Installation & Maintenance Manual

Two-Axis Rate Tables

AccudynA
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WWW.ACCUDYNA.COM

Revision History

Revision	Date	Editor	Changes
1.0	June, 2017	1010	First edition
2.0	March, 2021	10132,10150	Structural revision

Technical Support

Email: info@accudyna.com

Webpage: www.accudyna.com

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1. Scope

This document contains instructions needed for installation, maintenance and repair of the **two-axis rate tables** manufactured by Accudyna. Notes mentioned in this document reduce the possible risks during usage and increase the lifetime of the product. This product should only be used by a trained person, with sufficient attention to safety requirements. The goal of this document is to guide the installation personnel, user and certified repairing representative.

2. General Information

2.1. Conventional Signs

	Electrical Danger	Notifies possible electrical dangers
	Caution	Notifies possible dangers for personnel or UUT
Attention	General Caution	Shows an important note which can cause loss
Note	Reminder	Shows an important point which should be kept in mind

2.2. Referenced Documents

Specified Documents:

- Data Sheet
- Package Technical Drawing
- Electrical Technical Drawing
- Table-Top Technical Drawing
- Foundation Technical Drawing
- Remote Access Manual
- Test Procedures & Results Report

General Documents:

- Controller Software Manual
- Temperature Chamber Manual (if applicable)

3. Introduction

The two-axis rate table is used to test and calibrate a variety of inertial navigation systems and sensors, such as accelerometers, gyroscopes, inertial measurement units (IMUs), attitude-height reference systems (AHRS).

3.1. System Main Parts

Each two-axis rate table consists of two main parts: “Rate Table” and “Control Rack”. These two parts are connected by power and feedback signal cables. For easy communication between the control rack and rate table, a user-friendly Graphical User Interface (GUI) is provided on the control rack, which is an interface between the user and table.

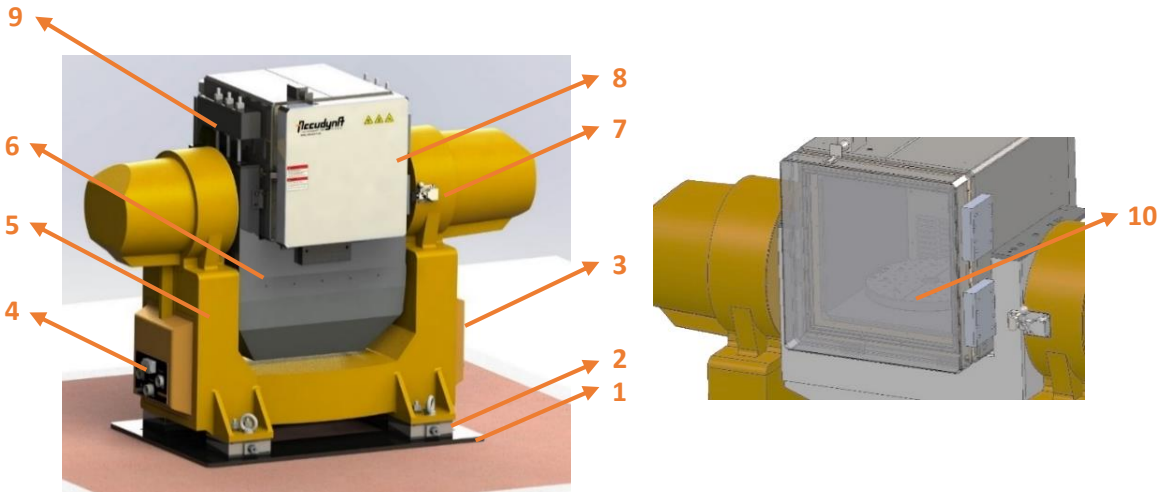
Example view of system main parts: “Control Rack” (left) and “Rate Table” (right)

3.1.1. Two-Axis Rate Table

Two-axis rate table is the part where motion commands are executed. This part consists of two-rotating axes: “Inner Axis” and “Outer Axis”, which are also called “Roll Axis” and “Pitch Axis”, respectively.

1. **Base Plate:**

   Steel plate on which the rate table is placed and fastened to the foundation.



