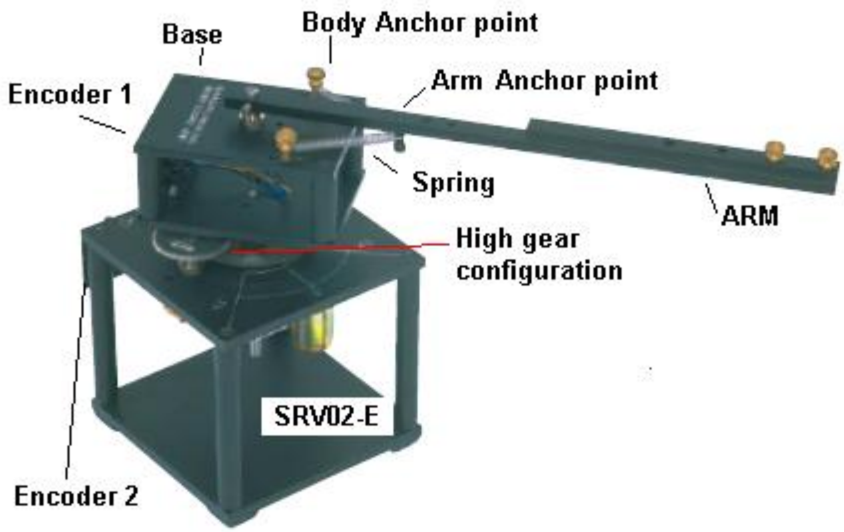
Rotary Flexible Joint module: Specifications

The Rotary Flexible Joint (ROTFLEX) module consists of a free arm attached to two identical springs. The springs are mounted to an aluminum chassis, which is fastened to the SRV02 load gear. A figure of the module is shown below.



The setup is as follows

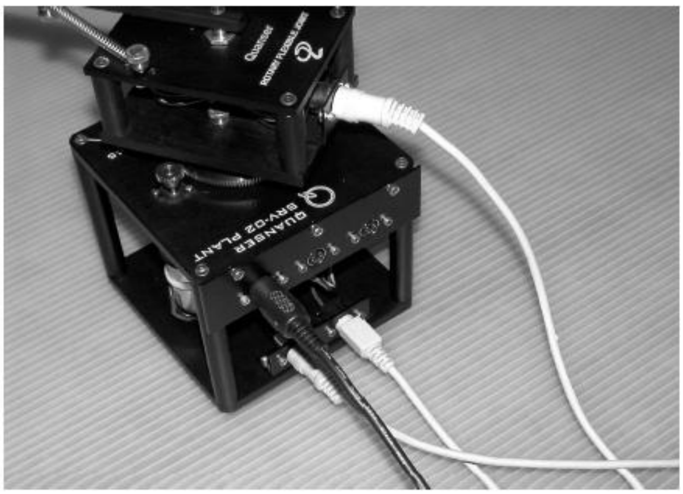


Figure 2: Flexible joint connections, back view.

Necessary equipment

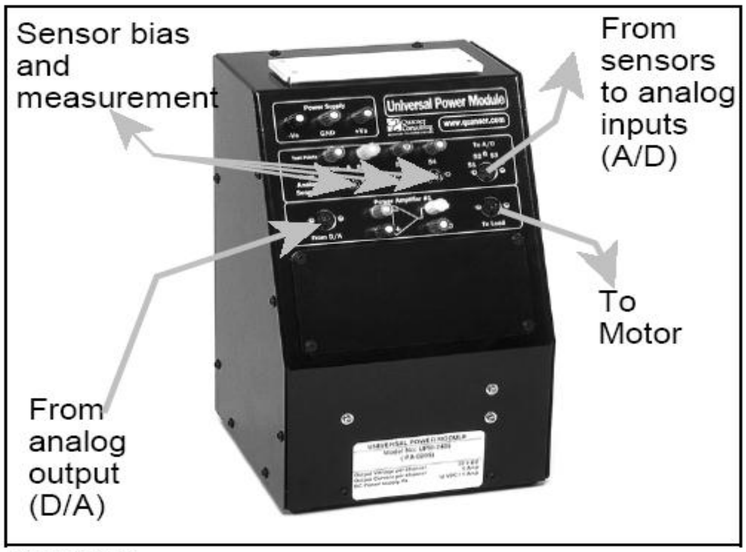
• 1 Universal Power Module, UPM-1503 (to drive the motor)
• 1 SRV 02ET servo DC motor.
• 1 Flexible Joint.
• 2 Encoder cables (to read the angle of the output shaft and the deflection of the arm).
• 1 Cable from the Power Amplifier (on the UPM) to drive the motor (6 Pin Din/ 4 Pin Din)
• 1 cable from the controller to the Input of the Power Amplifier (RCA / 5 PIN Din Mono)

