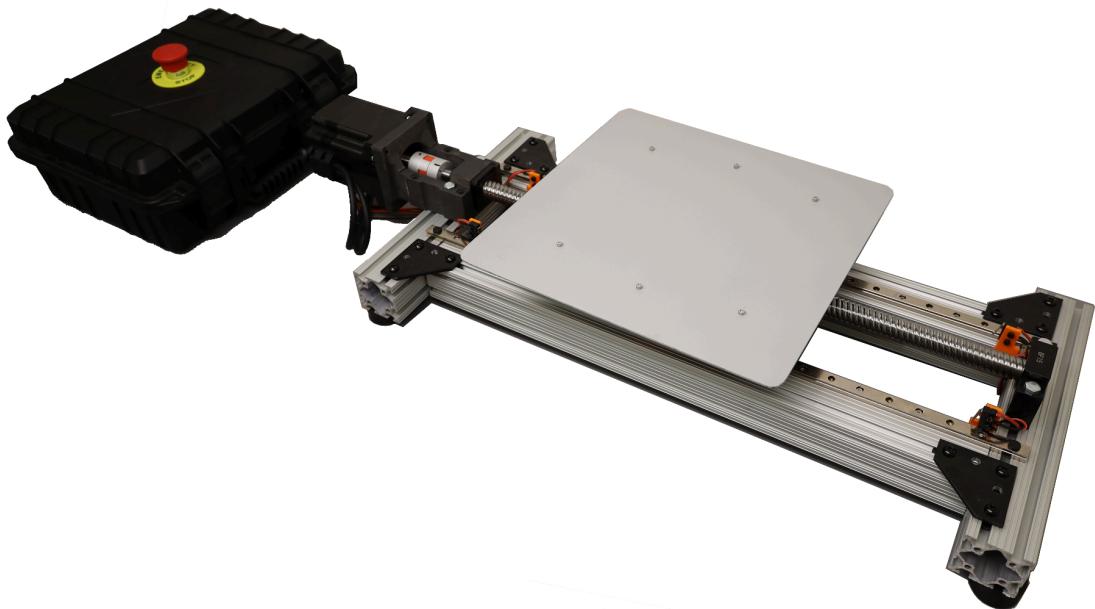


Product Manual: Precursor



Version Date: Nov 2024
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1. Introduction

Thank you for choosing the Seismove Precursor, a robust single-axis shake table developed to simulate seismic and vibration testing across various fields, including geotechnical research, structural engineering, and educational applications. Designed to deliver accurate single-axis motion with customizable displacement waveforms, the Precursor is equipped to handle both standard cosine displacement functions and user-defined inputs for diverse testing needs.

With a durable aluminum construction, advanced control options, and compatibility with multiple operating systems (Windows, macOS, and Ubuntu), the Precursor provides reliable performance and user-friendly operation. Safety features such as software-defined displacement limits, range limit sensors, and an emergency stop are integrated to ensure safe testing environments. Additionally, the shake table is equipped with Seismove Precursor Client software, allowing seamless control and customization of test parameters.

This user manual is intended to guide you through the installation, operation, and maintenance of the Precursor. Whether you are conducting research, demonstrations, or classroom exercises, the Precursor delivers precise, repeatable results, meeting the demands of both professional and educational users.

Model Number: SM-P (SM-P-001, SM-P-002, SM-P-003), SM-P1

Release Date: 12/23/2024

2. Safety Information

Before using the shake table, read this manual thoroughly to understand setup, operation, and maintenance requirements. This product is a precision device that requires adherence to all operational limits and safety precautions to avoid injury or damage.

General Safety Precautions

- Authorized Use Only: Unauthorized modifications to the shake table are prohibited as they may compromise safety features and void the warranty.
- Stable Placement: Ensure that the shake table is placed on a stable surface and securely mounted to prevent shifting or tipping during operation. For payloads over 2 kg, ensure that the shake table is securely bolted to a fixed platform to prevent shifting or tipping during operation.
- Clear Testing Area: Maintain a clear area around the shake table, keeping non-essential personnel and objects at a safe distance of at least 1 meter to prevent accidental collisions.
- Environmental Conditions: Avoid operating the shake table in direct sunlight, extreme temperatures, or damp conditions that may affect performance or safety.

