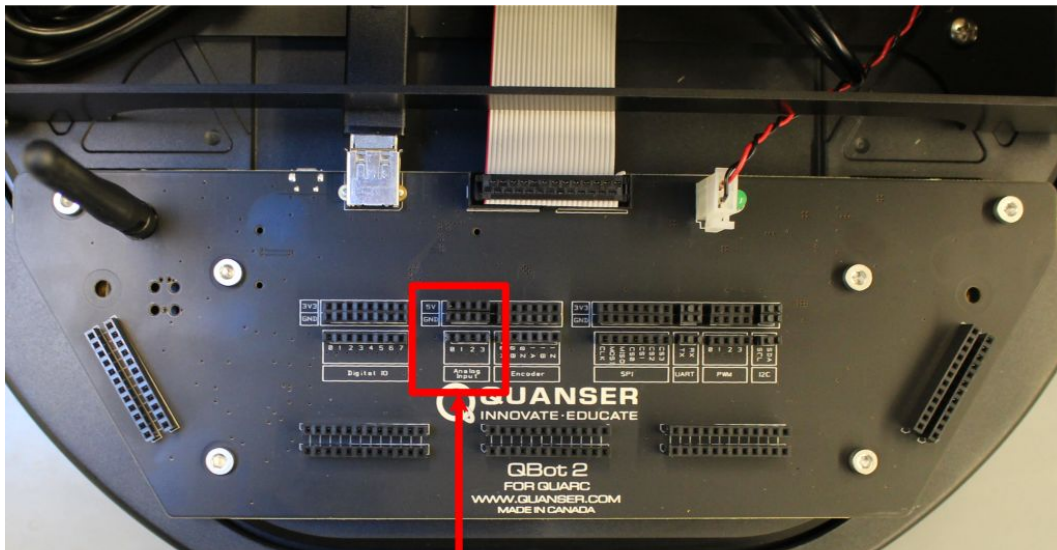


Digital I/O

Figure 2.6: The QBot 2 DAQ user digital I/O

2.3.2 Analog inputs

The QBot 2 provides four user analog input channels (Figure 2.7) that are rated for signals between 0 – 5 V and uses 12-bit analog to digital converters (ADCs). The analog inputs are accessed through the HIL API.

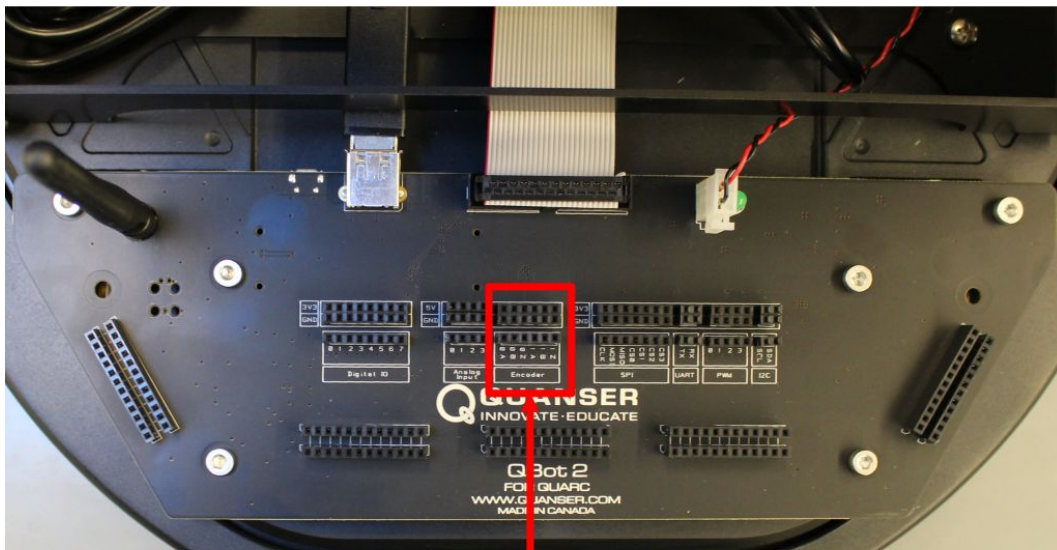


Analog inputs

Figure 2.7: The QBot 2 DAQ user analog inputs

2.3.3 Encoder inputs

The QBot 2 provides two user encoder input channels (Figure 2.8). Each encoder input channel has an A and B pulse as well as a Z index signal. The encoders are sampled at 100 kHz. The encoder inputs are accessed through the HIL API.



Encoder inputs

Figure 2.8: The QBot 2 DAQ user encoder inputs

2.3.4 PWM

The QBot 2 provides four user PWM outputs (Figure 2.9) that users can configure to output pulse-width modulated digital signals.

