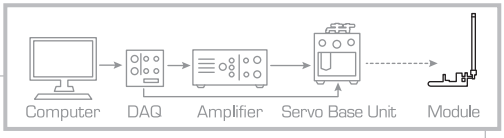
QUANSER
INNOVATE. EDUCATE.

Quick Start Guide: Rotary Inverted Pendulum

MATLAB SIMULINK

STEP 1 Check Components and Details

Make sure your Rotary Inverted Pendulum module includes the following components:



1. Rotary Inverted Pendulum module
2. Pendulum Link
3. T-Fitting (attached to shaft)
4. 5-pin DIN to 5-pin DIN encoder cable
5. Two sets of thumb screws
6. Two set of screws, screwed into fitting
7. 7/64 Allen key
8. Quanser Workstations Resources DVD* (includes controllers; digital versions of User Manual, Quick Start Guide and courseware; and other files)

*DVD supplied with the QUARC Real-time Rapid Control Prototyping software, see Step 2

STEP 2 Additional Components Required for Set Up

To complete the Rotary Inverted Pendulum set up, you will also need the following:

1. QUARC Real-time Rapid Control Prototyping Software Installation DVD
2. Rotary Servo Base Unit
3. Power Amplifier (VoltPAQ-X1 pictured)
4. One of the following data acquisition devices:
   a. Quanser Q2-USB, or
   b. Quanser Q8-USB, or
   c. NI PCI/PCIe with NI M and X Series Terminal Board
5. RCA to RCA cable
6. 4-pin DIN to 6-pin DIN motor cable
7. 5-pin DIN to 5-pin DIN encoder cable

Note: These components must be purchased separately.

To set up your Rotary Inverted Pendulum module, please read the following instructions carefully.

STEP 3 Install and Test QUARC

A. Make sure you have all required software, as listed in the QUARC Compatibility Table document located in the QUARC DVD folder.

B. See the QUARC Installation Manual for details on how to install the software.

C. Make sure you test the system using the Sine and Scope demo. You can access this by typing qc_show_demos in the Matlab prompt.

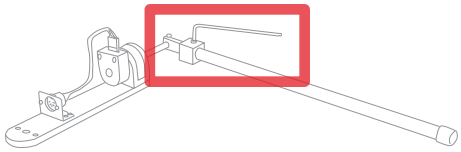
STEP 4 Set Up the Hardware

To set up your Rotary Inverted Pendulum module, please read the following instructions carefully. The connections shown below are illustrated using a generic data acquisition (DAQ) device and a VoltPAQ-X1 amplifier (you may have a different DAQ or amplifier). For detailed instructions, see the Rotary Inverted Pendulum User Manual (enclosed with shipment).

A Before proceeding, set up and test your Rotary Servo Base Unit. For detailed instructions, see the Rotary Servo Base Unit Quick Start Guide or User Manual.

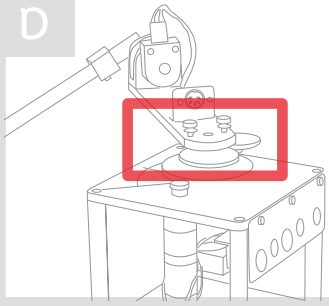
B Make sure everything is powered OFF before making any connections. This includes turning off your PC and the amplifier.

C



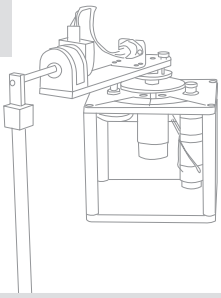
Insert the pendulum into the T-Fitting and fasten it using the set screw. The T-Fitting should be at the end of the metal shaft on the rotary arm and properly fastened.
Do not tighten the set screw too much.

D



Attach the Rotary Inverted Pendulum module to the Rotary Servo Base Unit load gear shaft using the two thumb screws.

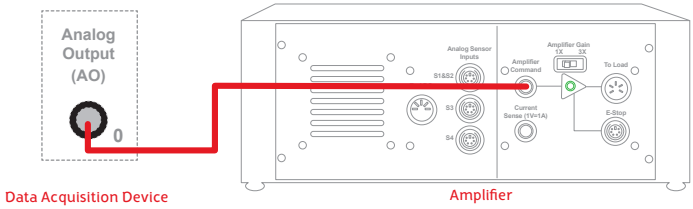
E



Place the Rotary Inverted Pendulum system on a table clear of any obstructions. It is recommended you clamp down the Rotary Servo Base Unit to the table.