Electrical Safety

- Voltage Compatibility: The shake table is designed for 110V or 220V AC input (default is 110V). Verify the input voltage setting before plugging in. Incorrect voltage can severely damage the equipment. To change the input voltage, please contact Seismove technicians for guidance. Unauthorized modifications to the device may result in damage and pose a risk of injury.

Operational Safety

- Regularly inspect the shake table for signs of wear, loose connections, loose bolts, or component damage. While every shake table is thoroughly inspected and tested prior to shipping, we recommend conducting an inspection upon receipt to ensure no damage occurred during transit.
- Safe Attire: Operators should avoid wearing loose clothing, jewelry, or other items that may become entangled in moving parts.

- Minimum Safe Distance: Maintain a distance of at least 1 meter from the shake table bed during operation to avoid accidental contact.
- Keep Area Clean: Prevent liquids, dust, and debris from coming into contact with the table to avoid interference or short circuits.
- Hands and Objects Clear: Keep hands, tools, and other objects away from moving parts while the table is energized or in motion.
- Test Without Payload First: Run the shake table alone to verify functionality before adding any payload.
- Payload Limit: Ensure the payload does not exceed the recommended weight limit. Refer to the Precursor datasheet for the payload capacity.
- Secure Heavy Payloads: For payloads over 200 grams, securely bolt the item to the bed for safe operation. Consult the Precursor datasheet for detailed payload mounting guidance.
- Disconnect When Not in Use: Always disconnect the shake table from the power source when it is not in use. This prevents accidental activation and protects the equipment from power surges.

Software and Operational Readiness

- Familiarize with Software: Before operating, review the Seismove Precursor Client software and watch the tutorial videos to ensure proper understanding: <https://github.com/seismove/Precursor>
- Emergency Stop Readiness: Ensure at least one person is actively operating the shake table. Familiarize yourself with the emergency stop feature for immediate shutdown in case of unexpected motion. Refer to Section 3, Product Overview, to locate the emergency stop button.

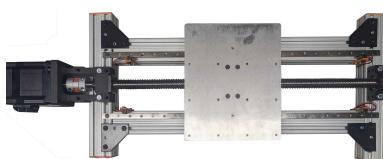
Operation Supervision

- Continuous Supervision Required: Do not leave the shake table unattended while in motion. An operator must always monitor the table to maintain safe operation.
- Avoid Bed Interference: Never attempt to stop or manually move the bed while the system is energized or in motion.

Personal Protective Equipment (PPE)

- Safety Goggles: Wear safety goggles while operating the shake table, especially during high-intensity simulations.
- Gloves: Use protective gloves when handling sharp or heavy objects for mounting.
- Ear Protection: For high-speed tests or environments with multiple devices operating, use ear protection if noise levels exceed safe limits.

3. Product Overview

Item	Figure	Quantity
Shake table body	 A photograph of the shake table body, showing a rectangular metal frame with two linear actuators attached to its sides.	1
Control box	 A photograph of the control box, which is a black rectangular case with a yellow circular button labeled "Emergency Stop" in the center.	1
Micro USB cable	 A photograph of a black Micro USB cable with a QR code on the connector.	1
Ethernet cable	 A photograph of a white Ethernet cable with standard RJ45 connectors.	1
IEC power cable	 A photograph of a black IEC power cable with a three-pronged plug.	
Mounting brackets	 A photograph of four silver-colored L-shaped metal mounting brackets.	4

Control box

- Control box includes a motor driver, shake table controller, and power supply. It has a fan to circulate the air to cool the heat. Any modification without Seismove authorization violates the warranty and may damage the control system.
- An emergency push button is mounted on top of the control box, as shown in the figure below. Before operating the shake table, ensure the emergency button is reset by rotating it clockwise until it clicks into place.



- In case of an emergency, press the button to immediately disable the motor. After activation, the button must be rotated to reset it before the shake table can be restarted. Always verify the button is in its reset position prior to use.

Mounting brackets

- Secure the shake table using the provided mounting brackets. For custom mounting instructions, refer to Appendix A1 in the Precursor Datasheet for the frame section diagram.

4. Installation and Setup

Unpacking and Inspection

- Carefully unpack the shake table and inspect all components for any signs of damage or missing items.

Read Safety Information

- Before mounting, review Section 2: Safety Information under General Safety Precautions for essential safety guidelines.