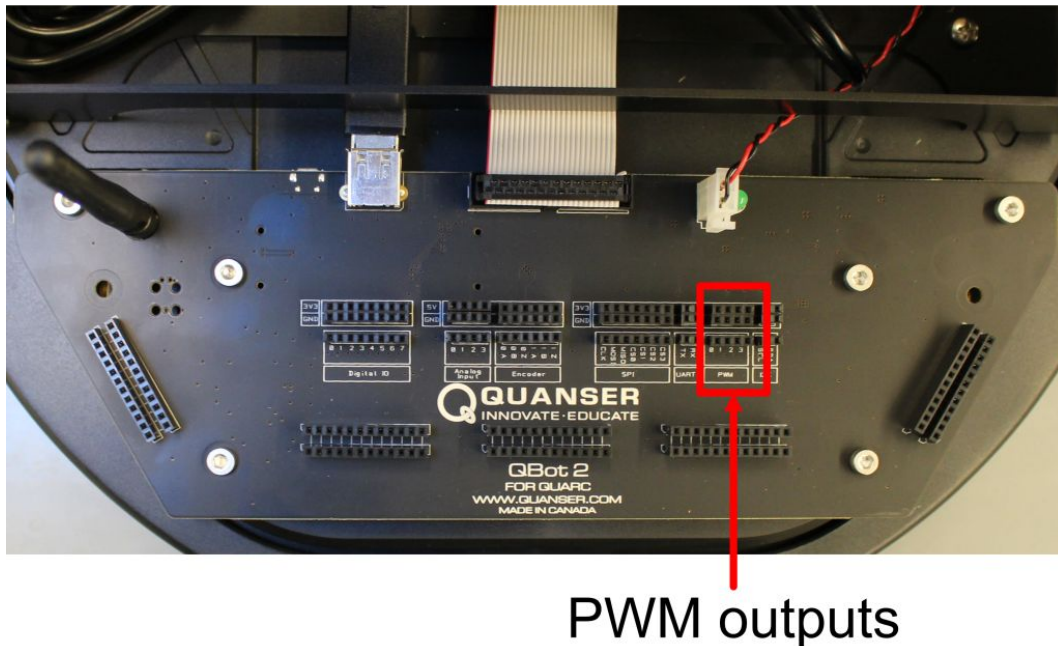


Figure 2.9: The QBot 2 DAQ user PWM outputs

2.3.5 SPI

The QBot 2 provides one Serial Peripheral Interface (SPI) bus (Figure 2.10), which is a synchronous serial data bus for interfacing other sensors or devices with the embedded computer. The SPI channel is accessed through the Steam API (see the SPI protocol in the **QUARC®** help).

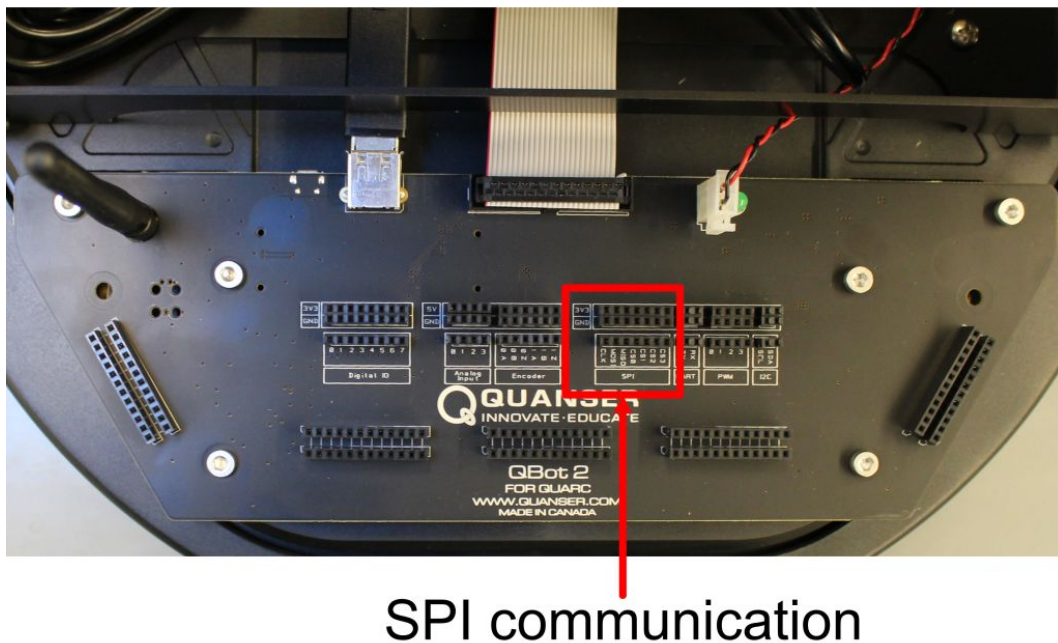
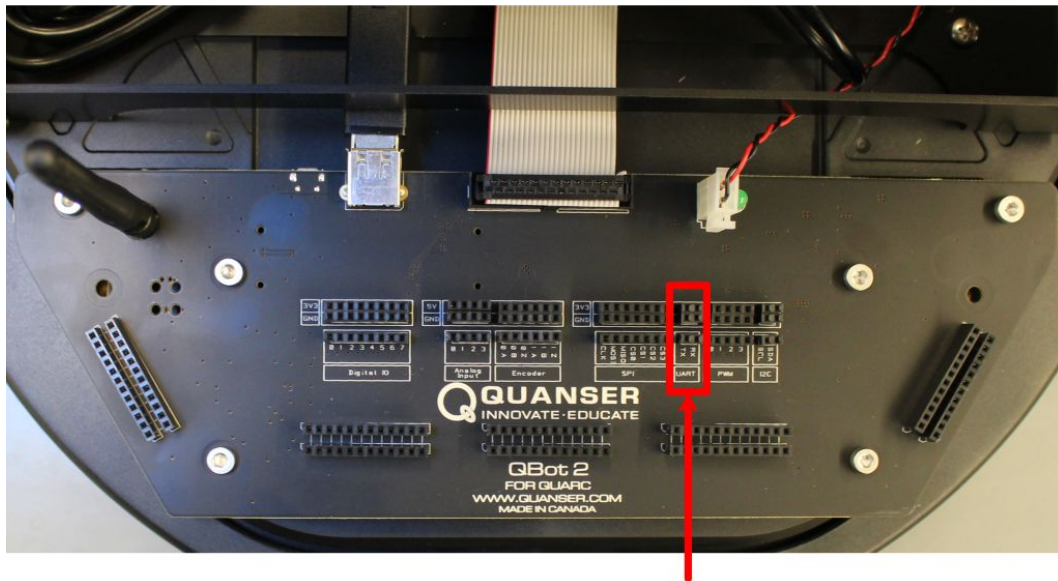


Figure 2.10: The QBot 2 DAQ SPI communication port

2.3.6 UART

The QBot 2 provides one UART serial port (Figure 2.11) that can be used to interface with 3.3 V (TTL) serial devices. The UART is accessed through the Steam API (see the serial protocol in the [QUARC®](#) help).

