

Qball-X4

Set Up and Demo Guide

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Qball Hardware

- Quad-rotor
- Sensors
 - Sonar
 - Accelerometer
 - Gyroscope
 - Magnetometer
- Quanser HiQ
 - Gumstix computer + IMU



Picking up the Qball

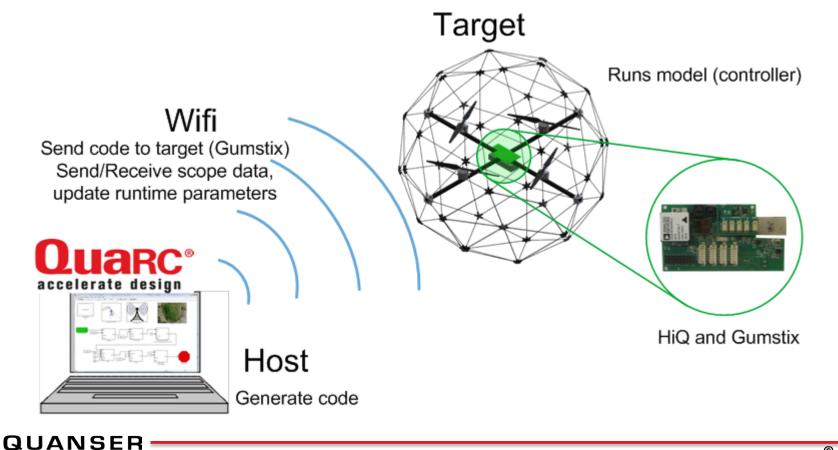
- Do NOT pick up the Qball by the cage
- Lift the Qball using both ends of the frame





Operation Overview

• Host PC running QUARC sends commands via TCP/IP connection to Qbot w/ Gumstix



Installation Overview

- 1. Install/test QUARC on HOST PC
- 2. Connect charged batteries
- 3. Set up wireless connection between PC and Qball
- 4. Test the Qball sonar sensor
- 5. Fly the Qball using the joystick



QUARC Software Requirements

- You NEED to install the following software BEFORE installing QUARC
 - MATLAB
 - Simulink
 - Simulink Coder
 - MATLAB Coder
 - Control System Toolbox
 - OptiTrack Users: also need Stateflow Toolbox
- See the QUARC Quick Installation Guide for details on the EXACT versions you need!





Installing QUARC

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- To install QUARC, follow the instructions in QUARC Quick Installation Guide carefully
- IMPORTANT: On the Features Installation screen, make sure select **Gumstix** Support and Simulink Beta **Components** features



Quick Installation Guide: Quarc QUARC 2.3, Quanser Real-Time Rapid Control Prototyping Software for Windows®1

STEP 1 Install MATLAB and Add-On Requirements

QUARC® supports both 32-bit and 64-bit versions of Microsoft Windows® 7.

Depending on the version of Microsoft Windows 7 used, ensure the corresponding 32-bit or 64-bit MATLAB® R2011a, R2011b, R2012a, or R2012b is installed on the computer with the following required add-ons accompanying the corresponding MATLAB version:

- Simulink
- Simulink Coder
- MATLAB Coder
- · Control System Toolbox, (required by most of Quanser's control laboratories)

For details, refer to the Compatibility Chart on page 12.

STEP 2 Install Microsoft Compiler Requirements

QUARC requires a MATLAB-supported C++ compiler.

Depending on the MATLAB version used, ensure only one of the following two Microsoft compilers is installed:

Microsoft Visual Studio Professional Edition 2010 (version 10.0) If MATLAB R2011a, R2011b, R2012a, or R2012b is used.

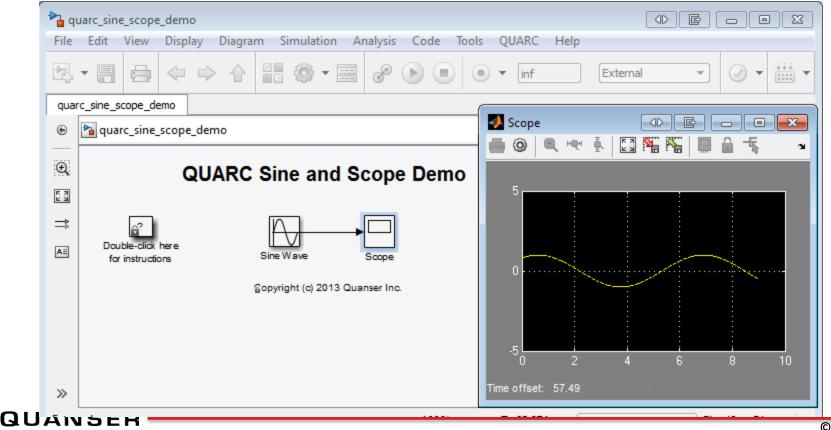
Microsoft Windows SDK 7.1 if MATLAB R2012a or R2012b is used.