Mounting the Shake Table

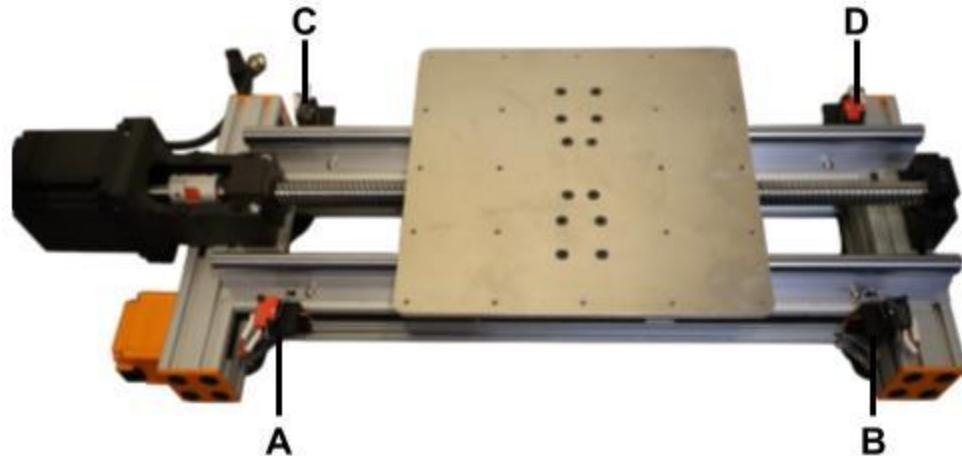
- Secure the shake table using the provided mounting brackets. For custom mounting instructions, refer to Appendix A1 in the Precursor Datasheet for the frame section diagram.

Reset Emergency Button

- Ensure that the emergency stop button is reset and ready for use. Operators should familiarize themselves with the location and operation of the emergency stop button through practice to ensure quick response in case of an emergency. Refer to Section 3, Product Overview, to locate the emergency stop button.

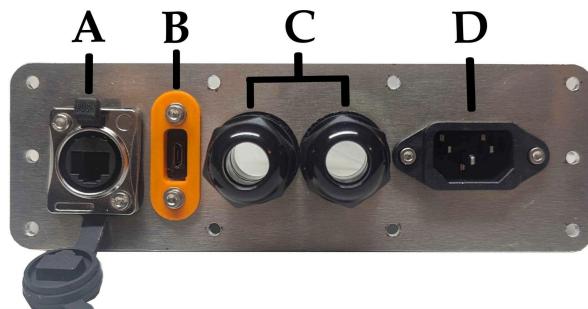
Range Limit Sensor Inspection

- Inspect the range limit sensors (Switches A, B, C, and D, as shown below). Adjust the sensors as follows:
 - Switch A and Switch B are used for calibration, and Switch C and Switch D are used for emergency stop.
 - Switch C and Switch D should be positioned further away (2-5 mm) from the center than Switch A and Switch B.
 - Use an allen key to fine-tune the distance of each sensor as needed.



Connect the control box

- The interface panel is located on the back of the control box. It features four ports labeled A, B, C, and D, as shown in the figure below. These ports are used for connecting various components of the shake table system, as described in the following. Ensure all connections are secure before operation.



- Port A is an Ethernet port dedicated to connecting the limit switch sensor hub. Use an Ethernet cable to connect Port A on the control box to the Ethernet port on the shake table. The shake table's Ethernet port is located at the orange hub near the motor, as shown in the figure below.



- Port B is a Micro USB port used to connect the control box to a PC or laptop.
- Port C is pre-wired with two cables. Please connect the other ends of these cables securely to the motor.
- Port D is the power port for the shake table. Use the included IEC power cable to connect Port D on the control box to a 110V or 220V power outlet. Note: The default voltage setting is 110V. To change the input voltage, please contact Seismove technicians for guidance. Using an incompatible input voltage may damage the shake table. Additionally, unauthorized modifications to the device may result in damage and pose a risk of injury.
- The system powers on automatically when the power cable is connected. Again, please make sure the emergency button is reset.

5. Operating Instructions

Download Software

- Download the Seismove Precursor Client software from the official Seismove Github: <https://github.com/seismove/Precursor>

Firmware

- Visit the official Seismove Precursor GitHub Repository to download the latest firmware and the firmware uploader software, if needed. Use the firmware uploader software to install the firmware on your device. Ensure that the firmware version is compatible with the Seismove Precursor Client software for optimal performance.