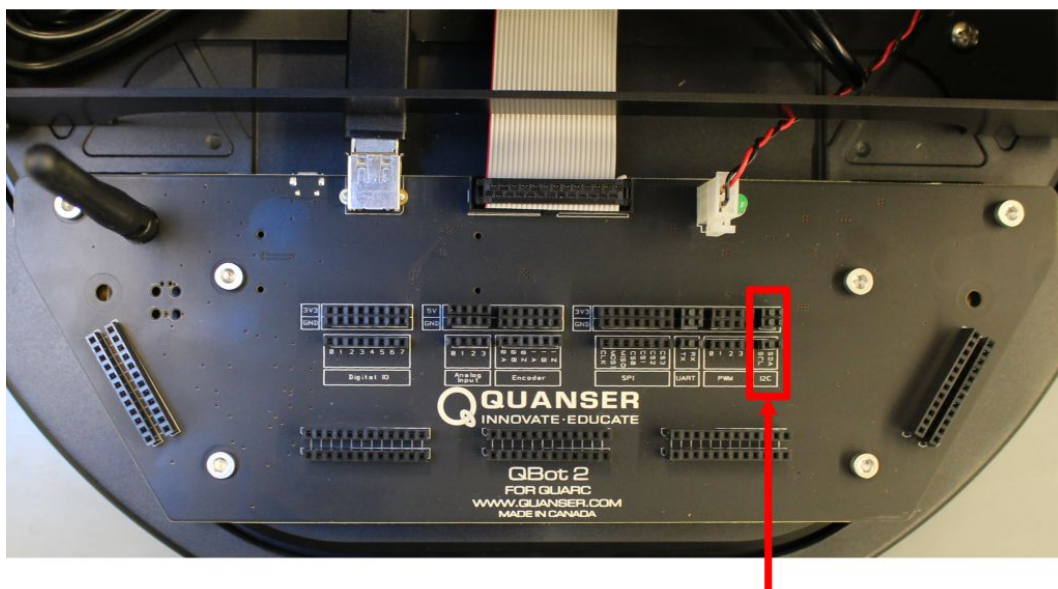


UART communication

Figure 2.11: The QBot 2 DAQ UART communication port

2.3.7 I²C

The QBot 2 provides one inter-integrated circuit (I²C) serial bus (Figure 2.12) for interfacing with external sensors and devices. The I²C channel is accessed through the Steam API (see the I²C protocol in the [QUARC®](#) help).



I2C communication

Figure 2.12: The QBot 2 DAQ I²C communication port

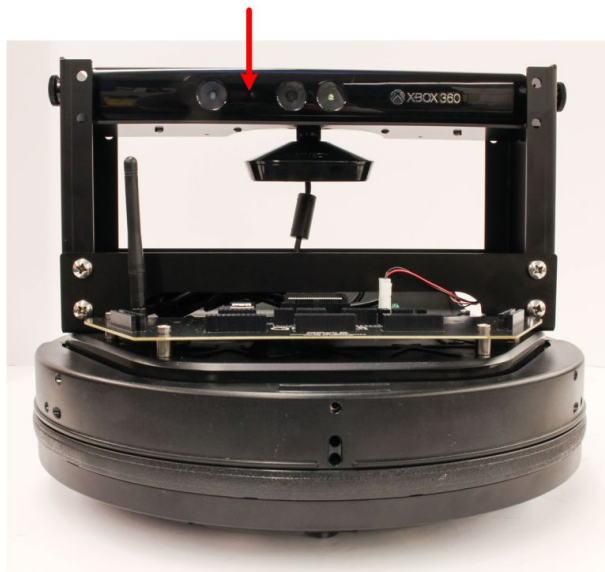
2.4 Gumstix DuoVero Embedded Computer

The Gumstix DuoVero is a small-scale embedded computer that runs the **QUARC®** runtime. With **QUARC®** installed, code generated from **Matlab® Simulink®** is cross-compiled, downloaded, and executed directly on the DuoVero. The DuoVero is connected directly to the QBot 2 DAQ on the bottom side of the PCB. The DuoVero also comes with integrated 802.11 b/g/n WiFi to allow wireless connection between the target Gumstix and the host computer and/or other vehicles.

2.5 The Kinect Sensor

The Microsoft Kinect sensor is an integrated RGB camera and depth sensor used in a variety of experiments (Figure 2.13a). The Kinect camera provides RGB image capture and 11-bit depth sensing at a resolution of 640×480 . The Kinect's depth sensor utilizes infrared light and has a range of 0.5 m to 6 m. Due to the type of infrared sensor, the QBot 2 Kinect should only be used indoors in locations without direct sunlight for best results.