Example view of two-axis rate table with chamber

2. **Leveling Wedges:**

   Using these wedges, the table can be aligned in two directions with a resolution of 1 arcsec relative to the horizon.

3. **Data Panel:**

   Contains data connectors of inner axis, outer axis, and chamber (if applicable), and user connectors that are connected to the table-top connectors.

4. **Power Panel:**

   Contains power connectors, such as inner and outer axes and the earth connector. It also contains chamber power and CO2 gas inlet if applicable.

5. **Base:**

   The main body of the device which is orange in color.

6. **Outer Axis:**

   The outer rotating axis of the device, which is dark gray in color, and the inner axis and chamber (if applicable) are located on it.

7. **Stow Lock:**

   The mechanical lock to fix the outer axis when installing or replacing the UUT.

8. **Chamber (if applicable):**

   Temperature chamber to create different thermal conditions.

9. **Balance weights:**

   Weights provided to balance the outer axis by moving the weights along the screws. It is also possible to add or remove required number of weights if needed.

10. **Inner Axis (Table Top):**

    The inner rotating axis of the device is inside the chamber. The table top is connected to the inner axis which contains connectors to transfer data from the “Unit Under Test (UUT)”.

3.1.2. Control Rack

The control rack is the part that can be used to communicate with the table. The rack includes three-phase lights and their sequence indicator, the main power supply switch, the emergency switch and communication ports. For easy communication between the control rack and table, the “Controller Software” is embedded with a GUI.

Example view of the control rack

1. **Power Panel:**

   Contains the indicator lights of three-phase power and phase sequence.

2. **PC:**

   The computer on which the “Controller Software” and GUI are installed.

3. **Control Panel:**

   Contains main power switch, emergency switch, computer power switch, and communication ports.

4. **Rear Panel:**

   Contains data and power connectors of inner axis, outer axis, and chamber (if applicable), and the main input from the three-phase power supply.

4. Installation Place

To ensure the best operational and safety conditions, the installation place should be prepared carefully. The following points are important and should be considered before installation:

4.1. Environmental Condition

Before installation of the system, a special laboratory having the following general conditions should be prepared for the rate table and control rack:

- **Temperature** should be kept about 22±2°C.

The accuracy of the system may differ in temperatures less than 19°C and higher than 25°C.

- **Relative Humidity** should be less than 80%.
- **Air** should be free from dust and corrosive gases.

Note

Fresh cement may generate chemical gases which can damage the system.

- **Enough luminescence** (100 lm/m^2) is recommended.

4.2. Preparing Installation Place

Paying attention to the following points in preparing the installation place has a key role in the proper operation of the system:

- Read and consider “Foundation Technical Drawing” requirements.
- The installation surface should be flat, hard and stable.
- The installation surface should be level within 1 mm.
- Keep the system far from small or big physical vibrations such as compressors, motors, etc.
- Keep the system far from electromagnetic interferences such as power supply, transformers, inverters, etc.

Note

If the user’s tests are sensitive to environmental vibrations, the inertial moment of foundation should be 1000-times higher than any rotating mass in the table.

4.3. Electrical Earth Connection

The installation site should have a well-designed electrical earth. Laboratories are usually equipped with an electrical earth using a copper plate or rod buried in a proper depth of an earth pit.

4.4. Safety and User Place

- The distance between table and the control rack should be more than 1 (m).
- If a high-rate rotation is needed, a wall or spacer should be placed between the user and system.

In high rate rotation, installed parts on the table top might be detached and harm the user.

- Enough space for the user to install the “Unit Under Test” on the table top and also operation of the maintenance instruments like cranes should be considered.

4.5. Emissioin of the System

In general, there is no emission from the system. However, distilled water, LN_2 and CO_2 leakage, noise, and heat are possible emissions of the system in the case of having temperature chamber.

Note

If the rate table is equipped with chamber, read “Chamber Manual” for more information.

5. Opening Packages

In addition to the rate table, the shipping packages include control rack, cables, documents, etc. For a complete list of the contents, please refer to “Packages Contents”.

Before opening the packages:

- Prepare the installation place according to the section 3.
- Check the packaging boxes carefully and report any damages.

During opening:

- Take all components out carefully, even small ones.
- Be careful! The packaging boxes are usually made out of wood, screws and nails.
- The rate table and control rack might be sealed in a vacuumed cover. Be careful not to damage them during opening.