Setup Before Running Software

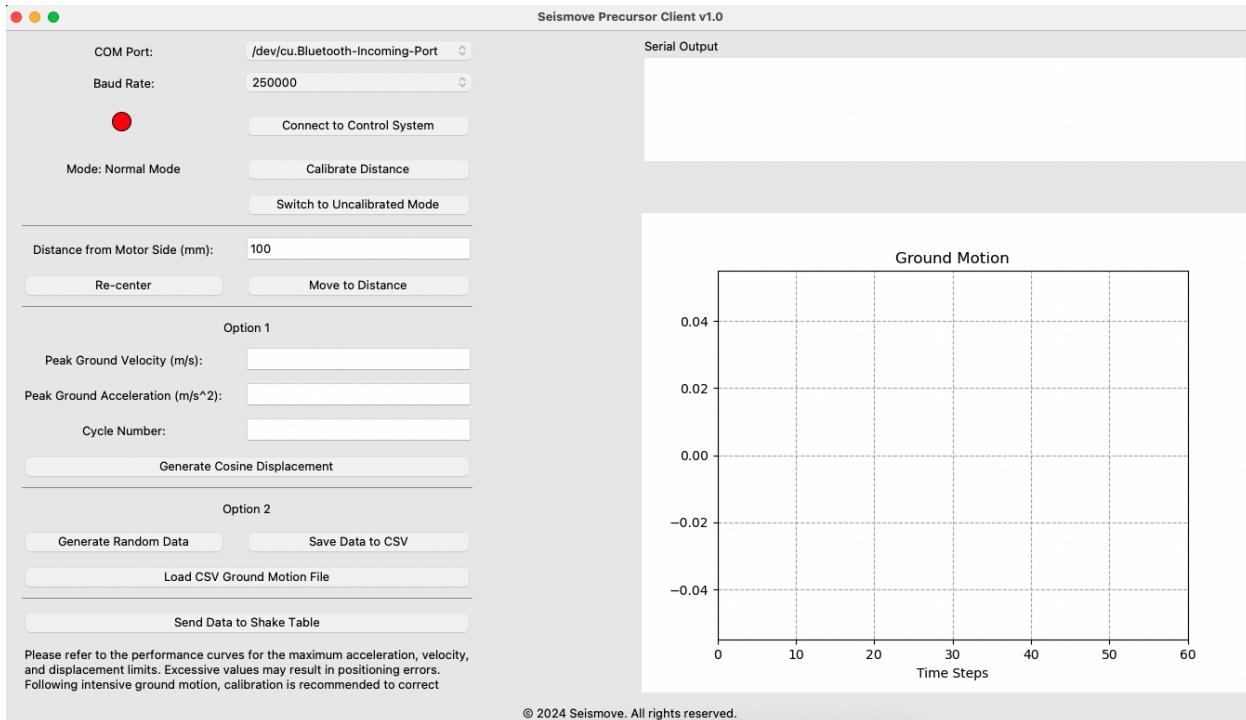
- Ensure the control box is properly connected and that the shake table is powered on.
- Reset the emergency button before proceeding.

Running the Software

- Windows: Double-click the application to start.
- macOS: Double-click the application to start.
- Ubuntu: Double-click the application to start.

Seismove Precursor Client Software

- Please ensure the control box is properly connected before running the software.



- Connect the device
 - Select the COM port of the shake table from the dropdown menu. If the COM port does not appear, close the software, verify the Micro USB connection, and restart the software.
 - Use the default Baud Rate for the initial connection.
 - Click the “**Connect to Control System**” button. If the connection is successful, the status light will turn green. The “**Connect to Control System**” button will change to the “**Disconnect**” button.
 - Once connected, you can adjust the Baud Rate if necessary.
- Disconnect the device
 - Click the “**Disconnect**” button to disconnect the device before closing the software.
- Calibrate distance
 - Click the “**Calibrate Distance**” button to initiate calibration.
 - Calibration is required before sending data to the shake table control system to ensure accurate and safe operation.
 - We provide **Uncalibrated Mode**, which assumes the bed is in the middle of the limit switches and may cause damage or injury. In the Uncalibrated Mode, calibration is not needed to send data to the shake table control

system. However, this mode may result in positioning errors, damage to the device, or potential injury.

