QUANSER
INNOVATE · EDUCATE

USER MANUAL

SRV02 Rotary Servo Base Unit

Set Up and Configuration

CAPTIVATE. MOTIVATE. GRADUATE.

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This product meets the essential requirements of applicable European Directives as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

1 Presentation

1.1 Description

The Quanser Rotary Servo Base Unit rotary servo plant, pictured in Figure 1.1, consists of a DC motor that is encased in a solid aluminum frame and equipped with a planetary gearbox. The motor has its own internal gearbox that drives external gears. The Rotary Servo Base Unit is equipped with two sensors: potentiometer and encoder. The potentiometer and encoder sensors measure the angular position of the load gear using different methods.

Figure 1.1: Quanser Rotary Servo Base Unit system

Caution

This equipment is designed to be used for educational and research purposes and is not intended for use by the general public. The user is responsible to ensure that the equipment will be used by technically qualified personnel only.

Note: This User Manual is for the Rotary Servo Base Unit Rev 2 system. If you are using the Rotary Servo Base Unit Rev 1 system (i.e. SRV02-ET), then please go to the Rev 1 User Manual for more information.

2 System Components

The Rotary Servo Base Unit components are identified in Section 2.1. Some of the those components are then described in Section 2.2.

2.1 Rotary Servo Base Unit Component Nomenclature

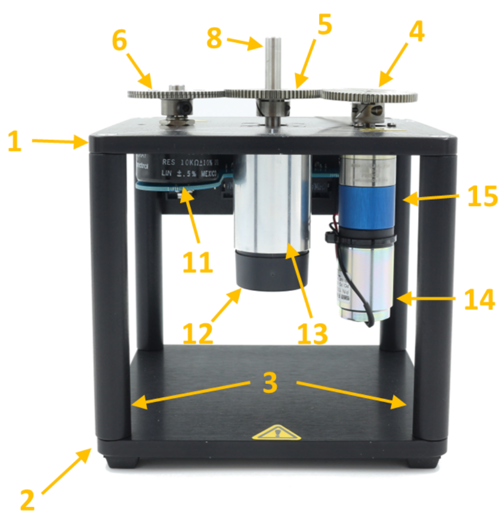
The Rotary Servo Base Unit components listed in Table 2.1 below are labeled in Figure 2.1a, Figure 2.1b, Figure 2.1c, Figure 2.1d, and Figure 2.1e. Note that Figure 2.1a shows the Rotary Servo Base Unit in the low-gear configuration and Figure 2.1b is the Rotary Servo Base Unit in the high-gear configuration. These different gear setups will be explained later in Section 4.1.

ID	Component	ID	Component
1	Top plate	12	Encoder
2	Bottom plate	13	Ball-bearing block
3	Posts	14	Motor
4	Motor pinion gear: 72-teeth (low-gear)	15	Motor Gearbox
5	Load gear: 72-teeth (low-gear)	16	Motor connector
6	Potentiometer gear	17	Encoder connector
7	Anti-backlash springs	18	Potentiometer connector
8	Load shaft (i.e. output shaft)	19	Bar inertial load
9	Motor pinion gear: 24-teeth (high-gear)	20	Disc inertial load
10	Load gear: 120-teeth (high-gear)	21	Thumb screws
11	Potentiometer		

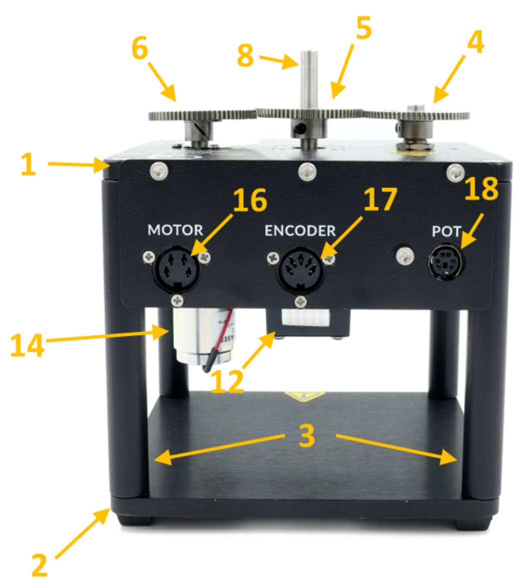
Table 2.1: Rotary Servo Base Unit Components

(a) Low-gear

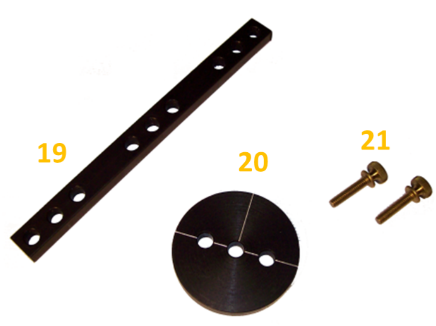
(b) High-gear



(c) Front view



(d) Connectors



(e) Inertial Loads

Figure 2.1: Rotary Servo Base Unit components

2.2 Component Description

2.2.1 DC Motor

The Rotary Servo Base Unit incorporates a Faulhaber Coreless DC Motor model 2338S006 and is shown in Figure 2.1c with ID #9. This is a high efficiency, low inductance motor that can obtain a much faster response than a conventional dc motor. The complete specification sheet of the motor is included in its specification sheet.