Rotary Flexible Joint module: Specifications

• 1 Cable from UPM (From Sensors) which can take back the information from the sensors like the Tachometer and Potentiometer (5 Pin Din Stereo / 4 RCA)

The following modules are listed below and their need and specifications will be listed below in order
1) Quanser UPM1503 Power Module or equivalent.
2) Quanser SRV02 Servo plant.
3) Quanser ROTFLEX – Rotary Flexible Joint Module.

Quanser UPM1503 Power Module

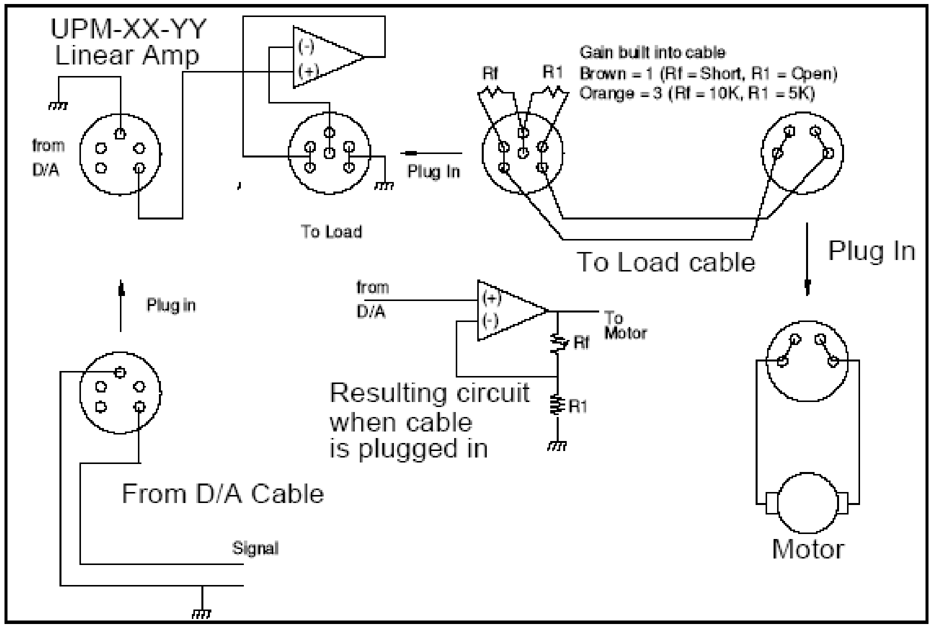


UPM XX-YY

The motors used in Quanser systems are DC motors. They may be either direct drive motors or geared motors. Geared motors have an internal gearbox which can be readily distinguished from the motor itself by examination. The motors are driven by the output of the amplifier. We use the UPM 1503 which has following specifications.

Power Modules					
Model	**Max Output voltage**	**Max Continuous Current**	**Output**	**Type**	**Number of Outputs**
UPM-15-03	15	3	Linear	Voltage	1

The resulting circuit when the cables are plugged into the power amplifier is as follows.



***UPM-XX-YY* Connections**

the ***UPM-XX-YY*** power modules is a 4 pin DIN connector which is connected to the motor as shown.