- **Uncalibrated Mode is designed for advanced users and is not recommended for beginners. Improper use of Uncalibrated Mode may lead to damage or injury, for which Seismove is not liable.**

Recommended Practice

- Always perform calibration before operating the shake table.
- Excessive calibration values may result in positioning errors. Following intensive ground motion tests, recalibrate to correct potential positioning errors and maintain operational safety.

Calibration process

- The bed moves toward the motor side (left) until it reaches Limit Switch A.
- Next, the bed moves toward the opposite end (right) until it reaches Limit Switch B.
- After reaching Limit Switch B, the bed automatically moves to the center position between the two limit switches.

Move to Distance

- Enter the desired distance from Limit Switch A into the input box, then click the “**Move to Distance**” button to move the bed to the specified position.

Re-center

- Click the “**Re-center**” button to return the bed to the center position.
- **Note:** Re-centering does not replace calibration. Calibration is still recommended after intensive ground motion to ensure accurate positioning and operational safety.

Waveform Support

- The Precursor shake table supports three types of waveforms with durations of up to 150 seconds.

Cosine displacement waveforms

- Enter Peak Ground Velocity, Peak Ground Acceleration, and Cycle Number.
- Click the “**Generate Cosine Displacement**” button to generate and visualize the waveforms.

Random ground motion

- Click the “**Generate Random Data**” button to generate and visualize a random waveform.

Custom waveforms

- Use a CSV format file with displacement data at a 100 Hz sampling rate.
A sample CSV file is as the following:

Time (s)	Displacement (m)
0.0	0.00697713905082111
0.01	-0.009616630293951602
0.02	-0.0005109518846108446
0.03	0.01900452754173314

- Click the “**Load CSV Ground Motion File**” button to select the CSV file and upload the custom waveform.

Send Data to Shake Table

- After generating and displaying a waveform, click the “**Send Data to Shake Table**” button to upload the data to the shake table control system. For waveforms with longer durations, the upload process may take a few minutes.
- Once the upload is complete, a confirmation prompt will appear:
 - **Yes**, to execute the ground motion.
 - **No**, to abort the ground motion execution.

Serial Output

- The serial output feature enables users to monitor real-time information from the shake table control system, providing valuable insights into its operation and performance.

6. Maintenance and Care

Cleaning

- Use an air duster to keep the shake table free from dust and debris.

Inspection

- Follow a regular inspection schedule to check for wear on moving components.

Lubrication

- Lubricate the ball screw every three months under standard usage. Only use lubricants suitable for ball screws; improper lubricants may impair the shake table's performance. We recommend Mobilgrease XHP 222 for optimal results.

Storage Guidelines

- Ensure the shake table is stored in safe conditions:
 - Storage Temperature: 0°C to 60°C
 - Humidity: Up to 80% non-condensing
- Storage Case: A storage case for the Precursor shake table is available separately for purchase.

Replacing Parts

- Replacing parts without proper guidance or authorization may damage the shake table. Please contact Seismove technical support for assistance with part replacements.

7. Technical Specifications

- Motion Specifications:
 - Max Displacement: ± 280 mm
 - Max Velocity: 2 m/s
 - Max Acceleration at 2 kg payload and maximum velocity: 5 g
 - Linear Resolution: 0.1 mm
- Maximum Operating Frequency: 25 Hz
- Payload Capacity at 1 g: 45 kg
- Maximum payload: 75 kg
- Degrees of Freedom (DoF): 1-axis
- Power Requirements:
 - Input Voltage: 110V AC or 220V AC (default is 110V AC). To change the input voltage, please contact Seismove technicians for guidance. Using an incompatible input voltage may damage the shake table. Additionally, unauthorized modifications to the device may result in damage and pose a risk of injury.
 - Maximum Power Consumption: 600 W
- Control System:
 - Control Interface: Micro USB
 - Software Compatibility: Windows, MacOS, Ubuntu
 - Control Modes: Predefined and customized waveforms
- Environmental Conditions:
 - Operating Temperature: 0°C to 40°C
 - Storage Temperature: 0°C to 60°C
 - Humidity: Up to 80% non-condensing

Appendix

A1. Performance Curves