The Microsoft Windows SDK 7.1 can be installed

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Testing QUARC

 After installing QUARC on the HOST PC, make sure you can run the quarc_sine_scope_demo



Qball Software

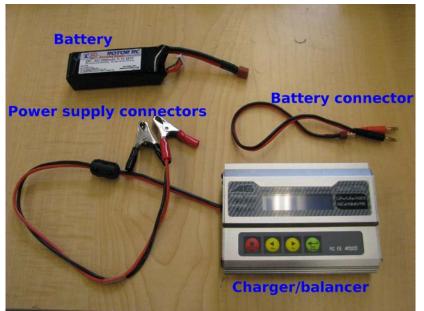
- Qball is already shipped with QUARC installed on the Gumstix embedded computer
- If you need to update QUARC on the Qball:
 - See

http://www.quanser.com/tutorials_quarc_gums tix



Step 2) Install Batteries

- Before starting, make sure have two fully charged Li-Po batteries
- See **Section 7** in *Qball-X4 User Manual* for full instructions





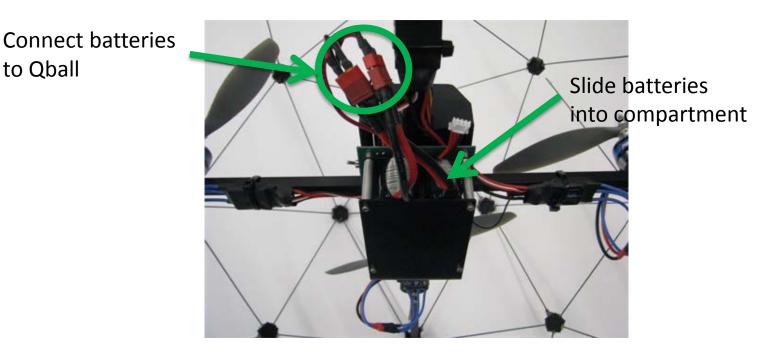
Charging Instructions



- 1. Connect charger to battery. There a. I connections for each battery:
 - 1. Connect battery to "3-cell" connector
 - 2. Connect red/black cables
- Configure charger for 3-cell LiPo battery 11.1 (3S) at 2.5A
- 3. Start charger:
 - 1. Hold down Start/Enter button until beep is heard
 - 2. Press Start/Enter again to confirm.
- 4. Charger will beep and display message when fully charged

Insert Batteries

- 1. Slide both LiPo batteries into compartment
- 2. Secure the batteries with the Velcro strap
- 3. Connect the red/black leads to Qball





Step 3) Wireless Connection

 Establish wireless connection between the host PC and the Gumstix embedded computer on the Qball/HiQ





Wireless USB Adapter

- Wireless USB adapter is supplied
- Install supplied wireless USB adapter in host PC





Disable Windows Firewall

• Go to Control Panel | Firewall

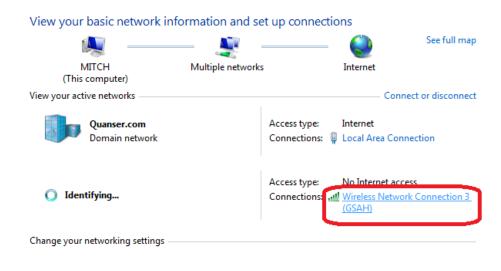
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Disable the Firewall (may interfere with Qball communication)

🕒 🗢 🖝 🕨 Control Panel	All Control Panel Items Windows Firewall			
Control Panel Home	Help protect your computer with Windows Firewall			
Allow a program or feature through Windows Firewall	Windows Firewall can help prevent hackers o through the Internet or a network.	or malicious software from gaining access to your computer		
Change notification settings	How does a firewall help protect my comput	ter?		
Turn Windows Firewall on or off	What are network locations? Update your Firewall settings			
💮 Restore defaults				
😚 Advanced settings	Windows Firewall is not using the reco	ommended		
Troubleshoot my network	settings to protect your computer. What are the recommended settings?			
	Do <u>m</u> ain networks	Connected 🤅		
	Networks at a workplace that are attached t	o a domain		
	Windows Firewall state:	Off		
	Incoming connections:	Block all connections to programs that are not on the list of allowed programs		
	Active domain networks:	Quanser.com		
	Notification state:	Notify me when Windows Firewall blocks a new program		
	Bome or work (private) ne	etworks Not Connected (
See also	<u>P</u> ublic networks	Not Connected 🔇		
Action Center				

TCP/IP Settings

- Go to the wireless network settings
- Select TCP/IPv4 and go to "Properties"



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Wireless Network Connection 3 Properties				
Networking Sharing				
Connect using:				
802.11 USB Wireless LAN Card #3				
<u>C</u> onfigure				
This connection uses the following items:				
Client for Microsoft Networks avast! Firewall NDIS Filter Driver QoS Packet Scheduler File and Printer Sharing for Microsoft Networks File and Printer Sharing for Microsoft Networks Internet Protocol Version 4 (TCP/IPv4) Internet Protocol Version 4 (TCP/IPv4)				
Link-Layer Topology Discovery Responder				
Description				
Transmission Control Protocol/Internet Protocol. The default wide area network protocol that provides communication across diverse interconnected networks.				
OK Cancel				