After opening:

- Compare the components with the list in the delivery receipt to make sure that all of the components have been delivered.
- Inspect all of the components and report any damages as soon as possible.
- Keep the packaging boxes for the future transportation.

6. Transportation and Installation

6.1. Transpotation

- The packages have shock absorbers, as the rate table and control rack are very sensitive to shocks and vibrations. Thus, after unpacking and during transportation, move them carefully to avoid any shocks or strong vibrations.

Attention

Avoid any shocks which can decrease the accuracy of the rate table.

- Before transportation, close the stow lock. The movement of axes during transportation can be dangerous for personnel or the rate table.
- Only use eye bolts or marked places to lift the rate table or control rack. Wrong transportation can deteriorate the accuracy of the rate table such as position accuracy, orthogonality, etc. or damage the mechanical components of the system.

Example of transportation with a crane

Attention

Lift the rate table only from the eye bolts on the base or marked places.

Transportation of the rate table can be done in two ways:

6.1.1. Using Crane

Almost all rate tables have eye bolts or specific places to connect belts and lift using crane. Only use these places to lift the rate table.

6.1.2. Using Fork-lift

Forks of the fork-lift should be placed under the rate table between the rate table legs. Before transportation, make sure that forks are opened enough to cover bottom of the rate table completely. To prevent damaging the rate table with forks, it is recommended to use wooden sheets between the forks and the table body.

Attention **To avoid possible damages, the rate table can be fastened to the forks using belts.**

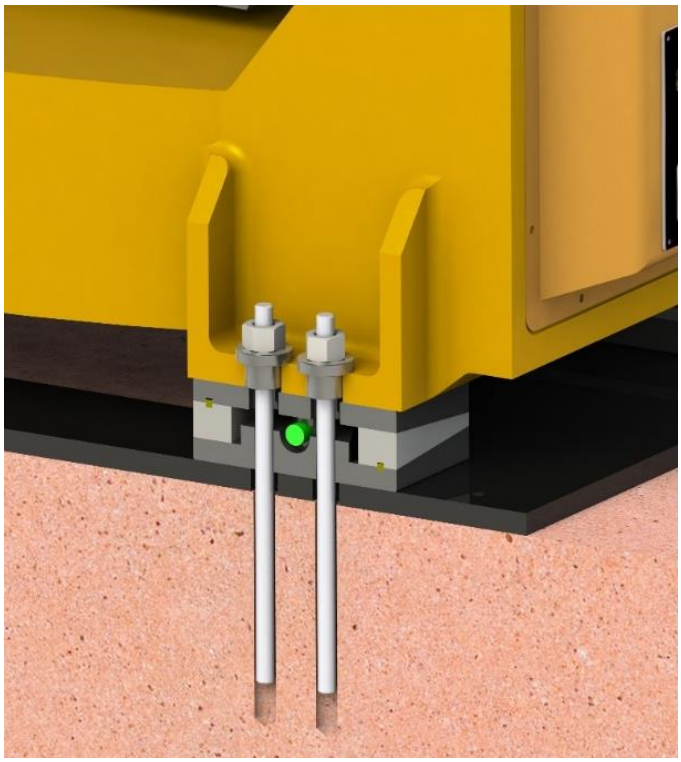
Attention **It is recommended to lift the rate table from the bottom of the base with a fork-lift (figure below).**

Example of fork positions

6.2. Installation

After opening the package and transporting the rate table to the proper installation place (see section 3), the rate table should be fixed on the foundation:

- If provided, use the base plate to fix the rate table on the foundation.
- Adjust the leveling wedges on the middle of their range before putting them beneath the table.
- For more information about the base dimension, its structure, and installation considerations see “Foundation Technical Drawing”.



Example view of fixing the rate table on the foundation

It is highly recommended to put safeguards around the rate table on the perimeter of the foundation. No one should enter this area during rate table operation as it will deteriorate the results of the tests. On the other hand, it is regarded as the danger zone of the rate table.

7. Setting up

7.1. Earthing

As electrical current can be induced on the body of the rate table, the body must be connected to the electrical earth before powering the rate table. It is necessary for the personnel safety and rate table proper functionality.