Caution

High-frequency signal applied to a motor will eventually damage the gearbox motor and the motor brushes. **The most likely source for high frequency noise is derivative feedback. If the derivative gain is set too high, a noisy voltage will be fed into the motor. To protect your motor, you should always band limit your signal (especially derivative feedback) to a value of 50 Hz.**

Caution

Input ± 15 V, 3 A peak, 1 A continuous.

Caution

Exposed moving parts.

2.2.2 Potentiometer

All Rotary Servo Base Unit models are equipped with a Vishay Spectrol model 138 potentiometer, shown in in Figure 2.1c with label #11. It is a single turn 10 kΩ sensor with no physical stops and has an electrical range of 352 deg. The total output range of the sensor is ± 5 V over the full 352 deg range. Note that a potentiometer provides an absolute position measurement as opposed to a relative measurement from, for instance, an incremental encoder. See its specification sheet for a full listing of the potentiometer specifications.

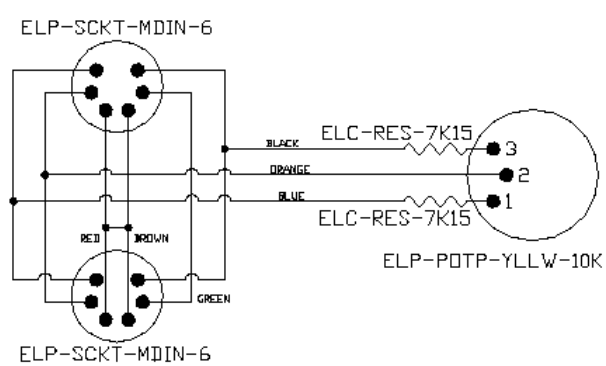


Figure 2.2: Rotary Servo Base Unit potentiometer wiring

As illustrated in Figure 2.2, the potentiometer is connected to a ± 12 V DC power supply through two 7.15 kΩ bias resistors. Under normal operations, terminal 1 should measure -5 V while terminal 3 should measure 5 V. The actual position signal is available at terminal 2.

2.2.3 Encoder

All Rotary Servo Base Unit models have an optical encoder installed that measures the angular position of the load shaft. It is pictured in Figure 2.1c with the label #12. The encoder used is a US Digital E2 single-ended optical shaft encoder that offers a high resolution of 4096 counts per revolution in quadrature mode (1024 lines per revolution). The complete specification sheet of the E2 optical shaft encoder is given in the US Digital specification sheet.

Remark that incremental encoders measure the relative angle of the shaft (as opposed to the potentiometer which measures the absolute angle).

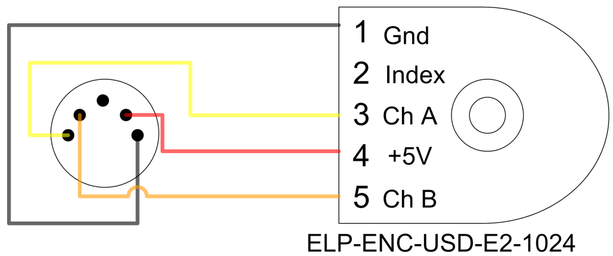


Figure 2.3: Rotary Servo Base Unit encoder wiring

The position signal generated by the encoder can be directly connected to the data-acquisition device using a standard 5-pin DIN cable. The internal wiring of the encoder and the 5-pin DIN connector on the Rotary Servo Base Unit, component #17, is illustrated in Figure 2.3.

Caution

Make sure you connect the encoder directly to your data-acquistion device and not to the power amplifier.

3 System Specifications

Table 3.1 lists and characterizes the main parameters associated with the Rotary Servo Base Unit. Some of these are used in the mathematical model. More detailed information about the gears is given in Table 3.2 and the calibration gains for the various sensors on the Rotary Servo Base Unit are summarized in Table 3.3.