Set IP Address

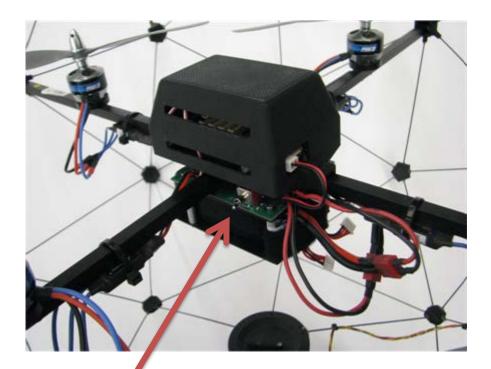
- Set host PC wireless adapter to an IP between 182.168.1.10 and 182.168.1.19
- Subnet =
 255.255.255.0
- No Gateway needed

Internet Protocol Version 4 (TCP/IPv4	4) Properties					
General						
You can get IP settings assigned aut this capability. Otherwise, you need for the appropriate IP settings.						
Obtain an IP address automatic	ally					
Ose the following IP address:						
IP address:	182.168.1.10					
Subnet mask:	255 . 255 . 255 . 0					
Default gateway:						
Obtain DNS server address automatically						
Use the following DNS server addresses:						
Preferred DNS server:						
Alternate DNS server:	• • •					
Validate settings upon exit Advanced						
	OK Cancel					



Power up Qball

- Turn ON the power switch on the Qball
- Should start to hear beeping noise
- Propellers will rotate incrementally



Turn ON power switch



GSAH Network

- "GSAH" network should appear under your wireless networks
- Connect to the GSAH network



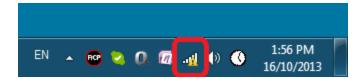


Check network status

- Once HOST PC IP is set, the GSAH network should NO longer say "Identifying..."
- Wireless icon will have an "!" mark

Unidentified network Access type: No Internet access Public network Connections: If Wireless Network Connection 3 (GSAH)			· · · ·	
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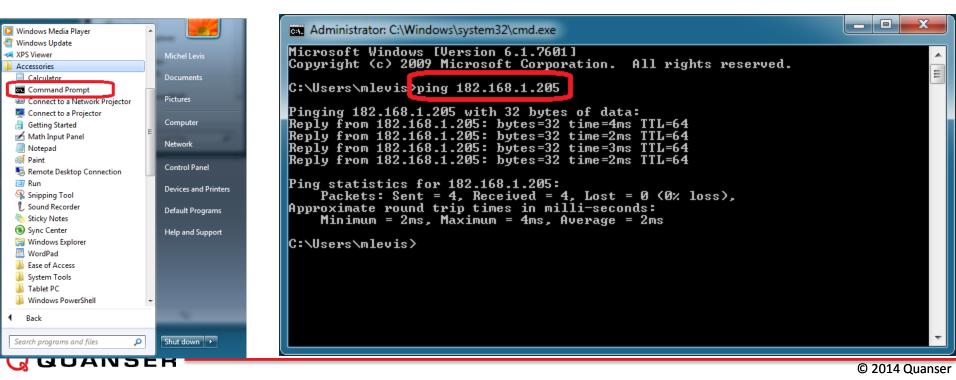
Qball IP

- Each Qball/Gumstix has a unique IP address
- IP address is labelled on the tail
 - between 182.168.1.20 and 182.168.1.254



Ping Test

- 1. Load "Command Prompt" (under Start | Accessories)
- 2. Enter "ping 182.168.1.xxx" command
- 3. Should get "Reply" message from Gumstix/Qball



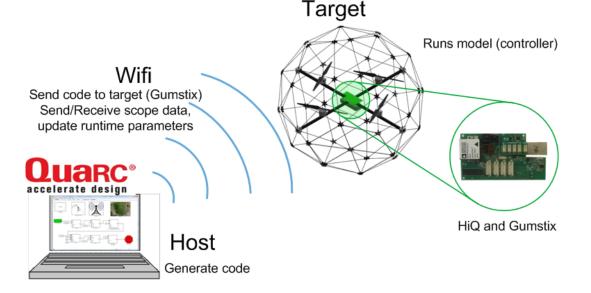
Step 4) Testing the Sonar

1. Open HOST controller

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Sends commands to Qball / monitor signals

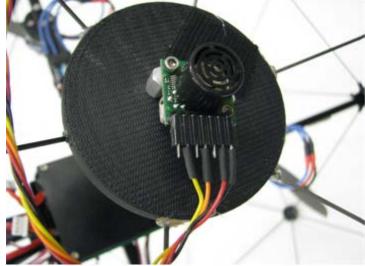
- 2. Open and configure Qball controller Download and runs on Gumstix
- 3. Run both controllers to fly Qball