Sensors on the SRV02 – ET

There are two types of sensors on the actuator

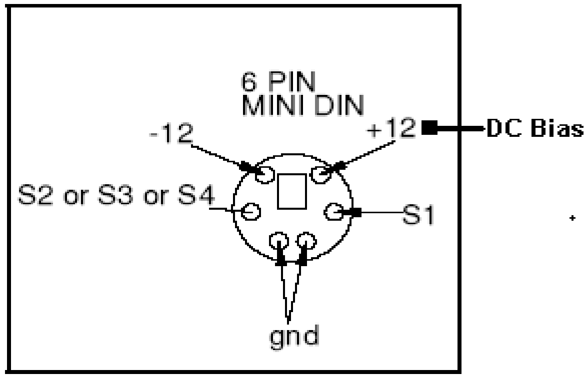
Analog sensors:

1) These are typically potentiometers which convert a desired quantity into voltage and hence they must be biased with a +-12 VDC. This bias is carried to the sensors via the 6 pin mini DIN cables that are connected from the UPM (from analog sensors) to the sensors itself.

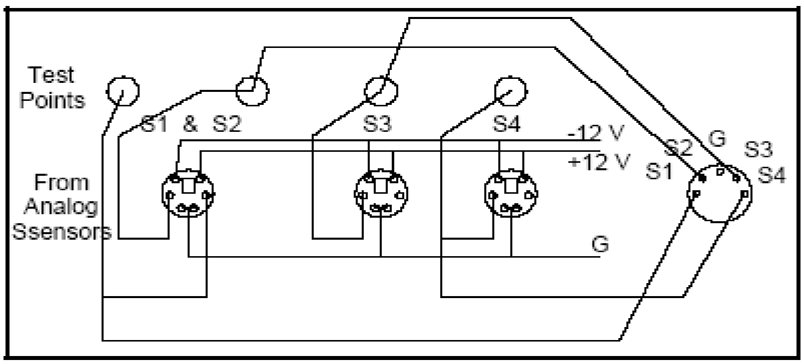
1) The sensor S1 measures the main sensor that is directly actuated and the other Sensors S2, S3; S4 can measure from other modules.

2) If the sensor cable is sent to a A/D converter then a 1μF capacitor has to be attached at each channel to reduce noise and anti aliasing.

The figure below shows the configuration. If we do not wish to use the UPM1503 then we need to incorporate the above features in the sensor signal that we obtain from the actuator.



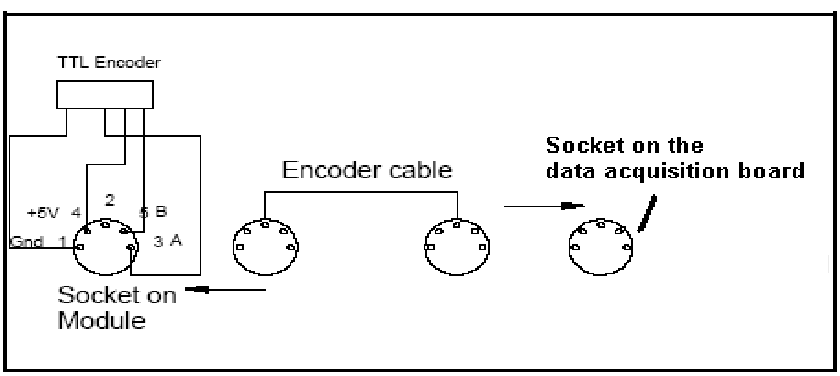
Mini Din Connection to Analog Sensors



Internal connection for analog sensors

Digital sensors

1) These are digital optical encoders which connect directly to the encoder pins on our controller box or data acquisition terminal board via a 5 pin DIN / 5 Pin Din cable.
2) Quadrature encoders generate 2 square waves which are 90 degrees out of phase. The two signals (A & B) are fed to an up/down counter which counts the transitions in the signals. Thus an encoder that generates 1000 pulses per revolution per channel will result in 4000 counts per revolution.
3) A counter and the software to read this count is required in the controller box to understand the value given by the encoders.