Symbol	Description	Value	Variation
V_{nom}	Motor nominal input voltage	6.0 V	
R_m	Motor armature resistance	2.6 Ω	$\pm$ 12%
L_m	Motor armature inductance	0.18 mH	
k_t	Motor current-torque constant	7.68×10^{-3} N-m/A	$\pm$ 12%
k_m	Motor back-emf constant	7.68×10^{-3} V/(rad/s)	$\pm$ 12%
K_g	High-gear total gear ratio	70	
	Low-gear total gear ratio	14	
η_m	Motor efficiency	0.69	$\pm$ 5%
η_g	Gearbox efficiency	0.90	$\pm$ 10%
$J_{m,rotor}$	Rotor moment of inertia	3.90×10^{-7} kg-m^2	$\pm$ 10%
J_{eq}	High-gear equivalent moment of inertia without external load	2.087×10^{-3} kg-m^2	
	Low-gear equivalent moment of inertia without external load	9.7585×10^{-5} kg-m^2	
B_{eq}	High-gear Equivalent viscous damping coefficient	0.015 N-m/(rad/s)	
	Low-Gear Equivalent viscous damping coefficient	1.50×10^{-4} N-m/(rad/s)	
m_b	Mass of bar load	0.038 kg	
L_b	Length of bar load	0.1525 m	
m_d	Mass of disc load	0.04 kg	
r_d	Radius of disc load	0.05 m	
m_{max}	Maximum load mass	5 kg	
f_{max}	Maximum input voltage frequency	50 Hz	
I_{max}	Maximum input current	1 A	
ω_{max}	Maximum motor speed	628.3 rad/s	

Table 3.1: Main Rotary Servo Base Unit Specifications

Symbol	Description	Value
K_{gi}	Internal gearbox ratio	14
$K_{\text{ge,low}}$	Internal gearbox ratio (low-gear)	1
$K_{\text{ge,high}}$	Internal gearbox ratio (high-gear)	5
m_{24}	Mass of 24-tooth gear	0.005 kg
m_{72}	Mass of 72-tooth gear	0.030 kg
m_{120}	Mass of 120-tooth gear	0.083 kg
r_{24}	Radius of 24-tooth gear	6.35×10^{-3} m
r_{72}	Radius of 72-tooth gear	0.019 m
r_{120}	Radius of 120-tooth gear	0.032 m

Table 3.2: Rotary Servo Base Unit Gearhead Specifications

Symbol	Description	Value	Variation
K_{pot}	Potentiometer sensitivity	35.2 deg/V	$\pm$ 2 %
K_{enc}	Encoder sensitivity (in quadrature mode)	4096 counts/rev	

Table 3.3: Rotary Servo Base Unit Sensor Specifications

4 Setup and Configuration

As discussed in Section 4.1, the Rotary Servo Base Unit can be setup with two different gear configurations depending on the experiment being performed. Also, Section 4.2 shows how the Rotary Servo Base Unit can be fitted with different loads.

Caution

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

4.1 Gear Configuration

4.1.1 Description

The Rotary Servo Base Unit can be setup in the low-gear configuration or the high-gear configuration, as pictured in Figure 4.1a and Figure 4.1b, respectively. The high-gear setup is required to be used with additional modules such as the ball-and-beam device, the flexible link module, and the gyroscope.

(a) Low-gear

(b) High-gear

Figure 4.1: Rotary Servo Base Unit Gear Configurations

4.1.2 Changing Gear Configuration

Follow this procedure to change between high-gear and low-gear ratio:

1. Using the supplied Allen keys, loosen the set screws on the three gear shafts.
2. Remove the gears from the shafts.
3. Slide the new gears into place as described below:
    - Low-gear configuration shown in Figure 4.1a: place the 72-tooth gear, ID #5 in Figure 2.1a, onto the load shaft, ID #8 in Figure 2.1a, and the 72-tooth pinion gear, ID #4 in Figure 2.1a, on the motor shaft.
    - High-gear configuration depicted in Figure 4.1b: slide the 120-tooth gear, ID #10 in Figure 2.1b, followed by the 72-tooth gear, ID #5 in Figure 2.1b, on the load shaft and place the 24-tooth pinion gear, ID #9 in Figure 2.1b, on the motor shaft.

Note: The potentiometer gear, component #6 in Figure 2.1b, is an anti-backlash gear and special precaution need to be taken when installing it. In order to insert it properly, rotate its two faces against each other such that the springs are partially pre-loaded. Do not fully extend the springs when you pre-load the gears.

4. Ensure the teeth of all the three gears are meshed together. Remark that in the high-gear setup, the top 72-tooth load gear is meshed with the potentiometer gear, ID #6 in Figure 2.1b.
5. Tighten the set-screws on each shaft with the supplied Allen keys.

4.2 Load Configurations

4.2.1 Description

The Rotary Servo Base Unit is supplied with two external loads: a bar and a disk. These can be attached to the Rotary Servo Base Unit load gear to vary the moment of inertia seen at the output. The Rotary Servo Base Unit with the end of the bar load connected is pictured in Figure 4.2a. Either the end of the bar or the center of the bar can be used. In Figure 4.2b the Rotary Servo Base Unit with the disk load attached is shown.