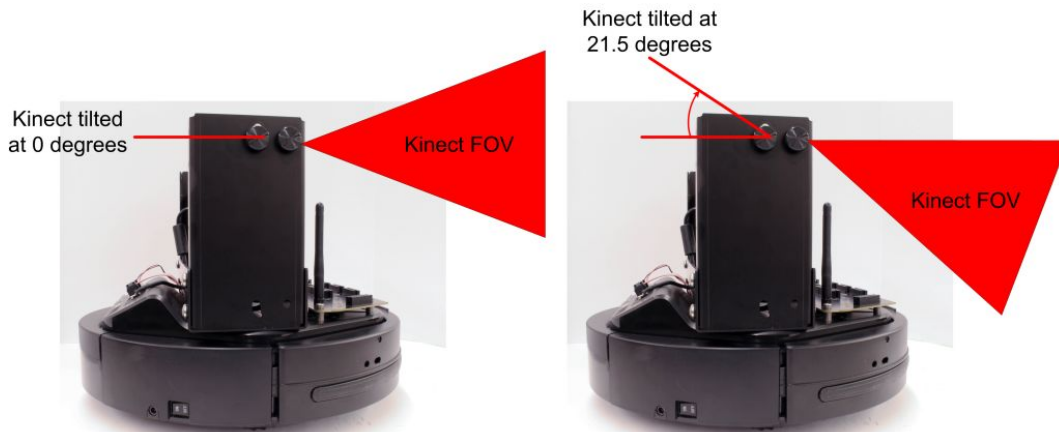
Kinect sensor



(a) The QBot 2 with Kinect sensor



(b) The QBot 2 Kinect thumb screws



(c) The QBot 2 Kinect tilted at 0 degrees and 21.5 degrees

Figure 2.13: The QBot 2 Kinext sensor

The QBot 2 Kinect is mounted on a structure that allows the Kinect to be oriented horizontally as well as tilted downward for various viewing positions. The QBot 2 Kinect structure has four thumb screws (two on each side) as shown in Figure 2.13b. To adjust the Kinect's viewing angle, loosen all of the thumb screws slightly but do not remove them all the way. Tilt the Kinect to the desired angle and tighten all of the thumb screws. The maximum and minimum angles are designed to allow the kinect to be oriented facing stright ahead (tilted at 0 degrees) as well as at an angle of 21.5 degrees such that the ground in front of the QBot 2 in the viewing angle as shown in Figure 2.13c.

2.6 QBot 2 sensors interface

This section describes the blocks that are used to read the QBot 2 sensors in **Simulink®** and write outputs to the QBot 2 motors. The **QUARC®** Hardware-In-the-Loop (HIL) blockset it used to communicate with **Quanser®** data acquisition cards. For detailed information on the HIL blockset see the **QUARC®** HIL user guide in the **Matlab®** help under *QUARC Targets | User's Guide | Accessing Hardware*.

2.6.1 QBot 2 I/O

The QBot 2 provides an interface to the I/O of the Kobuki robot platform including its wheel encoders, sensors, and motor outputs as well as several DAQ I/O channels for user expansion, which can be used to interface to a variety of third-party sensors and actuators. The I/O of the QBot 2 DAQ includes:

- 4 analog inputs
- 8 reconfigurable digital I/O
- 4 PWM outputs
- 2 encoder inputs
- 1 UART
- 1 SPI
- 1 I²C

2.3 shows the location of the I/O listed above on the QBot 2 DAQ.

The Kobuki platform provides the following I/O:

- 2 wheel encoder inputs
- 2 wheel speed outputs
- 2 digital LED outputs
- 4 digital power enable outputs
- 3 analog and digital cliff sensors
- 2 analog motor current inputs
- 3 digital bumper sensors
- 3 digital wheel drop sensors
- 3 digital buttons
- 2 overcurrent sensors
- 2 wheel PWM measurements

- 3-axis gyroscope
- 1 Z-axis angle measurement (heading)
- 1 battery voltage sensor

The analog, digital, and robot and DAQ I/O listed above is accessed using the **QUARC®** HIL blockset. The UART, SPI, and I²C communication channels are accessed through the **QUARC®** Stream blockset. For more information on accessing communication stream data see the **QUARC®** help under *QUARC Targets | User's Guide | Communications*. Table 2.2 lists the HIL blocks used to communicate with the QBot 2's data acquisition hardware.


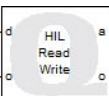

| Block | Description |
|--|--|
|  HIL Initialize QBot2 (qbot2-0) | <p>The HIL Initialize block selects the DAQ board and configures the board parameters. The HIL Initialize block is named via the <i>Board name</i> parameter, and all other HIL blocks reference the corresponding HIL Initialize through its name. The HIL blocks will interface to the DAQ specified in the HIL Initialize Board type parameter qbot2.</p> |
|  HIL Read Write1 (QBot2) | <p>The HIL Read Write block is used to read sensor measurements from the DAQ and robot and write motor commands to the QBot 2 motors. The inputs and outputs are specified with numeric channel numbers given in Table 2.4 and Table 2.3, respectively.</p> |
|  HIL Watchdog (QBot2) | <p>The HIL Watchdog block is used to set the timeout limit for the watchdog timer. For the QBot 2 DAQ board, if there is no motor output command received for a consecutive period of time exceeding the watchdog timeout value then the watchdog will trigger, forcing the motor outputs to 0. The default timeout value for the watchdog is 50 ms unless specified otherwise with this block. This block can be used to change the timeout value if 50 ms is not suitable.</p> |

Table 2.2: HIL blocks

| Channel type | Write channel numbers | Description | Units |
|--------------|---|--|-----------------|
| Analog | none | - | |
| PWM | 0 - 3 | User PWM outputs | % |
| Digital | 0 - 7 8 9 10 11 12 13 14 15 16 | Reconfigurable digital I/O User LED on QBot 2 DAQ LED1 red colour LED1 green colour LED2 red colour LED2 green colour Enable 3.3V power Enable 5V power Enable 12V/5A power Enable 12V/1.5A power | |
| Other | 2000 2001 16000 | Right wheel speed Left wheel speed Predefined sound (0=on sound, 1=off sound, 2=recharge, 3=button, 4=error, 5=task start, 6=task end) | m/s m/s - |