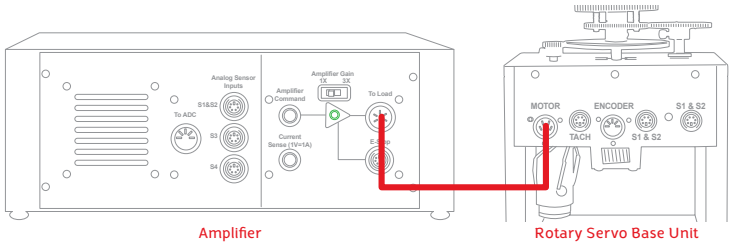
Make sure the pendulum is free to rotate 360 degrees.

F



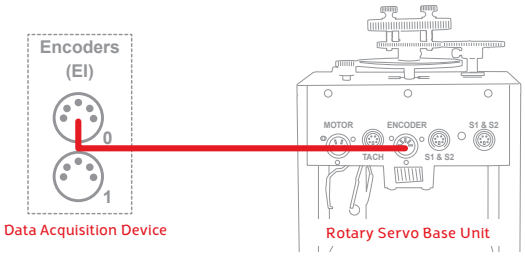
Using the RCA to RCA cable, connect **Analog Output Channel** #0 (AO #0) on the data acquisition device to the **Amplifier Command** socket on the amplifier.

G

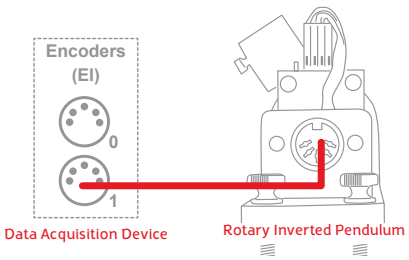


Using the 4-pin DIN motor to 6-pin DIN motor cable, connect the **To Load** socket on the amplifier to the **Motor** socket on the Rotary Servo Base Unit.

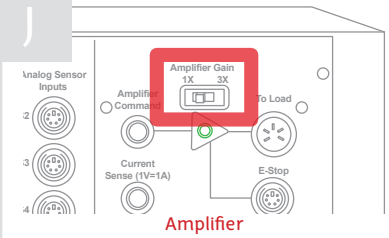
H Using the 5-pin DIN to 5-pin DIN encoder cable, connect the **Encoder** socket on the Rotary Servo Base Unit panel to the **Encoder Input Channel** #0 socket on the data acquisition device.



I Using the 5-pin DIN to 5-pin DIN encoder cable, connect the **Encoder** socket on the Rotary Pendulum module to the **Encoder Input Channel** #1 socket on the data acquisition device.



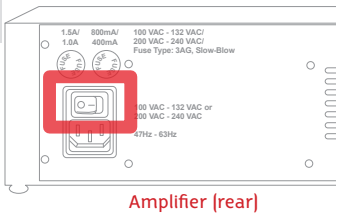
J



Amplifier

Attention VoltPAQ-X1 Users: Make sure you set the GAIN on the VoltPAQ-X1 to 1 when using any Rotary Servo Base Unit experiment.

K


Amplifier (rear)

Turn ON the power switch on the VoltPAQ-X1. It is located on the rear of the device.

STEP 5 Testing the Rotary Pendulum Module

Follow the procedure below to test your Rotary Inverted Pendulum.

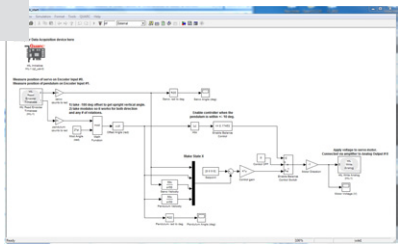
A

Make sure your PC and amplifier are powered ON.

B

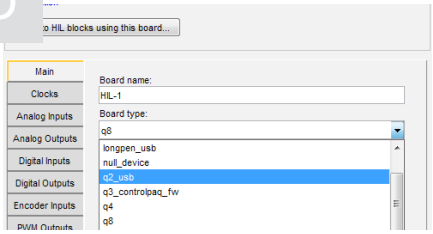
On the Resources DVD (supplied with the QUARC and Servo Base Unit package), locate the **Quick Start Folder**: Rotary\Rotary Inverted Pendulum\ Quick Start. Copy the Quick Start folder to your local hard drive.

C



Open the Simulink model file (.mdl) found under the Quick Start folder on your hard drive.