(a) Bar load

(b) Disc load

Figure 4.2: Rotary Servo Base Unit Load Configurations

4.2.2 Installing Load

Follow this procedure to connect either the bar or disc load to the load gear:

1. Slide the center hole of the load on the output shaft of the Rotary Servo Base Unit, component #8 in Figure 2.1b. For the bar load (ID #19 in Figure 2.1e), use either the center hole in the middle of the bar or the center hole at the an end of the bar onto the output shaft.
2. Align the two holes adjacent to the center hole with the screw holes of the load gear.
3. Using the two 8-32 thumb screws provided, ID #21 in Figure 2.1e, fasten the inertial load to the output gear. The Rotary Servo Base Unit with the bar load and the disk load attached is shown in Figure 4.2a and Figure 4.2b, respectively. Make sure all the screws are properly tightened before operating the servo unit.
4. For instructions on how to install one the Rotary Servo Base Unit modules (e.g. rotary flexible joint) see the user manual corresponding to that module.

Caution

Do not apply a load that weighs over 5 kg at any time.

5 Wiring Procedure

The following is a listing of the hardware components used in this experiment:

1. **Power Amplifier**: Quanser VoltPAQ-X1, or equivalent.
2. **Data Acquisition Board**: Quanser Q1-cRIO, Q2-USB, Q8-USB, QPID/QPIDe, NI DAQ, or equivalent.
3. **Rotary Servo Plant**: Quanser Rotary Servo Base Unit

See the corresponding documentation for more information on these components. The cables supplied with the Rotary Servo Base Unit are described in Section 5.1 and the procedure to connect the above components is given in Section 5.2.

Caution

When using a Quanser VoltPAQ power amplifier, make sure you set the Gain to 1!

5.1 Cable Nomenclature

The cables used to connect the Quanser Rotary Servo Base Unit system with a power amplifier and data acquisition device are shown in Table 5.1. Depending on your configuration, not all these cables are necessary.

Cable	Type	Description
 (a) RCA Cable	2xRCA to 2xRCA	Connects the analog output channel (D/A) of the data acquisition (DAQ) device to the power amplifier.
 (b) Motor Cable	4-pin-DIN to 6-pin-DIN	Connects the output of the power amplifier to the DC motor.
 (c) Encoder Cable	5-pin-stereo-DIN to 5-pin-stereo-DIN	Connects encoder to the data acquisition device (DAQ) encoder input. Namely, these signals are: +5 VDC power supply, ground, channel A, and channel B.
 (d) Analog Cable	6-pin-mini-DIN to 6-pin-mini-DIN	Connects an analog sensor to the power amplifier so it can be routed to the data acquisition device (DAQ). The calbe also carries a $\pm$ 12 VDC line from the amplifier in order to power a sensor and/or signal conditioning circuitry.
 (e) 5-pin-DIN to 4xRCA	5-pin-DIN to 4xRCA	This cable carries the analog signals, unchanged, from the amplifier to the analog input (D/A) channel on the data acquisition device.

Table 5.1: Cables used to connect Rotary Servo Base Unit to amplifier and data acquisition (DAQ) device

5.2 Connecting the Potentiometer and Encoder

This section describes the connections used to connect the Rotary Servo Base Unit plant to a data acquisition device and a power amplifier. This includes both the encoder and potentiometer sensors. The connections are summarized in Table 5.2, and pictured in Figure 5.1. Connection details are given below.

Note: The wiring diagram shown in Figure 5.1 is using a generic data acquisition device. The same connections can be applied for any data acquisition system that has 1x analog input, 1x analog output, and 1x encoder input.

Cable	From	To	Signal
1	DAQ: Analog Output #0	Amplifier *Amplifier Command* connector	Control signal to the amplifier.
2	Amplifier: *To Load* connector	Rotary Servo Base Unit *Motor* connector	Power leads to the Rotary Servo Base Unit dc motor.
3	DAQ: Encoder Input #0	Rotary Servo Base Unit *Encoder* connector	Encoder load shaft angle measurement.
4	Amplifier: *To ADC* connector	DAQ: White (S1) to Analog Input #0	Connects *Sensor 1* measurement to Analog Input #0.
5	Amplifier *S1 & S2* connector	Rotary Servo Base Unit *Potentiometer* connector	Potentiometer (S1) load shaft position measurement.