Table 2.3: QBot 2 output channels

| Channel type | Read channel numbers | Description | Units |
|--------------|----------------------|--|--------|
| Analog | 0 - 3 | User analog inputs | V |
| | 4 | Supply voltage (battery) | V |
| | 5 | Right cliff sensor | V |
| | 6 | Central cliff sensor | V |
| | 7 | Left cliff sensor | V |
| | 8 | Right motor current | A |
| | 9 | Left motor current | A |
| Encoder | 0 - 1 | User encoder inputs | counts |
| | 2 | Right wheel (2578 counts per revolution) | counts |
| | 3 | Left wheel (2578 counts per revolution) | counts |
| Digital | 0 - 7 | User reconfigurable digital I/O | |
| | 8 | Right bumper | |
| | 9 | Central bumper | |
| | 10 | Left bumper | |
| | 11 | Right wheel drop | |
| | 12 | Left wheel drop | |
| | 13 | Right cliff detected | |
| | 14 | Central cliff detected | |
| | 15 | Left cliff detected | |
| | 16 | Button B0 | |
| | 17 | Button B1 | |
| | 18 | Button B2 | |
| | 19 | Right overcurrent | |
| | 20 | Left overcurrent | |
| Other | 13000-13001 | User encoder 0-1 index position | counts |
| | 12000 | Timestamp | s |
| | 16000 | Charge state (0=discharging, 2=docking charged, 6=docking charging, 18=adapter charged, 22=adapter charging) | - |
| | 11000 | Right wheel PWM | % |
| | 11001 | Left wheel PWM | % |
| | 1002 | Z-axis angle | rad |
| | 3000 | X-axis angular velocity | rad/s |
| | 3001 | Y-axis angular velocity | rad/s |
| | 3002 | Z-axis angular velocity | rad/s |

Table 2.4: QBot 2 input channels

2.6.2 QBot 2 Kinect

The QBot 2 is integrated with a Microsoft Kinect sensor, which is capable of capturing RGB image data as well as 12-bit depth data at several resolutions and framerates. The Kinect sensor data is available through the **QUARC®** Multimedia blockset under QUARC Targets/Multimedia in the Simulink Library Browser. Table 2.5 shows the various blocks used to interface with the Kinect and describes their purpose. Note: to use the **QUARC®** Kinect blocks, you will need to have the Microsoft Kinect SDK v1.8 and the Microsoft Kinect for Windows Developer Toolkit v1.8 installed on the host PC.



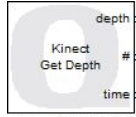


| Block | Description |
|---|--|
|  | The Kinect Initialize block is required to initialize the Kinect sensor and provide a name for the Kinect that other blocks use to associate with that sensor. |
|  | The Kinect Video Capture block is used to capture RGB or greyscale images from the Kinect sensor. You can specify the desired resolution as well as the output format (RGB or greyscale). The Video Capture block outputs a boolean <i>new</i> signal to indicate when a new frame is available so that it can be used to trigger image processing only once per frame. |
|  | The Kinect Get Depth block is used to output a depth-mapped image at the specified resolution. The Kinect can measure depth from 0.5 m to 6 m. |
|  | The Kinect Get Image block is used to acquire RGB or greyscale images from the Kinect. The image sensor type can be specified as the color or infrared image sensor. The image resolution can be selected as either 640×480 or 1280×960 . The image frame number is output from the block and can be used to trigger image processing when a new image is available. |
|  | The Display Image block is used to display image data on the host computer. The Display Image block accepts greyscale and RGB image matrices as its input. The Display Image block acts like a scope and is not synchronized with the model; in other words, if the Display Image block cannot keep up with the performance of the model it will not block the model thread(s). Since the Display Image block requires the images to be transmitted between the target and the host it is recommended that the images used for display purposes be downsampled or sent at a slower rate. |

Table 2.5: Kinect blocks

3 Setup

3.1 Setting up the QBot 2

Follow these steps to setting up the QBot 2:

1. Connect the battery inside the Kobuki robot.
2. Press the power button shown in Figure 2.2c. This should turn on both vehicle and QBot 2 DAQ and Gumstix computer. After you make sure that this works, turn off the robot and follow the steps below to establish network connection.

3.2 Establishing Network Connection

The QBot 2 package comes with a pre-configured wireless router and automatically connects to the WiFi network Quanser_UVS. It uses TCP/IP connection for communicating with the host computer and/or other Quanser® unmanned vehicles. The Host PC and each of the vehicles must have unique IP addresses and the range of these addresses are defined below (suggested):

| | |
|----------------------------|-------------------------------|
| Host PC(s) | 192.168.2.10 to 192.168.2.19 |
| Quanser vehicles (Gumstix) | 192.168.2.20 to 192.168.2.254 |

These Steps outlined below for setting up the host computer wireless connection only need to be performed once.

1. Power up and turn on the wireless router.
2. After turning on the router that is provided, wait for about 60 seconds for the wireless network to establish and then turn on the QBot 2 power and wait for it to boot up (approximately 60 seconds).
3. Connect your PC network card to any of the ports of the router (e.g. port number 1 to 4) using the network cable provided (you can also connect to the Quanser_UVS or Quanser_UVS-5G wireless network if your computer has wireless adapters, however, wired connection between your PC and the router is preferred for better performance). If you choose wireless connectivity between your PC and the router, you should use the password UVS_wifi to connect to the wifi network.
4. Using the *Windows Network Connection* utility in the *Windows Task Bar*, open the Network and Sharing Center.



Figure 3.1: Open network settings. The Unidentified network is related to the wired connection to the router. If you are using a wired connection to the router and you don't have wireless adapter, you will not see Quanser_UVS network.

5. Click on Change adapter settings.
6. Right-click on the Local Area Connection x, Unidentified network connection and click Properties. If you chose wireless connectivity between your PC and the router, choose the Wireless Network Connection instead, right click on it and click Properties.
7. Under *This connection uses the following items:*, select *Internet Protocol Version 4 (TCP/IPv4)* and click Properties.