Initial Sonar Test

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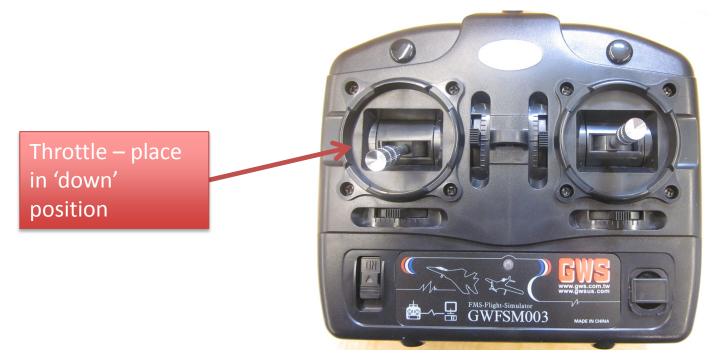
- Before flying the Qball, we will first make sure the sonar sensor is reading properly
- Using the sonar to detect the Qball height makes it easier to fly – especially the 1st time



Joystick

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- Connect joystick your PC via USB
- Make sure throttle is initially in the "down" position!

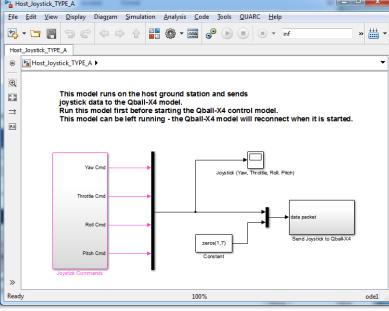


Open HOST Controller

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- 1. Go to the "\QBALL-X4\Controllers\Qball-X4" folder in MATLAB
- 2. Open the "Host_Joystick_TYPE_A" Simulink model

Or "Host_Joystick_TYPE_B" -- check label on your joystick



Open QBALL Controller

Open "qball_x4_control_v4" Simulink
 model

- doon-	_x4_control_v4				
<u>F</u> ile <u>E</u> o	dit <u>V</u> iew <u>D</u> isplay Diag <u>r</u> am <u>S</u>	imulation <u>A</u> nalysis <u>C</u> ode <u>T</u> oo	ls <u>Q</u> UARC <u>H</u> elp		
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к <u>и</u>		4 Joystic			
⇒	Control the Qball-X4 u	sing a joystick.			
AE	Switch between joystic	k and closed-loop control	using the switches inside		
	the Mode Control subs		y		
	In closed loop flight, o	ontrol the position of the QI	hall X/I by setting height		
		sition Commands subsyste			
			0		
		otor output signals in the H st MAT-file in HiQ\SAVE DA			
			, ,		_
	Position Commands	Mode control	Calculate Roll Pitch Heading	SAVE DATA	
			-	(black box)	
	HiQ Joystid	from host Pitch Controller	Roll Controller Yaw	Controller Controlsig	nal mixing
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Ready			100%		ode1



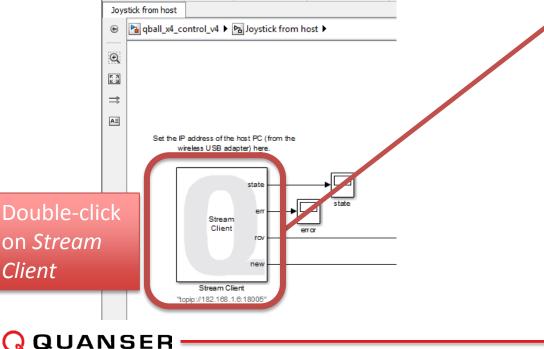
Configure Model

- In *qball_x4_control_v4*, go to QUARC | Options and select the *Interface* panel
- Add the following to the MEX-file arguments field: tcpip://{IP of Gumstix}:17001

Configuration Parameters: qb	oot_drive/Configuration (Active)
Select:	Software environment
Solver Data Import/Export Optimization	Code replacement library: C89/C90 (ANSI)
Diagnostics Hardware Implementat Model Referencing	✓ Support non-finite numbers
Simulation Target Gode Generation	Code interface Image: Classic call interface
···Report ···Comments ···Symbols	Data exchange
····Custom Code ····Debug ····Interface	Interface: External mode
····QUARC ····Optimization ····BasicAnalysis	Host/Target interface Transport laver:
LoopsAnalysis AliasAnalysis	MEX-file arguments: '-w -d /tmp -uri %u' 'tcpip://182.168.1.205:17001'
FunctionAnalysis InlineAnalysis Miscellaneous Custom	Memory management Static memory allocation