Table 5.2: Rotary Servo Base Unit Wiring

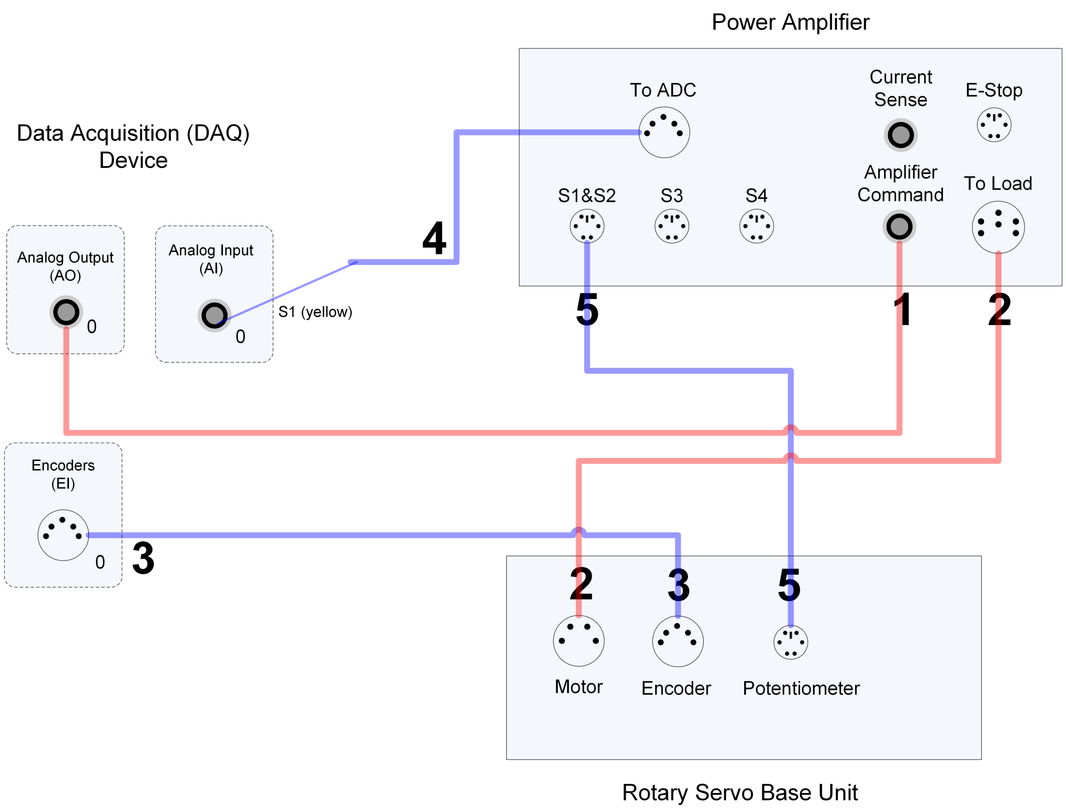


Figure 5.1: Connecting the Rotary Servo Base Unit to a DAQ and Amplifier

Follow these steps to connect the Rotary Servo Base Unit system:

1. Make sure that your data acquisition (DAQ) device has been installed and tested as discussed in its corresponding User Manual (or Quick Start Guide if using a Quanser DAQ).
2. Make sure everything is powered off before making any of these connections. This includes turning off your PC/laptop and the amplifier.

3. Connect one end of the 2xRCA to 2xRCA cable from the Analog Output Channel #0 on the data acquisition device to the *Amplifier Command* connector on the amplifier, i.e. use both white or both red RCA connectors. See cable #1 shown in Figure 5.1.
4. Connect the 4-pin-stereo-DIN to 6-pin-stereo-DIN that is labeled from *To Load* on the amplifier to the *Motor* connector on the Rotary Servo Base Unit. See connection #2 shown in Figure 5.1.
5. Connect the 5-pin-stereo-DIN to 5-pin-stereo-DIN cable from the *Encoder* connector on the Rotary Servo Base Unit panel to Encoder Input # 0 on the data acquisition device, as depicted by connection #3 in Figure 5.1.

Caution

Any encoder should be directly connected to the data-acquisition device (or equivalent) using a standard 5-pin DIN cable. DO NOT connect the encoder cable to the amplifier!

6. Connect the *To ADC* socket on the amplifier to Analog Inputs #0 on the data acquisition device using the 5-pin-DIN to 4xRCA cable, as illustrated in Figure 5.1. The RCA side of the cable is labeled with the channels: yellow is S1, white is S2, red is S3, and black is S4. The yellow S1 connector goes to Analog Input Channel #0.
7. Connect the *Potentiometer* connector on the Rotary Servo Base Unit to the *S1 & S2* socket on the Rotary Servo Base Unit using the 6-pin-mini-DIN to 6-pin-mini-DIN cable. This connection is labeled #5 in Figure 5.1. It carries the potentiometer (S1) measurement.

5.3 Connecting the Tachometer (Rev 1)

Caution

This section is for the Rotary Servo Base Unit Rev 1 system (i.e. SRV02-ET) that includes the tachometer connection. The Rotary Servo Base Unit Rev 2 does not includes a tachometer.

This section describes how to connect the Rotary Servo Base Unit Rev 1 plant to a data acquisition device and a power amplifier. The connections are summarized in Table Table 5.3 and illustated in Figure 5.2. Connection details are given below.

Note: The wiring diagram shown in Figure 5.2 is using a generic data acquisition device. The same connections can be applied for any data acquisition system that has least 2x analog inputs, 1x analog output, and 1x encoder input.