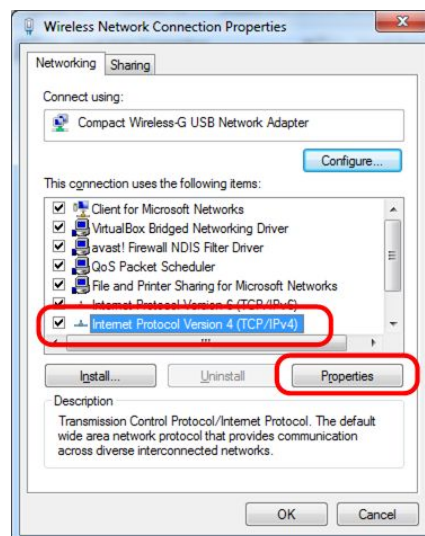


Figure 3.2: Network properties

8. Instead of obtaining an IP address of the computer automatically, select *Use the following IP address* and enter the following:

IP address: 192.168.2.10 (For multiple host PCs, use different IP addresses within the valid range)
Subnet mask: 255.255.255.0

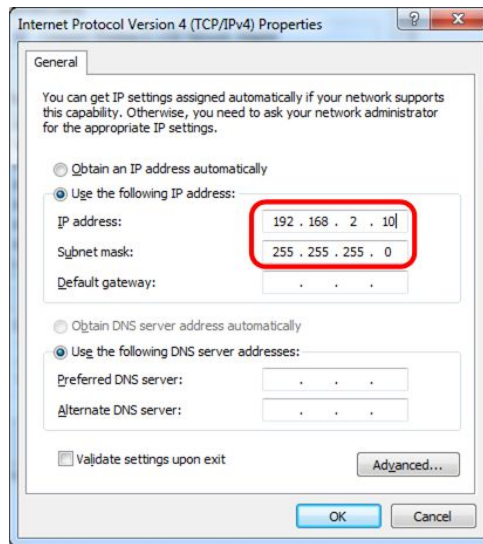


Figure 3.3: IP settings

9. Make sure you can ping the router by typing `ping 192.168.2.1` in the Run box in Windows (go to the *Start* menu and search for Run and click Run, Figure 3.4). If the connection to the router is successful you will see the ping replies in the command window. If you cannot ping the router, check network connectivity and your IP address before going to the next steps.
10. If the QBot 2 is powered on, the QBot 2 can be pinged by typing `ping {IP of the QBot 2}` in the Run box in Windows (go to the *Start* menu and click Run, Figure 3.4). The QBot 2 IP address is labeled on the DAQ PCB as shown in Figure 3.5. If the connection is successful you will see the ping replies in the command window. If you cannot ping the robot, power cycle the QBot 2 and wait for about 60 seconds to reboot.

Note: You may need to disable Windows firewall to establish a connection.

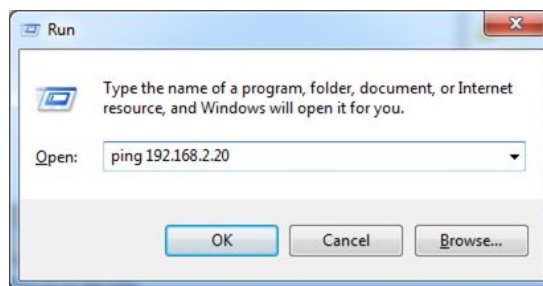


Figure 3.4: Pinging the QBot 2

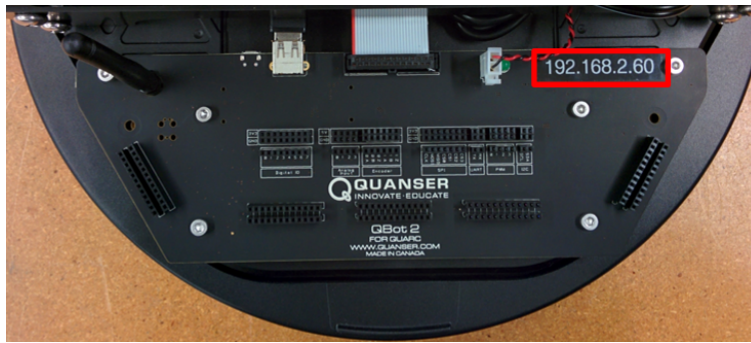


Figure 3.5: QBot 2 IP address label

3.3 Configuring models for the QBot 2 target

Note: This section applies only to files that are run on the Gumstix target (i.e., on the QBot 2) such as `qbot_2_control_v1.mdl`. **Simulink®** should have a new menu item called **QUARC** once **QUARC®** has been installed. The following steps are required to setup a new **QUARC®** model for the QBot 2:

1. Create a new **Simulink®** model, or open an existing model to be run on the Gumstix.
2. Click on the **QUARC** menu, then select Options.
3. The System target file under **Code Generation** should be `quarc_linux_duovero.tlc`. Browse through the system target list to locate the proper file if necessary (Figure 3.6).

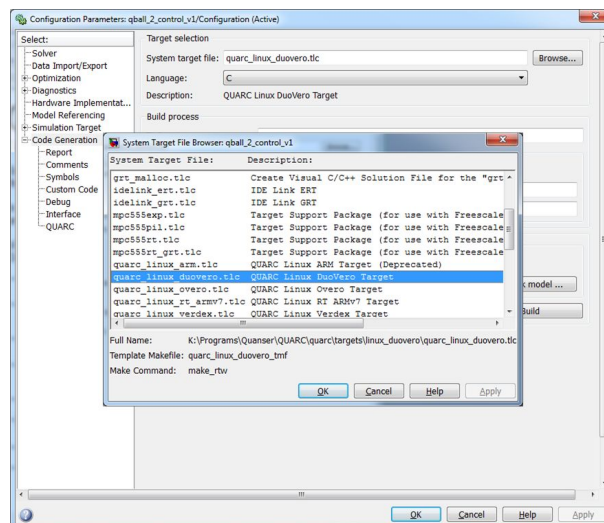


Figure 3.6: **QUARC®** Option Menu

4. In order to run the **QUARC®** model on the target vehicle, the target's IP address must be specified. To setup the default target address for **all linux-duovero targets**, go to the **QUARC** menu and select Preferences. The **Target type** parameter should be set to `linux_duovero`. Replace the **Default Model URI** with the IP address of the desired target vehicle, e.g., `tcpip://192.168.2.20:17001`.