Setup HOST IP

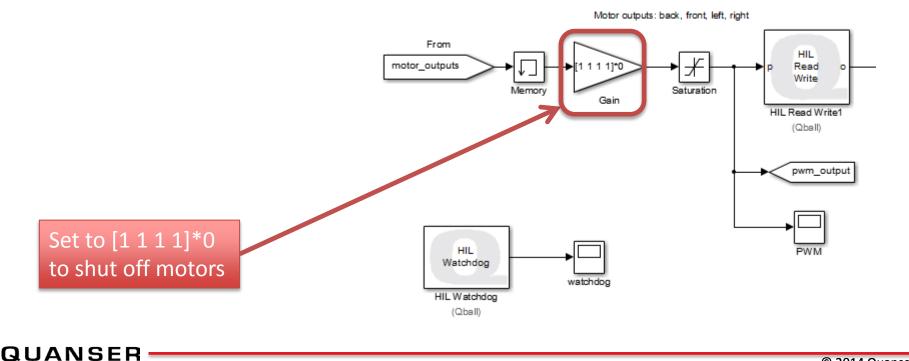
- In *qball_x4_control*, go to the "Joystick from host" subsystem
- 2. Set the IP address of your HOST PC in the *Stream Client* block (e.g. 182.168.1.6)



🛃 Source Block Parameters: Stream Client						
_ Stream Client						
Connects to a remote host and sends and/or receives data from that host.						
Main Signal Data Types						
Source of URI: Specify via dialog (do not evaluate)						
URI of host to which to connect:						
tcpip://182.168.1.6:18005						
Apply URI to all configurations (including normal simulation)						
Send buffer size in bytes:						
1460 Set IP address						
Receive buffer size in bytes: of HOST PC						
1460 OTTIOSTFC						
Byte ordering: little endian (Intel - LSB first)						
Optimize for: Minimum latency 🗸						
Implementation: Use non-blocking VO						
Send options: Do not send data						
Receive options: Receive most recent data						
Default output value:						
zeros(11,1)						
Sample time (seconds):						
qc_get_step_size						
Active during normal simulation						
OK Cancel Help Apply						

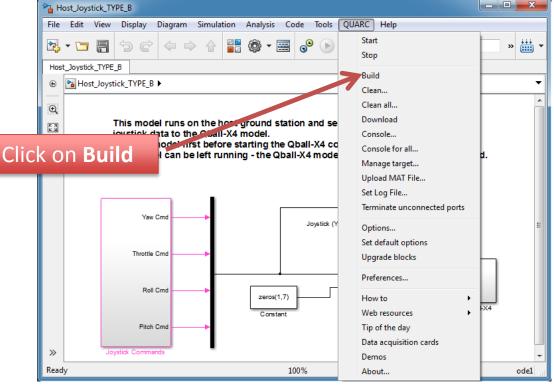
Turn OFF Motors (for now)

- 1. In order to test the sonar, we need to temporarily deactivate the motors
- 2. Go to HiQ subsystem
- 3. Set the Gain block to "[1 1 1 1]*0"



Build HOST Controller

 In the Host_Joystick_TYPE_B, go to QUARC | Build



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Build Qball Controller

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In *qball_x4_control_v4*, go to *QUARC* Build
 Build

Start 2 🖸 🔁 - 🗁 🖷 🛞 - 🚍 Stop gball_x4_control_v4 Build gball_x4_control_v4 > ۲ Clean... Clean all... Q Joystick Download Console... Click on Build using a joystick. Console for all... Manage target... AΞ Switch between joystick and closed-loop control us Upload MAT File... the Mode Control subsystem. Set Log File... Terminate unconnected ports In closed-loop flight, control the position of the Qba and heading in the Position Commands subsystem Options... Set default options View IMU data and motor output signals in the HiQ Upgrade blocks Data is logged to a host MAT-file in HiQ\SAVE DAT Preferences... How to Web resources Tip of the day Data acquisition cards Demos Position Commands Mode control About...

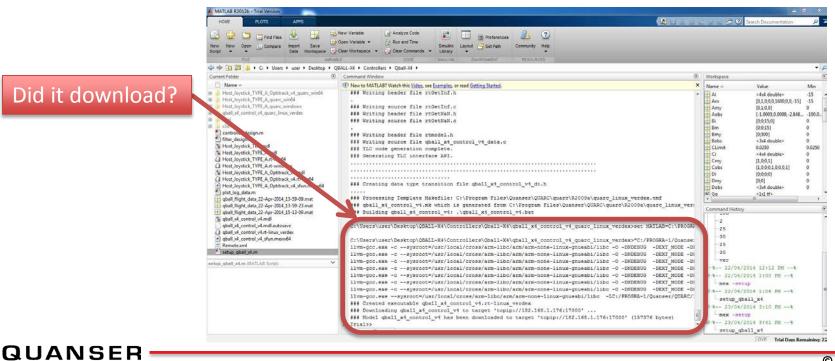
MATLAB Prompt

• The following message should be shown in the MATLAB Command Window:

Created executable qbot_drive.rt-linux_verdex

Downloading qball_x4_control_v4 to target 'tcpip://182.168.1.205:17000' ...

Model qball_x4_control_v4_drive has been downloaded to target
 'tcpip://182.168.1.205:17000'



Did it download?

 If the "target downloaded to..." message was NOT seen in the MATLAB prompt then go <u>here</u>.