For this purpose, a low resistance wire must be used to connect the body to the electrical earth of the installation building. For better connection, the rate table is equipped with an earth connector.

Example view of earth connector

Attention

Do not apply thread locking glue to the earth connector threads! It will drastically reduce the electrical conductivity.

Always inspect the proper earthing before powering up.

7.2. Connecting to Power

After making sure about the proper earthing, perform following steps to connect the system to the power:

1. Read and consider “Electrical Technical Drawing” requirements.
2. Connect all power and data cables according to the “Electrical Technical Drawing” and existing written labels on the connectors.
3. Turn off the main circuit breaker and lock it.

4. Plug the power input cable.
5. Make sure the main switch is turned off and then turn on the main circuit breaker.
6. Check for the phase sequence green light to light up.

Note

Check the phase sequence if the green light does not light up.

Do not open the labeled parts as there is a risk of electrocution!

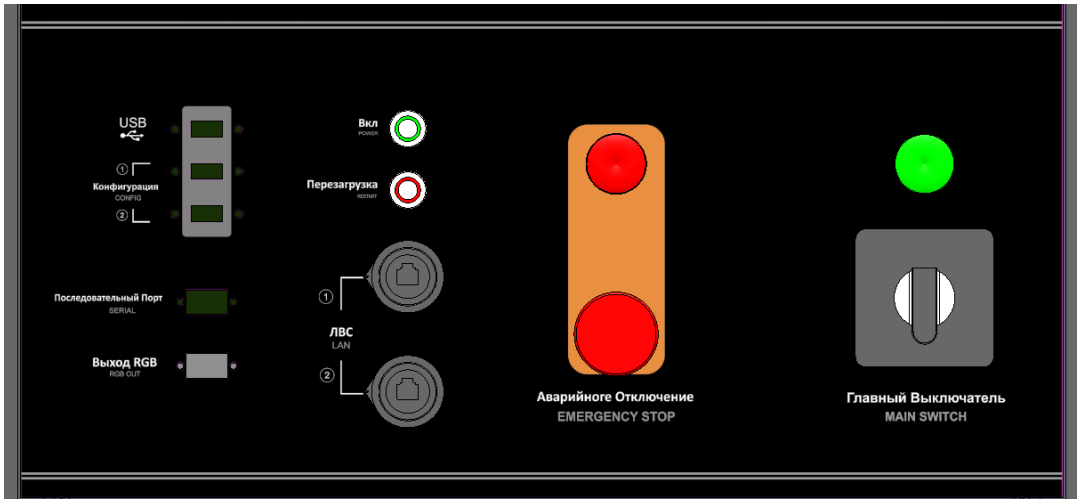
Example view of the power input cable and the indicator lights

7.3. Poweing up

Follow these steps to start the rate table:

Inspect connections of all cables before start.

1. Power on the “Main Switch” by placing it on the 1 status.
2. Make sure that “Emergency Stop” is disabled.
3. Turn on the PC using “POWER” key.
4. Run “GUI” software on the desktop.
5. Read “Controller Software Manual”.
6. Enable the axis.



Example view of the control panel containing “Main Switch”, “Emergency Stop” and “POWER” key.

7.4. Emergency Stop

If an unusual manner is seen from the motors or there is a risk of danger for personnel, push “Emergency Stop” button on the control rack to stop axes.

Note

Due to the body, table top and UUT inertia, the system will not stop immediately.

7.5. Turning off

To turn off the system, do the following steps:

1. Click on the “Stop” button on GUI and wait for the axes to stop completely (see “Controller software Manual”).

Attention

Do not turn off the power when the system is running.

2. Disable axes on the GUI.
3. Close the GUI.
4. Shutdown the PC.

Attention

Due to existence of “Data Freeze” on the PC, if any data is saved on the C drive (C:), transfer them to the D drive (D:) before shutting down the PC.