Alternatively, to set the target address for the **current model only** open the model options under the **QUARC | Options** menu and choose **Code Generation > Interface** on the left hand pane. Under the MEX-file arguments, type `'-w -d /tmp -uri %u', 'tcpip://{IP of Gumstix}:17001'`. Include the single quotation marks (Figure 3.7). Replace `{IP of Gumstix}` with the IP of your Gumstix, e.g. `'tcpip://192.168.2.20:17001'`.

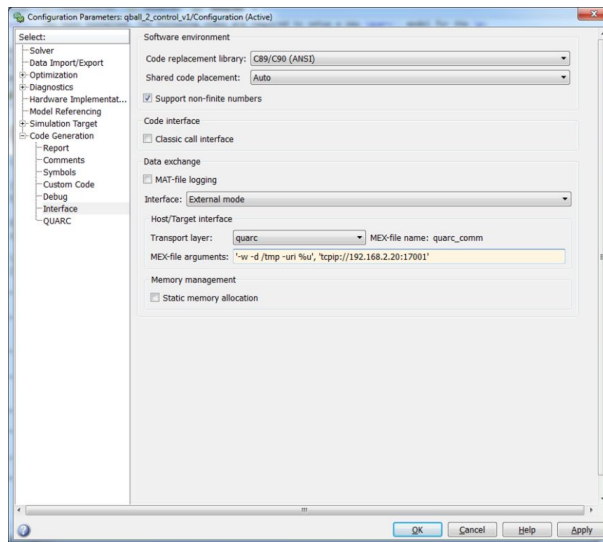


Figure 3.7: Model target IP settings

5. Select External for simulation mode, instead of Normal, which indicates that the model is to be run on the target machine (Gumstix) rather than simulating the model on the host machine.
6. The model is now ready to be compiled and downloaded to the target. If the wireless connection to the vehicle has been established, a **QUARC®** console can be opened to show additional messages and progress during model compilation by going to the menu item **QUARC | Console** for all. Building the model (**QUARC | Build**) will begin the code generation and compiling steps. Output from the compilation is shown in the **QUARC®** console. This step may take a few minutes to complete.

4 Troubleshooting

For any issue, the first and easiest troubleshooting solution on any electronic device is to reboot the device. Turn off the QBot 2, then turn it back on again. For troubleshooting any problem with the QBot 2, it is always a good idea to open the **QUARC®** console in case additional information is printed to the console by going to the **QUARC®** menu and clicking on Console for all... The console must be opened after the QBot 2 has booted and established a WiFi connection. If the console is opened successfully it establishes a connection to the target and the console window has the title `QUARC Console for * at tcpip://192.168.2.xxx:17000`, where xxx corresponds to the IP address of the QBot 2.

If you are still unable to resolve the issue after reading through this section, contact tech@quanser.com for further assistance.

Q1 You cannot ping the QBot 2

Make sure the router is on and the WiFi light on the router is on. Check that the network adapter of the host PC is connected to the router (or the wireless network Quanser_UVS or Quanser_UVS-5G) and is configured according to the network configuration procedure outlined in this manual (Section 3.2). Verify that you can successfully ping the QBot 2 by going to the Windows *Start* | *Run* and typing `ping 192.168.2.xxx`, where xxx corresponds to the IP address of your QBot 2. Turn off the QBot 2 power and remove the DAQ PCB by removing the six screws shown in Figure 4.1 and verify that the Gumstix and antenna are properly connected. Make sure the Gumstix and antenna are securely connected and retry the above steps to establish a wireless connection. Recycle the power or turn on the robot and wait for approximately 60 seconds.

□ □ □

Q2 The model fails to build/connect or the QUARC console does not successfully open

Turn on the QBot 2 and look at the QBot 2 DAQ PCB between the DAQ and the Kobuki chassis base. When the QBot 2 powers up, you will see a green LED come on on the bottom of the DAQ. After approximately 30 seconds, a red LED will flash to indicate the QBot 2 WiFi is powering on, and is attempting to connect to the WiFi network. If the red LED flashes and remains on, then the WiFi module is functioning and is able to find the wireless network. If the red LED flashes and then turn off, the QBot 2 is not connected to the wireless network. Check that the network adapter of the host PC is connected to the router (or the wireless network Quanser_UVS or Quanser_UVS-5G) and is configured according to the network configuration procedure outlined in this manual (3.2). Verify that you can successfully ping the QBot 2 by going to the Windows *Start* | *Run* and typing `ping 192.168.2.xxx`, where xxx corresponds to the IP address of your QBot 2. If the red LED never flashes, the wireless antenna or Gumstix may be disconnected. Turn off the QBot 2 power and remove the DAQ PCB by removing the six screws shown in Figure 4.1 and verify that the Gumstix and antenna are properly connected. Make sure the Gumstix and antenna are securely connected and retry the above steps to establish a wireless connection.