New New Open Compare Import Save	New Variable & Analyze Code Open Variable ~ Open Variable ~	C O Scara	eh Documentation	1
		Workspace		
□ Name +		and the second second	Value	Min
Antonia and Antoni	<pre>### Writing Normed back we builted to the stand Annual Annua</pre>	A A	<pre>«4.4 double> «1.100.1000.0.100.00.15] [0.100.0009.2544 [0.00150] [0.0153] [0.0153] [0.0153] [0.0153] [0.0013] [0.0013] [0.0013] [0.0013] [0.0013] [0.0013] [0.0013] [0.0013] [0.0014] [0.00.01] [0.0014] [</pre>	-15 -15 0

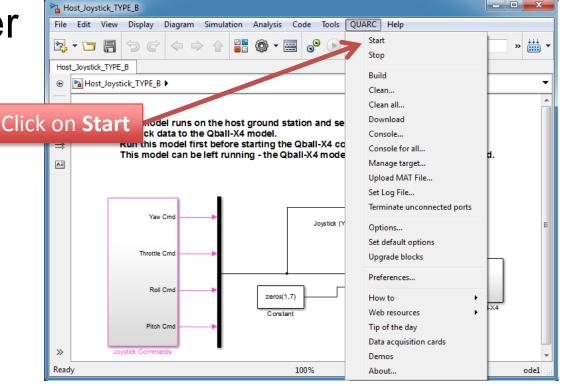
Not dov

to Qball

Run HOST Controller

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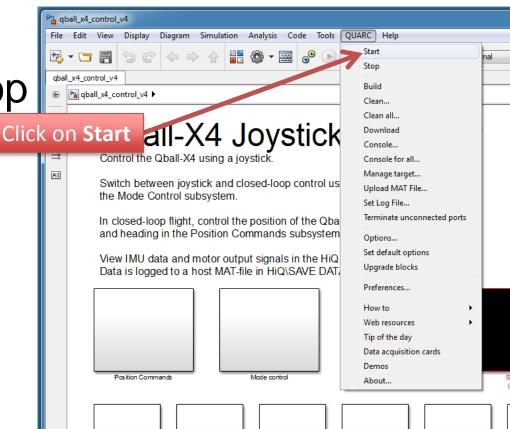
- In Host_Joystick_Type_B, go to QUARC | Start
- Always start this controller BEFORE the Qball controller



Run Qball Controller

- In *qball_x4_control*, go to *QUARC* | Start
- Always start this controller AFTER the HOST
 PC controller
 File Edit View Display Diagram Simulation Analysis Code Tools QUARC Help
- Beeping should stop

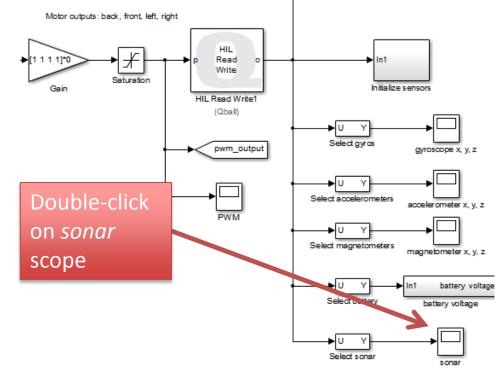
-- If you don't start this after the HOST, you will get communication error prompts



Testing Sonar

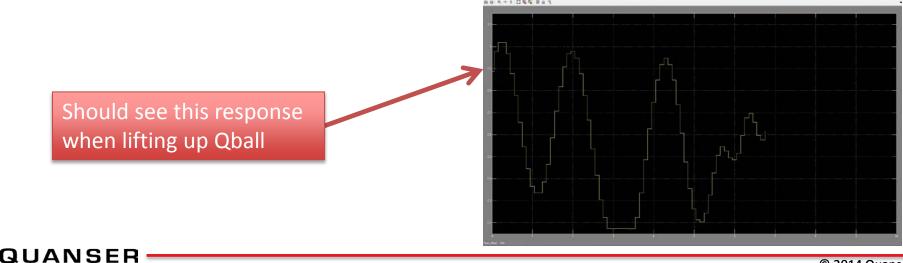
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- Select the *qball_x4_control_v4* controller
- Go into the *HiQ* subsystem and doubleclick on the *Sonar* scope



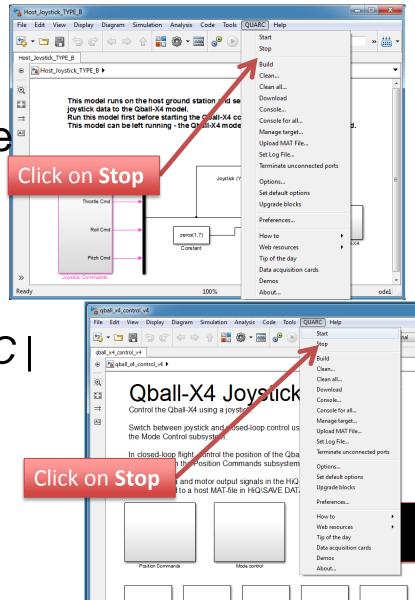
Testing Sonar

- Sonar shows the height measurement
 Note: range about 0.2 m to 7.6 m
- Manually lift up the Qball by the edges (as shown <u>here</u>)
- Is the Sonar scope showing the measurement?