5. Turn off the “Main switch” on the control rack.

8. Initial Settings

After installation and turning the rate table on, some initial settings should be done by the user before performing any tests:

8.1. Leveling

Leveling a two-axis rate table means to align its inner axis direction perpendicular to the gravity while the outer axis is set to zero. To do this, a high precision spirit level or inclinometer with about 5 arcsec accuracy is needed. The procedure is as follows:

1. Loosen all nuts of the base.
2. Choose three wedges (if there are more than three).
3. Place axes in their zero position.
4. Put the spirit level on the table top in the direction of two arbitrary wedges and read the spirit level.
5. Rotate the corresponding axis 180° and read the spirit level again without touching the spirit level.
6. Calculate the difference between two readings and adjust the wedges to compensate half of this difference.
7. Rotate the Spirit level 90° and repeat step 4 to 6 for the third wedge.
8. Slowly tighten the nuts and repeat the above steps to level the table with an accuracy better than 1 arcsec.

Example of a leveling wedge and corresponding nuts

Attention

It is recommended to inspect the level of the rate table once a month in the first year and adjust it if necessary.

8.2. North alignment

If the UUT is sensitive to the rotation of the earth, the user may need to align the second axis with respect to the earth rotation. However, in the case of a two-axis system, the base orientation should be changed, which is possible using an optional alignment tool for high accuracy adjustment (it is not available in all two axis models).

8.2.1. Procedure

According to the needed accuracy, one of the following methods can be chosen:

1. **Using digital compass:**

   This method is easier, but with less accuracy which is about 0.5° in the best condition and open space. Note that this method gives the direction of the magnetic north which is slightly different from geographical north. It can be corrected by knowing the geographical location of the rate table.

2. **Using Theodolite:**

   If an accuracy about 1 arcsec is needed, a Theodolite should be aligned by the rate table in the north direction.

9. Testing

The user is responsible to perform the following tests (at least) **once a year or after any accidents** to make sure that the accuracy is not changed:

- Leveling (see section 8.1)
- Position accuracy & repeatability test
- Rate stability test
- Orthogonality test
- Wobble test

Attention

Record the results to track the system behavior.

Note

For more information about testing, see "Test Procedures & Results Report".

9.1. Position Accuracy & Repeatability Test

In this test, the response of an axis to a command is compared with a high accuracy polygon as a reference, three to five times. This comparison is done using an autocollimator. The system accuracy is determined from either Peak-Peak or rms of the results, while its repeatability is determined by the standard deviation of the results. Both accuracy and repeatability are reported in arcsec unit.

9.2. Rate Stability Test

Each axis is equipped by an encoder. The rate stability of the axis can be measured using the feedback of this encoder. In this test, the rate table is commanded by a range of rates as reference rates and the average rate is measured many times in a fixed spatial interval. The rate stability is evaluated as the standard deviation of measured values divided by the reference rate and is reported in percent or part per million (ppm).

9.3. Orthogonality Test

To measure deviation of axes from orthogonal state, fix the digital spirit level on the table top and relatively set it to zero. Command the inner axis to rotate 180° and do the first measurement. Command the outer axis to rotate 180° and relatively set the spirit level to zero. Command the inner axis to rotate 180° again and do the second measurement. See "Test Procedures & Results Report" for calculations.

9.4. Wobble Test

Measure wobble error of each axis at 0, 30, 60 … 330° positions using a two-axis autocollimator and a plane mirror or using two orthogonally positioned digital spirit levels. To evaluate the wobble error, use the least square circle in the polar representation and average radius in rectangular representation. Perform the test and evaluate the wobble error according to "Test Procedures & Results Report".

10. Usage and Maintenance

10.1. Waranty

If it is not mentioned in the contract, all products have 24 months warranty.

10.2. Usage

This product is designed and manufactured to use for test and calibration of position and inertial navigation sensors such as Accelerometers, Gyroscopes, and their combination with dimension limitations specified in “Datasheet”.

Attention

Any usage of this product other than the above mentioned applications or surpassing the “Datasheet” limitations will result in the loss of warranty.

10.3. User Limitations

10.3.1. Limitations of the PC Operating System

Control rack includes a PC to operate the “Graphical User Interface” software. For security reasons, the operating system of this PC is designed to switch back to its predefined condition after shutting down. This means that new saved data in the C drive (C:) will not remain after system restart. However, user can save data in the D drive (D:).

Attention

User cannot install any new software on the PC.

10.3.2. Limitations of Opening the System

User is not allowed to open the rate table or control rack without permission of Accudyna.