□ □ □

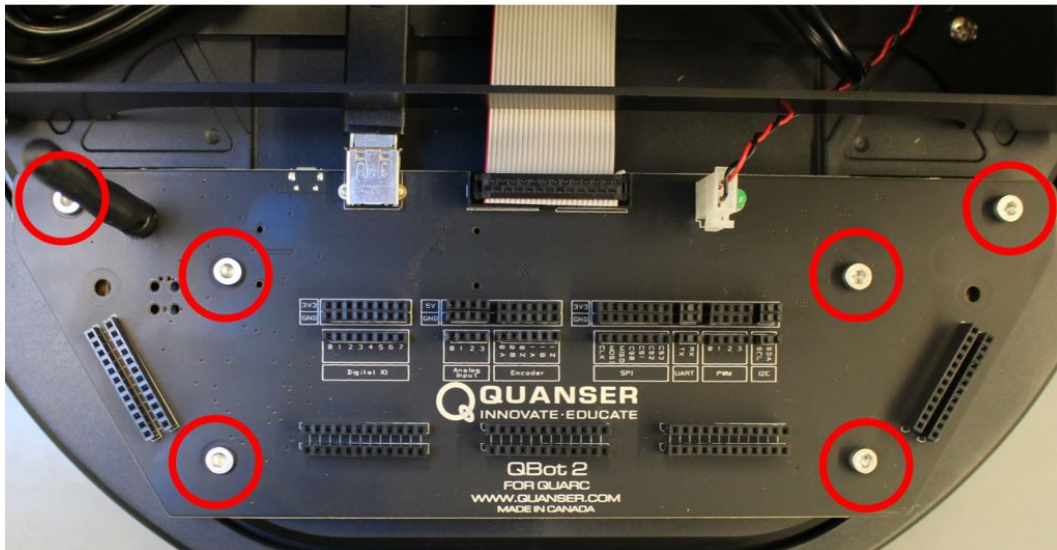


Figure 4.1: The QBot 2 DAQ mounting screws

Q3 The QBot 2 sensors are not being read correctly or they are stuck at some constant value

Using the HIL Read block, output all possible channels. Check these outputs using scopes and displays, and determine if the problem lies with a particular sensor, or set of sensors, or if the issue is global across all sensors.

□ □ □

Q4 The **Simulink®** model appears to run slowly (i.e., the simulation time runs slower than actual time), or the console displays the message *Sampling rate is too fast for base rate*

- (a) The maximum sample rate recommended for the QBot 2 is 1000 Hz (*sampletime*0.001 s). However, if there are complex calculations (such as image processing) performed within the model, then this could potentially limit the sample rate of the model (suggested sample rate of 100 Hz or 50 Hz). Try reducing the model sample rate in the menu *QUARC | Options | Solver* by increasing the *Fixed-step size (fundamental sample time)* parameter.
- (b) To determine the execution time of blocks or subsystems within the model, use the *Computation Time* block found in the *QUARC library | Sources | Time*. This block outputs the computation time of a function call subsystem, measured using an independent high-resolution time source. Blocks can be placed inside a function call subsystem and connected to the *Computation Time* block to determine their execution time during each sample instant. This helps identify the bottlenecks in the model (blocks/subsystems with the highest execution time) and can identify blocks/subsystems whose computation time is greater than the sample time of the model. Try increasing the sample time of those blocks whose computation time is greater than the sample time of the model so that the blocks run in a slower rate thread.
- (c) If you are using image processing blocks, ensure that they are only executed when there is new image data available or at a slower rate than the image acquisition rate. Otherwise, the embedded computer is spending time processing image data that has already been processed, which can cause the model's computation time to increase undesirably. For complex image processing, consider lowering the rate of the image processing blocks and/or downsampling the source images to a lower resolution to speed up processing time.
- (d) If you are using image processing blocks, ensure that signal duration is set to 1 by going to *Tools | External Mode Control Panel | Signal & Triggering | Duration* menu on the model (The default value is 10000).

□ □ □

Q5 Trying to start the QBot 2 model results in the error *Unable to locate the dynamic link library or shared object*

This error indicates that the QBot 2 driver is not found on the target. Make sure that the model target type is set to *quarc_linux_duovero* by navigating to the *QUARC®* menu *QUARC | Options | Code Generation* pane and

changing the System target file to `quarc_linux_duovero.tlc`. Open a console through the QUARC® menu *QUARC| Console for all*, and verify that the console window displays the target IP of your QBot 2 in the window title.

□ □ □

Q6 Building a model fails when the error *Not enough system resources are available to perform the operation*

When several models are compiled, the disk space on the Gumstix may become full, and you will no longer have space to build models. Using the clean option in the QUARC® menu under *QUARC | Clean all* will remove all generated code and compiled code for the current model, but this will only free up the space used by the current model. To view all models currently downloaded on the target select *Manage target* under the QUARC® menu. The current model's target must be powered on and ready to accept a connection. The target information is displayed including all models that have been downloaded to the target. To clear all downloaded models select all the models in the list and click *Remove*. Note: this will only remove generated code from the target and will not delete the source models on the host PC.

□ □ □

5 Technical Support

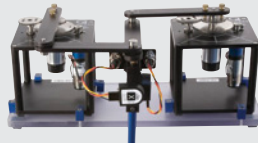
To obtain support from Quanser, go to <http://www.quanser.com/> and click on the Tech Support link. Fill in the form with all the requested software and hardware information as well as a description of the problem encountered. Also, make sure your e-mail address and telephone number are included. Submit the form and a technical support person will contact you.

Solutions for teaching and research in robotics and autonomous systems

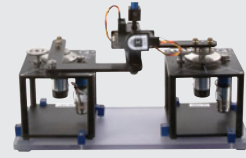
► 2 DOF Robot



► 2 DOF Gantry



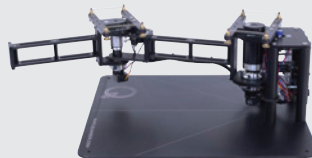
► 2 DOF Inverted Pendulum



► 2 DOF Planar Robot



► 2 DOF Serial Flexible Joint



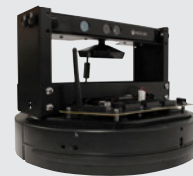
► 2 DOF Serial Flexible Link



► 6 DOF Denso Open Architecture Robot



► QBot 2



► QBall 2



► Unmanned Vehicle Systems Lab



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