Cable	From	To	Signal
1	DAQ: Analog Output #0	Amplifier *Amplifier Command* connector	Control signal to the amplifier.
2	Amplifier: *To Load* connector	Rotary Servo Base Unit *Motor* connector	Power leads to the Rotary Servo Base Unit dc motor.
3	DAQ: Encoder Input #0	Rotary Servo Base Unit *Encoder* connector	Encoder load shaft angle measurement.
4	Amplifier: *To ADC* connector	DAQ: • S1 to Analog Input #0 • S2 to Analog Input #1	Connects analog sensor signals S1 and S2 to Analog Input Channels #0 and #1, respectively.
5	Rotary Servo Base Unit *S1 & S2* connector	Rotary Servo Base Unit *TACH* connector	Combine potentiometer (S1) and tachometer (S2) signals.
6	Amplifier *S1 & S2* connector	Rotary Servo Base Unit *S1 & S2* connector	Potentiometer load shaft angle (S1) measurement and tachometer (S2) load shaft rate measurement.

Table 5.3: Rotary Servo Base Unit Rev 1 Wiring

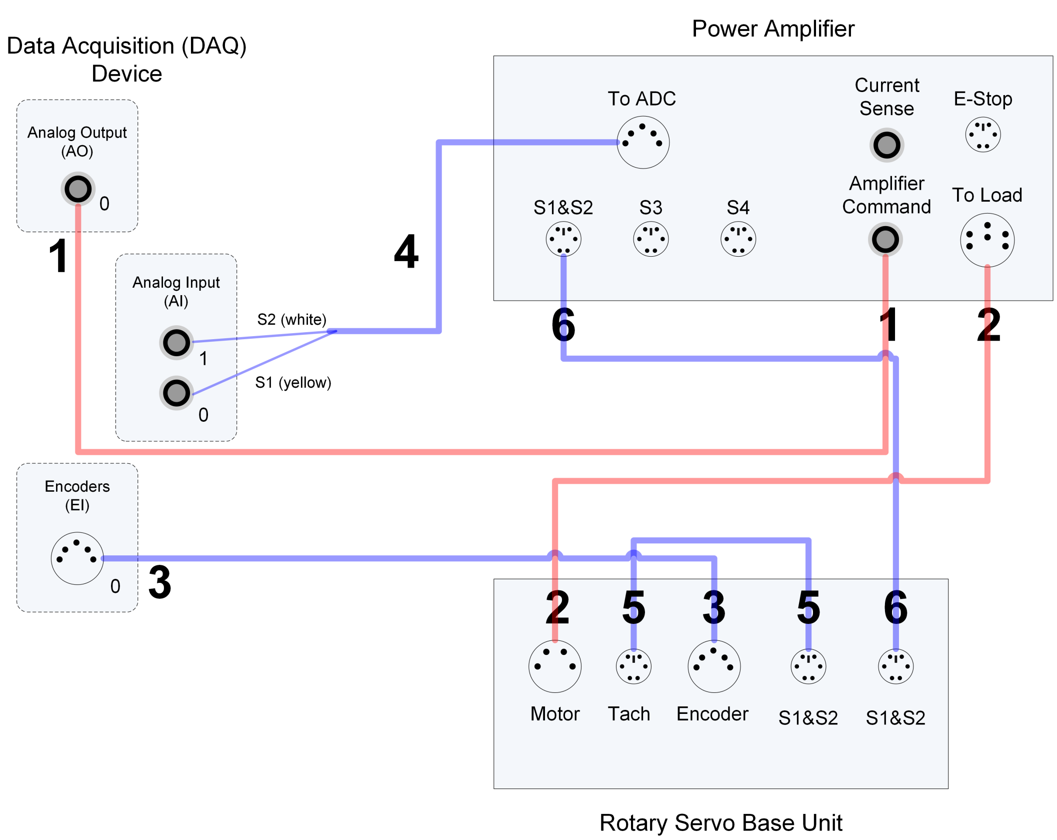


Figure 5.2: Connecting the Rotary Servo Base Unit to a Single-Channel Amplifier and Two-Channel DAQ

Follow these steps to connect the Rotary Servo Base Unit system:

1. Make sure that your data acquisition (DAQ) device has been installed and tested as discussed in its corresponding User Manual (or Quick Start Guide if using a Quanser DAQ).
2. Make sure everything is powered off before making any of these connections. This includes turning off your PC/laptop and the amplifier.
3. Connect one end of the 2xRCA to 2xRCA cable from the Analog Output Channel #0 on the DAQ to the *Amplifier Command* connector on the amplifier, i.e. use both white or both red RCA connectors. See cable #1 shown in Figure 5.2.
4. Connect the 4-pin-stereo-DIN to 6-pin-stereo-DIN that is labeled from *To Load* on the amplifier to the *Motor* connector on the Rotary Servo Base Unit. See connection #2 shown in Figure 5.2.
5. Connect the 5-pin-stereo-DIN to 5-pin-stereo-DIN cable from the *Encoder* connector on the Rotary Servo Base Unit panel to Encoder Input #0 on the DAQ, as depicted by connection #3 in Figure 5.2.