D



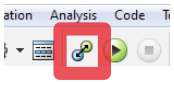
Configure HIL Initialize window

Double-click on the HIL Initialize block and choose the board that is installed on your system (e.g. Q2-USB).

E

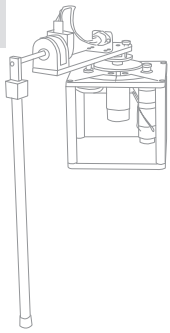
Click on the **Build Model** button on the Simulink model toolbar.

F



Once the model code has been compiled, click on the **Connect To Target** button.

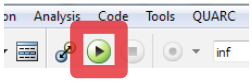
G



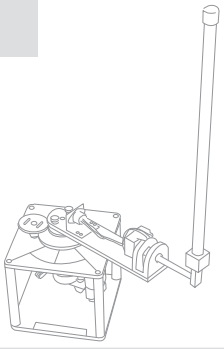
Make sure the pendulum is hanging downwards and is motionless.

H

Click on the **Run** button to start the QUARC real-time model.

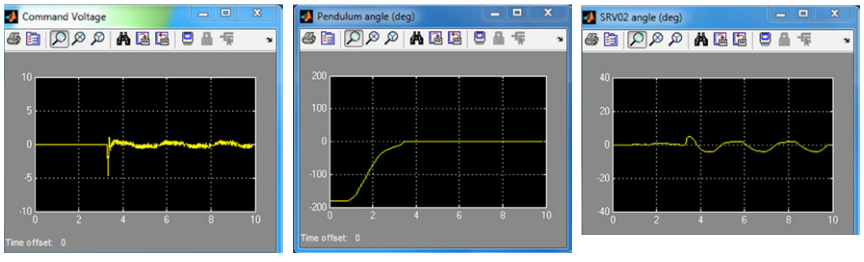


I



Manually rotate the pendulum to its upright vertical position. When the controller engages, immediately release the pendulum and it should start to balance.

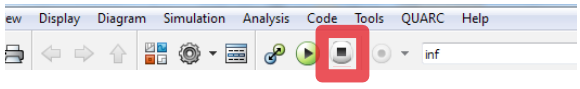
J



The scopes should look similar to those shown here. Otherwise, consult the trouble-shooting section at the end of this guide.

The **Pendulum Angle** scope shows the measured pendulum angle relative to the *upright vertical position*. Initially it starts at -180 degrees. As the pendulum rotates to the vertical position, the balance control engages and maintains the upright position.

K



Click on the Simulink Stop button to **stop** the running model.

TROUBLESHOOTING

Please review the following recommendations before contacting Quanser's technical support engineers.

1. Make sure the cables are firmly connected.
2. Check the connection (outlined in Step 4 in this guide).
3. Make sure the Rotary Servo Base Unit has been set up and tested successfully. Review the Rotary Servo Base Unit Quick Start Guide and User Manual setup or troubleshooting section for more information.

Getting an error when trying to build or run the Quick Start Simulink model (.mdl)

A. Type ver in the Matlab Command Window and verify that QUARC is on the list. If not, then go through the QUARC Quick Installation Guide to install QUARC. If it is listed, run mex-setup as described in the QUARC Installation Guide.

B. If the "... specific kernel level driver for the specified card could not be found" error is prompted when you attempt to run, then you may not have selected the correct data acquisition (DAQ) device in the HIL Initialize block or the DAQ device has not been installed properly (refer to the DAQ device User Manual).

The Motor is not responding.

A. Review connections in Steps 4F and 4G.

B. Ensure the power amplifier is powered on and operational, i.e., when using VoltPAQ-X1 verify that the green LED is lit.

C. Verify the data acquisition device is functional.

D. See the Rotary Servo Base Unit User Manual for more troubleshooting information.

The Encoder is not reading.

A. Review connections in Steps 4H and 4I.

B. Verify that the data acquisition (DAQ) device is functional. Refer to the DAQ User Manual for troubleshooting guidelines

C. See the Rotary Servo Base Unit User Manual for more troubleshooting information.

STILL NEED HELP? For further assistance from a Quanser engineer, contact us at tech@quanser.com or call +1-905-940-3575.

Expand the Rotary Servo Base Unit to the following popular experiments using Quanser Rotary Control add-on modules.

Double Inverted Pendulum

Flexible Link

Flexible Joint

Ball and Beam

LEARN MORE To find out about the full range of Quanser Rotary Control modules, visit www.quansercontrollabs.com