Attention

Warranty will be voided if the rate table or control rack are opened without Accudyna permission.

Attention

If any repair or part change is needed, contact technical support.

10.4. UUT Changing

10.4.1. Mechanical Considerations

User is responsible for safe installation and changing of the UUT. A thread matrix is provided on the table top for this purpose. On some table tops, reference holes are provided for the UUT alignment (see “Table-Top Technical Drawing”).

Note following points during the UUT installation:

- Try to adjust the center of mass as near as possible to the axis of rotation.
- Use at least 3 screw to fix the UUT.
- Apply the proper torque (Max 10 Nm for M6 screws).

Attention

Fix the UUT on the table top firmly. Other than safety of the user, it will prevent possible errors due to movement of the UUT with respect to the table top.

- In two- and three-axis systems, lock axes using stow lock for safety.
- Be sure the axis on which the chamber is mounted is locked before opening the door of the chamber. Otherwise the axis will become unbalanced and it will cause a collision between the door and base. It may also cause an incident for the user or UUT.
- In two- and three-axis systems, use balancing weights (see next section).

Always make sure the rate table axes are disabled before entering the danger zone. Stay in a safe distance from the rate table while the axes are rotating. There is a serious risk of crushing or fatal injuries.

For the safety of the user, keep the system turned off while mounting/dismounting the UUT.

If a temperature chamber is available, follow safety cautions specified in "Temperature Chamber Manual".

10.4.2. Axis Balancing

It is necessary to adjust center of mass of the UUT on the axis of rotation to avoid perturbing effects of unbalance torque. If this is not possible due to UUT dimensions, perform the balancing procedure as follows:

1. Disable all axes.
2. Place the axis on an arbitrary angle and release.
3. If the axis starts to rotate in any direction, the axis is unbalanced.
4. Use proper balance weight configuration to compensate the unbalancing torque.
5. Repeat these steps to have no preferred angle for the axis.

10.4.3. Electrical Considerations

Almost all rate tables are equipped with some connectors on the table top. These connectors allow the user to communicate with the UUT. After mechanical installation of the UUT, user can connect UUT cables to connectors and get data from the corresponding connectors on the rate table body.

Note

For more information about the pinout of table-top connectors, see the "Electrical Technical Drawing".

10.5. Parts Lifespan

Lifespan of the mechanical parts is related to the environmental condition, temperature, and axes rotation (rate of rotation and number of turns). In the experimental operation conditions, lifespan of the mechanical parts are as follows:

- **Sliprings:** about 5 million turns
- **Motors:**
  - Brushless: more than 20 years
  - With brush: 10000 hours for brushes

Attention

Contact technical support for any necessary replacement of parts.

10.6. Storage Condition

1. It is recommended to store the rate table and control rack in their boxes.
2. Keep the cover on the rate table and control rack.
3. Storage place should be free from moisture and dust.
4. Storage temperature of the rate table is within 0-50°C.

10.7. Diagnosis

10.7.1. Electrical

Problems	Troubleshooting
The power status lights are off.	1. Check that the plug has power using voltmeter. 2. Check cable connections. 3. Check if the Main switch is not failed or disconnected. 4. Contact technical support.
The phase sequence control light is not green.	1. Change the phases sequence in the plug. 2. Contact your power supplier company. 3. Contact technical support.
The power status lights are on, but the control panel is not working.	Contact technical support.
The control panel is working, but motors are not working.	1. Rotate the axes manually. If the position value is not changing on the GUI, turn off the system and check the cables from the control rack to the rate table. 2. Contact technical support.

10.7.2. Mechanical

Problem	Troubleshooting
It seems that the system accuracy has decreased.	1. Repeat the testing procedures (see section 9) 2. Ask a certified company to do the calibration. 3. Contact technical support.
The table top is not level in zero position.	Repeat the leveling procedure (see section 8.1)
The rate table has vibration during high speed rates.	1. Make sure that leveling wedges are firmly fixed. 2. Perform balancing procedure (see section 10.4.2) 3. The motor might be in “Foldback” status due to long time working with high torque. 4. Contact technical support.
Unusual sound is heard from bearings.	Contact technical support.
If any other unusual behaviors have been seen	Contact technical support.