Sonar Working?

- 1. If the sonar is reading properly, then place the Qball back down
- 2. Stop both controllers:
 - In *qball_x4_control_v4* controller, go to *QUARC* | Stop
 - 2. Similarly, stop the *Host_Joystick_Type_B* controller.



Step 5) Flying the Qball

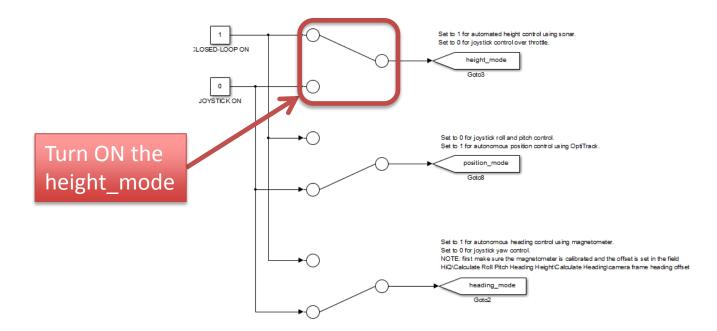
- 1. Turn ON automated height control (using sonar)
- 2. Enable the motors
- 3. Fly the Qball



Turn ON Height Control

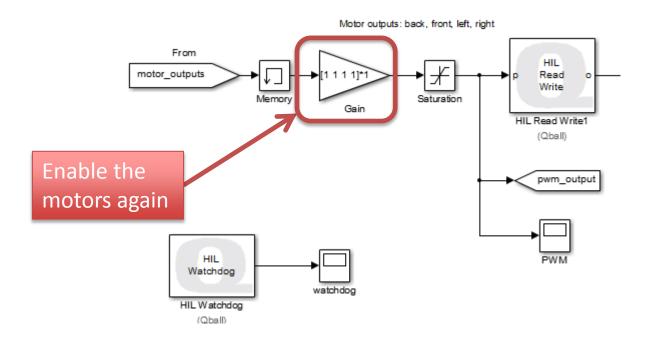
- Go to the Mode Control subsystem in the qball_x4_control_v4
- Turn ON the *height_mode* switch

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Enable the Motors

 In *qball_x4_control_v4*, set the *Gain* block in the *HiQ* subsystem back to [1 1 1 1]*1



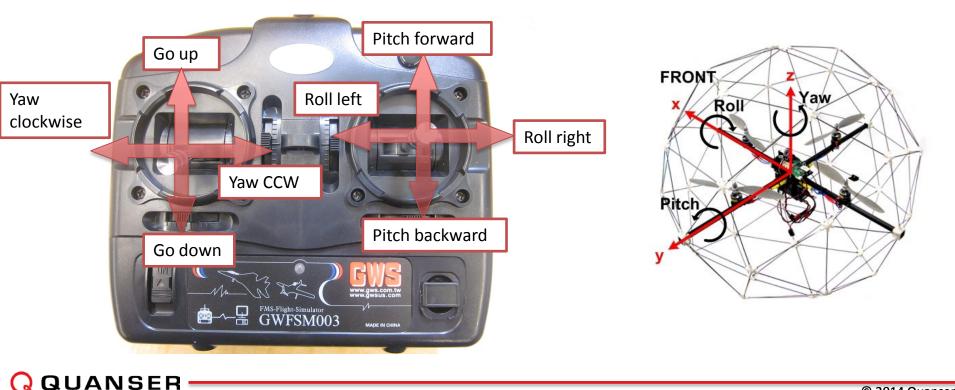
Run the Controllers

- Run the controllers following the same procedure:
 - Run Host_Joystick_Type_B (i.e. go to QUARC | Start)
 - Run qball_x4_control_v4
 - Note: always run the qball controller AFTER the host controller



Controlling the Qball

- You have control of the pitch and yaw
- Height control is automated
- Make slow movements Qball is very sensitive to the commands



Slowly Increase Throttle

- 1. Slowly increase the throttle of the joystick
- 2. Propellers should eventually start spinning and Qball will start lifting
- 3. Most of control done with RIGHT pitch/roll joystick control



Control mostly done w/pitch/roll joystick control

Keep Tail Towards You

- Try to keep the Qball tail (marked in orange tape) towards you
- Use the yaw controller on the joystick





Stopping the Qball

- 1. Bring joystick throttle DOWN to land Qball
- 2. Stop the *qball_x4_control_v4* controller
- 3. Stop the *Host_Joystick_Type_B* controller