Caution

Any encoder should be directly connected to the data-acquisition device (or equivalent) using a standard 5-pin DIN cable. DO NOT connect the encoder cable to the amplifier!

6. Connect the *To ADC* socket on the amplifier to Analog Inputs #0-1 on the DAQ using the 5-pin-DIN to 4xRCA cable, as illustrated in Figure 5.2. The RCA side of the cable is labeled with the channels: yellow is S1, white is S2, red is S3, and black is S4. The yellow S1 connector goes to Analog Input Channel #0 and the white S2 connector goes to Analog Input Channel #1.
7. Connect the *TACH* connector on the Rotary Servo Base Unit to the *S1 & S2* socket on the Rotary Servo Base Unit using the 6-pin-mini-DIN to 6-pin-mini-DIN cable. This connection is labeled #5 in Figure 5.2. It combines the potentiometer (S1) measurement with the tachometer (S2) measurement.
8. Connect the *S1 & S2* connector on the Rotary Servo Base Unit to the *S1 & S2* socket on the amplifier using the 6-pin-mini-DIN to 6-pin-mini-DIN cable. See connection #6 in Figure 5.2. This carries the potentiometer (S1) and tachometer (S2) signals.

6 Testing and Troubleshooting

This section describes some functional tests to determine if your Rotary Servo Base Unit is operating normally. It is assumed that the Rotary Servo Base Unit is connected as described in the Section Section 5, above. To carry out these tests, it is preferable if the user can use a software such as QUARC® or LabVIEW™ to read sensor measurements and feed voltages to the motor. See Integration laboratory experiment to learn how to interface the Rotary Servo Base Unit with QUARC. Alternatively, these tests can be performed with a signal generator and an oscilloscope.

6.1 Motor

6.1.1 Testing

Ensure the Rotary Servo Base Unit motor is operating correctly by going through this procedure:

1. Apply a voltage to analog output channel #0 of the terminal board using, for example, the QUARC software.
2. The motor gear, component #4 shown in Figure 2.1b, should rotate counter-clockwise when a positive voltage is applied and clockwise when a negative voltage is applied. Remark that the motor shaft and the load shaft turn in opposite directions.

6.1.2 Troubleshooting

If the motor is not responding to a voltage signal, go through these steps:

- Verify that the power amplifier is functional. For example when using the Quanser VoltPAQ device, is the green LED lit?
- Check that the data-acquisition board is functional, e.g. ensure it is properly connected, that the fuse is not burnt.
- Make sure the voltage is actually reaching the motor terminals (use a voltmeter or oscilloscope).
- If the motor terminals are receiving the signal and the motor is still not turning, your motor might be damaged and will need to be repaired. Please see Section Section 7 for information on contacting Quanser for technical support.

6.2 Potentiometer

6.2.1 Testing

Test the Rotary Servo Base Unit potentiometer with the following procedure:

1. Using a program such as QUARC, measure the analog input channel #0.
2. The potentiometer should output a positive voltage when the potentiometer gear, component #6 in Figure 2.1b, is rotated counter-clockwise. The measurement should increase positively towards 5 V until the discontinuity is reached, at which point the signal abruptly changes to -5 V and begins to increase again.

6.2.2 Troubleshooting

Follow the steps below if the potentiometer is not measuring correctly:

- Verify that the power amplifier is functional. For example when using the Quanser VoltPAQ device, is the green LED lit? Recall the analog sensor signal go through the amplifier before going to the data-acquisition device (except when using the Q3 ControlPAQ). Therefore the amplifier needs to be turned on to read the potentiometer.
- Check that the data-acquisition board is functional, e.g. ensure it is properly connected, that the fuse is not burnt.
- Measure the voltage across the potentiometer. Ensure the potentiometer is powered with a ± 12 V at the 6-pin-mini DIN connector and ± 5 V at the potentiometer terminals, as described in Section 2.2.2. If the voltage from the wiper does not change when you rotate the potentiometer shaft, your potentiometer needs to be replaced. Please see Section Section 7 for information on contacting Quanser for technical support.

6.3 Encoder

6.3.1 Testing

Follow this procedure to test the Rotary Servo Base Unit encoder:

1. Measure Encoder Input Channel #0 using, for instance, the QUARC software.
2. Rotate the Rotary Servo Base Unit load gear, component #5 in Figure 2.1b, one rotation and the encoder should measure 4096 counts in quadrature mode.

   Note: Some data acquisition systems do not measure in quadrature and, in this case, one-quarter of the expected counts are received, i.e. 1024 counts. In addition, some data acquisition systems measure in quadrature but increment the count by 0.25 (as opposed to having an integer number of counts). Make sure the details of the data-acquisition system being used is known. The counters on the Quanser DAQ boards measure in quadrature and therefore a total of four times the number of encoder lines per rotation, e.g. a 1024-line encoder results in 4096 integer counts for every full rotation.

