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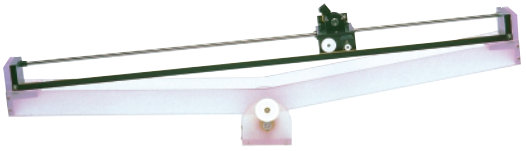
LINEAR CONTROL CHALLENGE

IP01/IP02 + SEESAW = SEESAW Experiment

Product Information Sheet L7 - 1 - rev. C



Description

The SEESAW module is designed to accommodate either the IP01 or IP02. It consists of two long arms hinged onto a support fulcrum. The SEESAW rotates on an instrumented fulcrum, and the tilt angles are measured by either an encoder or a potentiometer. Experimental objective is to maintain balance by driving linear cart (IP01/IP02) back and forth.

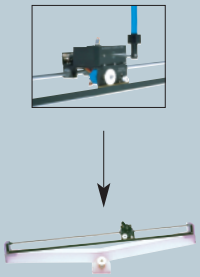
Key Features

- Modular design (experiments are easily interchangeable)
- Precisely machined polycarbonate SEESAW system with a durable matte finish
- High quality parts (e.g. anti-backlash gear)
- High Resolution Optical Encoder to measure the SEESAW-E tilt angle
- Single-turn potentiometer to sense the SEESAW tilt angle
- Variable IP01 or IP02 Track Height Position
- Fully documented system models & parameters
- Fast and Easy attachment to the IP01 or IP02 servo plant
- Open architecture design
- Fully compatible with Matlab/Simulink

Curriculum Topics

- Tracking Control & Regulation
- Disturbance Rejection
- Robust Control (H-Infinity, μ - Synthesis, Sliding Mode)
- Intelligent Control (Neural Networks, Fuzzy Logic, AI, Genetic Algorithms)
- State-Space Design (Full/Partial State-Feedback, Observer Design)
- Multivariable Control Design
- Root Locus Design
- Frequency Analysis (Bode and Nyquist Methods, Lead-Lag Compensation)
- System Modeling & Simulation (Unstable, Non-Minimum Phase)
- System Identification
- Real-Time Control
- Discrete Time Sampling

Range of IP01/IP02 Challenges



Either the IP01 or the IP02 linear motion servo plant serves as the base unit for Quanser's Linear Control Challenges. With easily interchangeable modules, you can transform the IP01 or IP02 into any of these experiments:

SISO Configurations ***(Single Input, Single Output)***

IP01 or IP02: Position Control
IP01 or IP02: Speed Control
SIP: Linear Single Inverted Pendulum Control
SPG: Linear Single Pendulum Gantry Control
SESIP: Linear Self-Erecting Single Inverted Pendulum Control
SLFJ: Single Linear Flexible Joint Control
SLFJ-plus-SIP: Single Linear Flexible Joint with Single Inverted Pendulum Control
DLFJ: Double Linear Flexible Joint Control
SEESAW: Seesaw Control
SEESAW-plus-SLFJ: Seesaw with Single Linear Flexible Joint Control
FIP: Linear Flexible Inverted Pendulum Control
DBIP: Linear Double Inverted Pendulum Control
AMD-1: One-Floor Active Mass Damper Control

MIMO Configurations (***Multiple Input, Multiple Output***)

SEESAW-Pendulum: Two Seesaw Modules Coupled Together to Control the Single Inverted Pendulum
AMD-2: Two-Floor Active Mass Damper Control

Some configurations require IPO2, please confirm at time of order.

IP01/IP02 Model Range

Model	Description
IP01	The IP01 is instrumented with a 10-turn potentiometer to measure cart position. Pendulum angle is measured using a potentiometer whose range is restricted by mechanical stops.
IP02	The IP02 is instrumented with two quadrature optical encoders,one each for cart position and pendulum angle. The shaft to which the pendulum is attached allows for the pendulum to be suspended in front of the cart, free of the mechanical stops. This permits additional configurations with unrestricted movement of the pendulum.

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SEESAW Model Range

Depending on the module options, the SEESAW(-E) module tilt angle can either be sensed via a potentiometer or an encoder, whose shaft is coupled to the rotation axis through a pinion-and-anti-backlash-gear system.

Model / Option	Description
SEESAW	Standard SEESAW module. The module is equipped with a single-turn potentiometer to measure the tilt angle.
SEESAW-E	Identical to the SEESAW module but with an optical encoder instead of the potentiometer to measure the tilt angle.

Typical Response

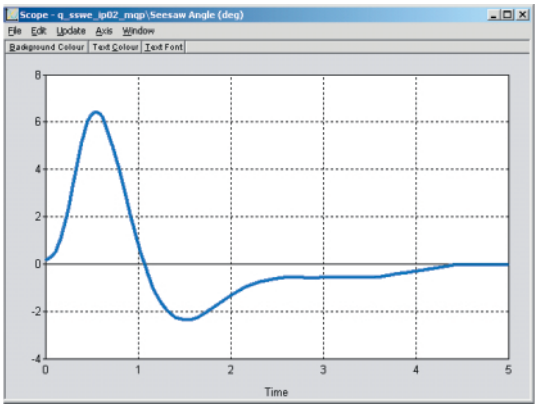

Figure 1 - Actual SEESAW Tilt Angle in Response to a Disturbance Tap (Using Full-State Feedback)

The following graph illustrates the SEESAW disturbance rejection performance by representing the actual tilt angle in response to a tap to the SEESAW. A full-state-LQR closed-loop design is used.

System Requirements

The SEESAW(-E) module is designed as a support for the IP01 or IP02 cart-plus-rack system. Along with the IP01 or IP02 plant, the following components are required to complete the experimental setup:

Component	Quanser Recommended (Common Configuration)	Alternative
Power Module	Quanser UPM 1503/2405	Alternate Power Amplifier (Minimum requirements: +/- 12V, 3A)
Control Hardware	Quanser Q4, Q8 Series Quanser Q3 ControlPaQ-FW*	dSPACE DS1104** National Instruments E- or M-Series DAQs**
Control Software	Quanser QuaRC	The Mathworks – RTWT, xPC dSPACE – ControlDesk National Instruments – LabVIEW

* configuration with Q3 ControlPaQ-FW amplifier-on-board control unit does not require UPM power module
** Quanser offers interface boards for NI E- and M- series & dSPACE DS1104 boards.

System Specifications

Specification	Value	Units
Seesaw Dimensions (L x D x H)	1.12 x 0.2 x 0.4	m
SEESAW-plus-Rack System Mass	3.3	kg
Moment Of Inertia of the Seesaw System	0.427	kg.m2
Distance from Pivot to IP01 or IP02 Track	0.14	m
Distance from Pivot to Seesaw System's C. of G.	0.058	m
SEESAW(-E) Geartrain Gear Ratio	3	
SEESAW Potentiometer Bias Power	±12	V
SEESAW Potentiometer Sensitivity	0.2482	rad/V
SEESAW-E Encoder Resolution	4096	counts/rev
	0.0879	deg/count

For IP01/IP02 specifications please refer to Product Information Sheet L1