Common Download Issues

- Are you still connected to the GSAH network?
- Go back to the "**ping test**" to confirm that you can "talk to" the Gumstix/Qbot
- Make sure you set the correct IP and port in *qbot_drive* (e.g. 'tcpip://182.168.1.140:17001')
- Gumstix may be TOO full



Gumstix Full

No

to

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 If it cannot download due to "Not enough system resources..." – Gumstix may be full

MATLAB R2012b - Trial Version			×
HOME PLOTS APPS		👔 🔄 🔄 🕄 Search Documentation	P
New New Open D Compare Import Save Script	New Variable Analyze Code		
FILE	VARIABLE CODE SIMULINK ENVIRONMENT RESOURCES		
🗢 🔶 🔁 🔀 🌗 C: 🕨 Users 🕨 user 🕨 Deskt	op ▶ QBALL-X4 ▶ Controllers ▶ Qball-X4 ▶		
Current Folder	Or Command Window	Workspace	(
🗋 Name 🔺	(1) New to MATLAB? Watch this Video, see Examples, or read Getting Started.	Name - Value N	Min
Host Joystick, TYPE, A. Optitrack, y4. quarc, wind Host Joystick, TYPE, A. quarc, wind Host Joystick, TYPE, A. quarc, wind g qball, wf_controller, design, m Host Joystick, Trest, mdl Host Joystick, Trest, Armid Host Joystick, TYPE, A. mid Host Joystick, TYPE, A. wind Host Joystick, TYPE, A. wind WFEA, Optitrack, v4. wind WFEA, Optitr	4 4 ### Writing source file rt_monfinite.c . ### Writing header file rtGetInf.h . . ### Writing source file rtGetInf.c ### Writing header file rtGetNaN.h . ### Writing source file rtGetNaN.c . ### Writing source file qball_wig=control_v4_data.c . ### Writing source file qball_wig=control_v4_data.c . ### TLC code generation complete. . ### Generating TLC interface API. .	Air c4x4 double> Air Am [0,1,0,0,0,1600,0,0-15]	-15 -15 0 -100.0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Ly4-mdh Ly4-mdh Apally4_controly4_fun.mex.¥4 Remote and ★ setup_gball_s4.m setup_gball_s4.m	<pre>### Building qball_x4_control_v4: .\qball_x4_control_v4.bat C:\Users\user\Desktop\QBALL-X4\Controllers\Qball-X4\qball_x4_control_v4_quarc_linux_verdex>set MATLAB=C:\PROGRA C:\Users\user\Desktop\QBALL-X4\Controllers\Qball-X4\qball_x4_control_v4_quarc_linux_verdex>"C:\PROGRA-1/Quanse: llvm=goc.exe = c -=sysroot=/usr/local/cross/arm-libc/arm/arm-none-linux-gnueabi/libc -0 -DNDEBUG -DEXT_MODE -DI start_scale_scale_scale_scale_scale_scale_scale_scale_scale_scale_scale_scale</pre>	-2 -25 -30 -25 -30 -25 -30 -422/04/2014 12:12 PM* -822/04/2014 1:00 PM* -822/04/2014 1:00 PM* -822/04/2014 3:10 PM* -823/04/2014 3:10 PM* -823/04/2014 3:41 PM* -823/04/2014 3:41 PM* -8	

Clear Out Gumstix

- 1. Go to QUARC | *Manage target...*
- 2. Set IP in URI

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- 3. View models downloaded to target
- 4. Select and remove ALL models
- Try building "qball_x4_control_v4" again

🛃 QUARC Target Information			_ _ X
QUARC Target Overview			
URI: tcpip://182.168.1.205:17000			.
Type: linux_verdex	Description:	QUARC Linux Verde	x Target
Version: 2.3.549.0	Revision:	24768	
Date: 2013/03/11	Compiled:	Jul 3 2013 00:27:39	
Models currently loaded on the target			
		۹ ۳	Stop Kill
- Models configured to load at boot		^	Do not load at boot
quarc_build qbot_receive_optitrack_test_mkFile.zip qbot_receive_optitrack_test.zip			Remove Load Load at boot Download
		~	Open
Auto-refresh Refresh Console	Save		Help Close

Still having issues?

- Still not downloading... go to the FAQ page at: <u>http://www.quanser.com/FAQ</u>
- See Section 8 in Qball User Manual

Quanser Qball-X4: User Manual

8. Troubleshooting Guide

For any issue, the first and easiest troubleshooting solution on any electronic device is to reboot the device. Turn off the Qball-X4, then turn it back on again. For troubleshooting any problem with the Qball-X4, 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 Qball-X4 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://182.168.1.xxx:17000", where xxx corresponds to the IP address of the Qball-X4.

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

8.1. The Qball has crashed! What should I do?

First, make sure that the model is stopped and the power is turned off. Do not approach the Qball if the model is still running or the propellers are turning. Upon stopping the Qball model, a saved data MAT-file is created on the host PC in the current directory. Make a

Contact Technical Support

If you are still having issues, contact technical support at:

http://www.quanser.com/ContactUs