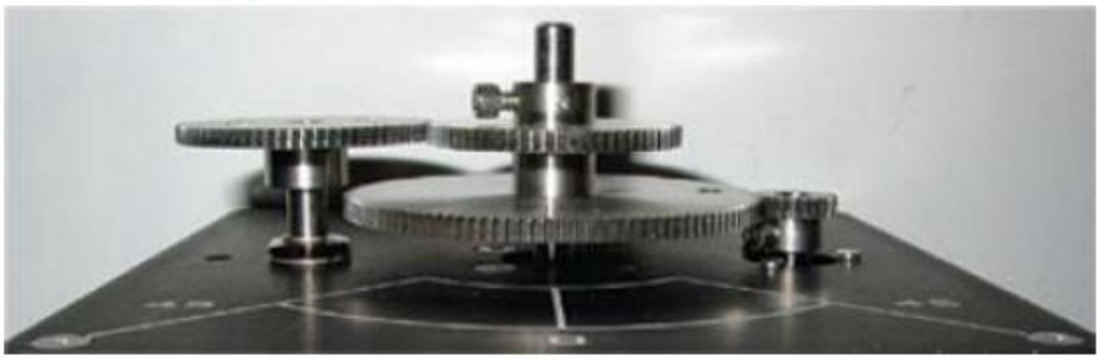
Obtaining data from the encoders

Rotary Flexible Joint module: Specifications

The encoders are very essential in this experiment as they acquire the angle information of the output shaft and the deflection of the arm.

Quanser SRV02 Servo plant

The flexible joint module consists of the SRVO2 servomotor in the high gear configuration and flexible joint. The system parameters are as follows.

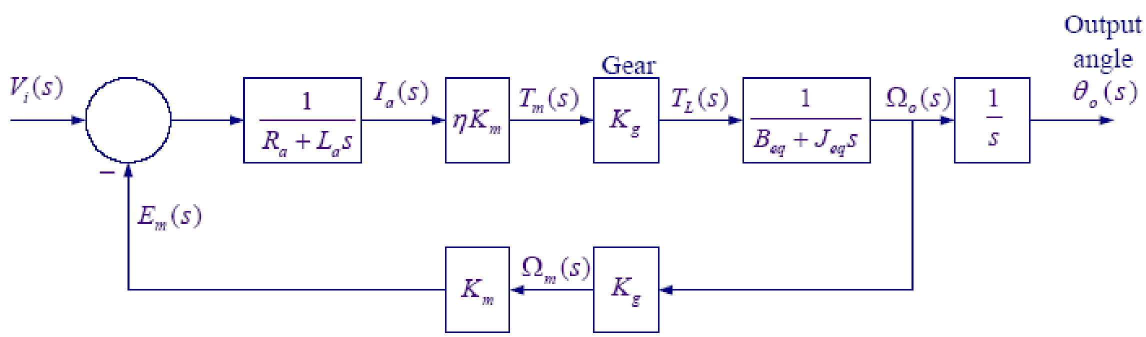


High-gear ratio configurations

	Description	**Value**
R_a	Armature resistance	2.6 Ω
K_m	Motor Voltage constant	.00767 V-s/rad
K_t	Motor torque constant	.00767 N-m/A
J_t	Armature inertia	3.87 x 10^{-7} Kg m^2
J_{tach}	Tachometer inertia	.7 x 10^{-7} Kg m^2
K_g	High gear ratio	(14)(5)
B_{eq} = Kg2 $B_m + B_l$	Equivalent viscous friction referred to second gear	4 x 10^{-3}
η_{mr}	Motor efficiency due to rotational loss	.87
η_g	Gear box efficiency	.85
η	Total efficiency	.7395