6.3.2 Troubleshooting

If the encoder is not measuring properly, go through this procedure:

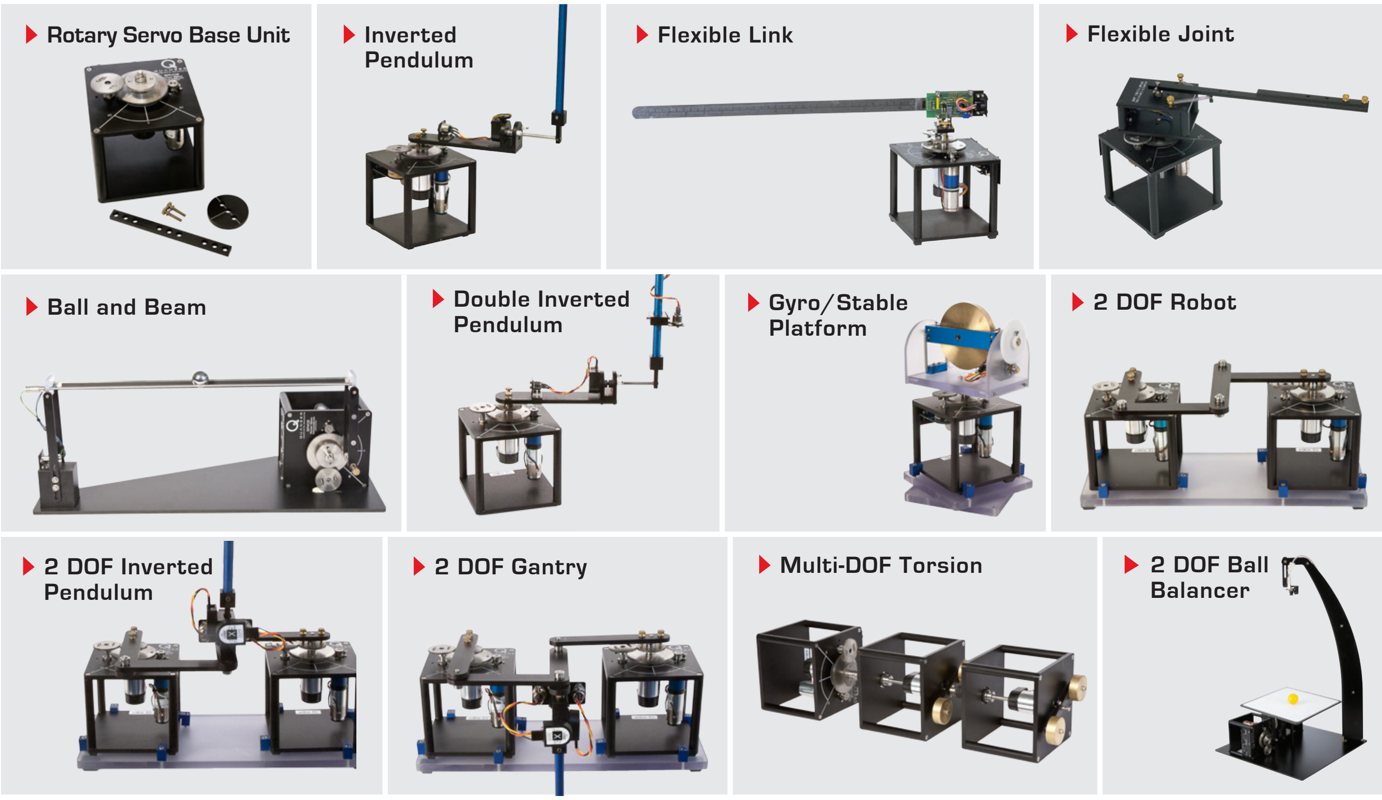
- Check that the data-acquisition board is functional, e.g. ensure it is properly connected, that the fuse is not burnt.
- Check that both the A and B channels from the encoder are properly generated and fed to the data-acquisition device. Using an oscilloscope, there should be two square waves, signals A and B, with a phase shift of 90 degrees. If this is not observed then the encoder may be damaged and need to be replaced. Please see Section Section 7 for information on contacting Quanser for technical support.

7 Technical Support

To obtain support from Quanser, please visit the Technical Support page at quanser.com/support.

1. Read the FAQ at quanser.com/support/faq/ to see if your issue is addressed.
2. If your issue persists, go to quanser.com/support/technical-support. Fill in the form with all the requested software and hardware information as well as a description of the problem encountered. Make sure your e-mail address and telephone number are included. Submit the form and a technical support person will contact you.

Over ten rotary experiments for teaching fundamental and advanced controls concepts



Quanser's rotary collection allows you to create experiments of varying complexity – from basic to advanced. Your lab starts with the Rotary Servo Base Unit and is designed to help engineering educators reach a new level of efficiency and effectiveness in teaching controls in virtually every engineering discipline including electrical, computer, mechanical, aerospace, civil, robotics and mechatronics. For more information please contact info@quanser.com.

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