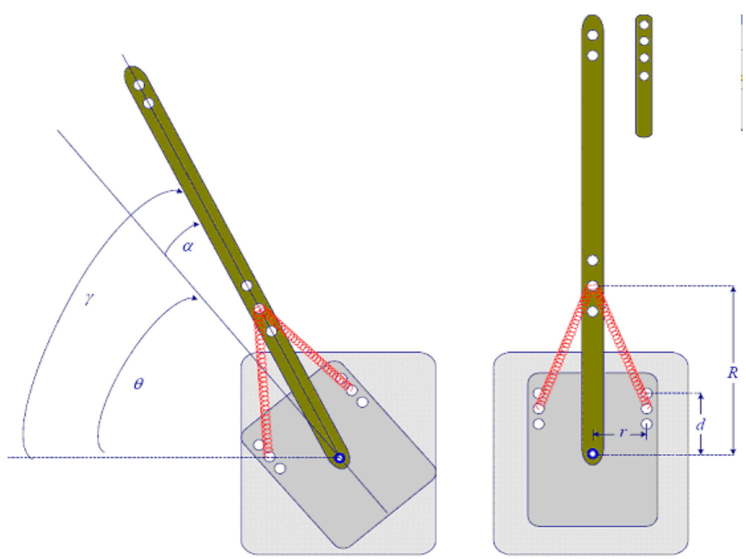
Rotary Flexible Joint module: Specifications

	Gear Inertia	J_{120}	4.1835×10^{-5} Kg m^2
		J_{72}	5.4435×10^{-6} Kg m^2
		J_{24}	1.0081×10^{-7} Kg m^2
J_l= J_{120} + 2(J_{72}+ J_{24}	Load Inertia	5.2823 x 10-5 Kg m^2	
J_{eq}	Equivalent inertia	.0023 Kg m^2	



Servo plant block diagram

Quanser ROTFLEX – Rotary Flexible Joint Module



A schematic picture of the Flexible Joint.

Rotary Flexible Joint module: Specifications

<table>
<tr><th></th><th colspan="2">Description</th><th colspan="4">Value</th></tr>
<tr><td>θ</td><td colspan="2">Servo gear angular displacement</td><td colspan="4"></td></tr>
<tr><td>ω</td><td colspan="2">Servo gear angular velocity</td><td colspan="4"></td></tr>
<tr><td>α</td><td colspan="2">Arm angular deflection</td><td colspan="4"></td></tr>
<tr><td>ν</td><td colspan="2">Arm angular velocity</td><td colspan="4"></td></tr>
<tr><td>γ</td><td colspan="2">Total deflection</td><td colspan="4"></td></tr>
<tr><td rowspan="3">R</td><td rowspan="3">Distance from joint to arm anchor</td><td>1</td><td colspan="4">10.10 cm</td></tr>
<tr><td>2</td><td colspan="4">8.90 cm</td></tr>
<tr><td>3</td><td colspan="4">7.60 cm</td></tr>
<tr><td rowspan="3">d</td><td rowspan="3">Distance from joint to body anchor</td><td>A</td><td colspan="4">3.18 cm</td></tr>
<tr><td>B</td><td colspan="4">2.54 cm</td></tr>
<tr><td>C</td><td colspan="4">1.91 cm</td></tr>
<tr><td>r</td><td colspan="2">Fixed distance</td><td colspan="4">3.18 cm</td></tr>
<tr><td>m</td><td colspan="2">Mass of main arm</td><td colspan="4">64.00 gm</td></tr>
<tr><td>L</td><td colspan="2">Length of main arm</td><td colspan="4">29.85 cm</td></tr>
<tr><td>m_{sh}</td><td colspan="2">Mass of short arm</td><td colspan="4">30.00 gm</td></tr>
<tr><td>L_{sh}</td><td colspan="2">Length of short arm</td><td colspan="4">15.24 cm</td></tr>
<tr><td rowspan="3">J_{arm}</td><td colspan="2" rowspan="3">Arm’s moment of inertia</td><td>Arm inertia without external load (short arm)</td><td colspan="3">Location of the short arm on main arm</td></tr>
<tr><td rowspan="2">0.0019002</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>0.003526</td><td>0.0038938</td><td>0.0043002</td></tr>
<tr><td rowspan="5">K_{stiff}</td><td colspan="2" rowspan="5">Linear estimate of the joint stiffness</td><td rowspan="2">Position of spring anchor on arm</td><td colspan="3">Position of spring</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>1</td><td>1.6911</td><td>1.3949</td><td>1.0931</td></tr>
<tr><td>2</td><td>1.5136</td><td>1.2485</td><td>0.98319</td></tr>
<tr><td>3</td><td>1.3694</td><td>1.1234</td><td>0.88651</td></tr>
</table>