

# Request For Proposal (RFP)

## Single Axis Position & Rate Table with Thermal Chamber

### 1.0 Introduction

This document describes the systems configuration and required performance characteristics of the electronic and mechanical subsystems and the computer interface requirements of a Single Axis Position & Rate Table with Thermal Chamber.

Detailed cost-effective technical proposals along with price and delivery schedule are invited. The supplier should quote for a **standard product** with necessary modifications conforming to the detailed specifications given here. The proposed system configuration shall be of proven design and off the shelf available item with minor modifications to account for tabletop size and slip rings. Proposed system shall have good track record to assure the performance of the system over years. Deviations from these specifications, if any should be brought out clearly so as to assess their suitability. A compliance matrix against each of the specifications shall be prepared and attached with the quotation.

- (i) Basically the system comprises of a Single Axis Position & Rate Table integrated with Thermal Chamber, power amplifier and a controller with GUI. Common controller for Rate Table and Thermal Chamber is preferred.  
The system shall be capable of
  - (a) Operation from the control console (Local mode).
  - (b) Remotely from a digital computer (Remote mode).
  - (c) Accept the analog signals in external mode (Analog Input mode).
- (ii) In local and remote mode, the system should be capable of being commanded in Position mode, Rate mode and Sinusoidal Oscillation mode. In analog input mode the analog input shall be configured for Position mode or Rate mode.
- (iii) The controller must provide a flexible and user-friendly GUI environment for the control of the table by way of data entry, display and monitoring. It should be possible to make data entries in local mode through GUI using keyboard or touch screen.
- (iv) In remote mode, it should be controlled by an external digital computer through any of the built-in computer interfaces of the controller.
- (v) Controller should have an analog output function (programmable) which will provide an analog voltage equivalent to the position or rate of the system.
- (vi) Thermal chamber operation should be made possible through both local mode and remote mode. Provision shall exist for the data entry of set temperature, temperature limits and display of the set and current temperature. Provision shall exist to log the temperatures in both mode of operation.

- (vii) Built in diagnostics, data logging capability and servo debug tools shall be provided to ascertain system health prior to its utilization. The controller must provide features for easy fault diagnosis of the total system.
- (viii) System should have a provision to provide the current rate, position and temperature information to an external digital computer through any of the built in interfaces at a minimum periodicity of 1milli second upon a polling request.
- (ix) The proposal must clearly spell out the system engineering aspects with the aid of appropriate diagrams. Such a description is essential to ensure the clarity on the total system.

1.1 Quantity : 1 number

## 2.0 System Configuration

### 2.1 General

The Single Axis Table with Thermal Chamber shall have a single axis position and rate table integrated with thermal chamber. The table shall be mechanically isolated from the thermal chamber to avoid vibration. The table shall be grouted to the foundation with expansion bolts through 3-point levelling mechanism. Levelling wedges shall have the provision to level the table to arcsecs and the range shall be to the extent of  $\pm 1^\circ$ . Even though the access to the UUT is through slip rings, provision shall exist in the chamber side walls to take out the harness through circular ports. Necessary provision shall be made in the chamber door to view the UUT during the thermal test. The thermal chamber door shall be of double hinged type to support easy opening and closing of the door.

The axis of rotation of the table shall be vertical. The axis shall be capable of full angular freedom and shall be supported on anti friction bearings.

### 2.2 Servo components

The drive for the table shall be preferably direct drive torquers. The table must incorporate an **absolute position transducer package** directly mounted to the axis shaft. **The position readout has to be absolute readout** without any homing requirement.

### 2.3 Table Top

The table top of the axis shall interface with the Unit Under test (UUT). Suitable MIL standard connectors mounted at the periphery of the table top shall permit electrical access to UUT. **Two sets of mating connectors** suitable for both table top and table base connectors along with crimping tool and pin removal tool must be provided. Preferred connector type MIL-DTL-24308 – 37 pin. Detailed part number to be provided in the quotation.

The material used for the table top must be Anodised aluminium alloy Type : PERALUMAN-460, EN AW-5083, which maintains the level on its surface over a period of time. The flatness of the table top must be less than 50 micron in the payload area.

**Standard hole patterns (50 mm matrix with M6 holes) equipped with solid thread inserts with locking keys must be provided. Threaded inserts without locking keys or helicoil inserts are not acceptable.** The hole patterns needed for adapter plates for checkout/calibration must also be taken care of.

## 2.4 Electrical Access/ Slip Rings

Slip ring capsule must be provided for electrical access of the UUT as per the details furnished under specifications. **The wiring schematic of the user slip rings must be furnished along with the offer along with connector details.**

Construction of the machine should be such that slip ring is accessible for maintenance without complete tear down to avoid recalibration of the system.

The slip ring make offered must be of proven make / type especially with regard to specifications like insulation resistance, noise, life etc.

Ultra low capacitance cables shall be used to connect the slip rings to the connectors so as to pass high frequency analog & digital signals through the slip rings.

Maximum frequency of the signals/ speed of RS485 lines that can be passed through the slip ring shall be clearly mentioned in the offer.

The life of the slip rings offered in terms of number of millions of rotations shall be clearly mentioned in the offer. Typical life of the slip ring shall be 1 million rotations or more.

## 2.5 Thermal Chamber

The thermal chamber cooling shall be based on mechanical refrigeration and the heating shall be through heaters. Suitable air circulation mechanism shall be provided to ensure the uniformity of temperature inside the chamber. Alert mechanism shall be made available to detect the failure of air circulation mechanism.

The evaporator coil of the refrigeration network shall be placed away from the UUT area to avoid condensed water falling over the UUT. Provision shall exist to drain the condensed water to be taken away through gravity flow. Built in dehumidifier provision shall be made available to avoid the condensation over the UUT during heating phase.

The table shall be mechanically isolated from the thermal chamber to avoid vibration.

Necessary safety mechanism shall be implemented to switch off the heating or cooling in case of loss of temperature control. An independent secondary protection mechanism shall be provided to protect the UUT from high and low temperature limits in addition to the ones provided in the main temperature controller.

## 2.6 Thermal Management

**Necessary forced air-cooling must be provided in order to avoid any hot spots in the system.**

## 2.7 Spares

All the essential spares for the trouble free operation of the table during its service life with minimum down time must be quoted as an option.

## 3.0 System Specifications

### 3.1 General

#### 3.1.1 Payload

- a. Table top size : 300 mm dia
- b. Mass : 25 Kgs
- c. Inertia : 0.5 Kg-m<sup>2</sup>

#### 3.1.2 User Slip Ring and Electrical access to UUT

- a. Mechanical
  - i. 25 lines of 2A at 150 Volts DC individually shielded for analog signals.
  - ii. 20 pairs of RS422 lines twisted pair with shielding.
  - iii. 1 line for analog shields grouped together.
  - iv. 1 line for RS422 shield lines grouped together.
- b. Electrical
  - i. Resistance : <1 ohm
  - i. Noise : <20 milli ohms for two lines at a rate 10 deg/sec  
\* two lines will be tested in series
  - ii. Insulation : >100 Megohms @ 250 V DC  
\* Between any slip ring and chassis  
\* Between any two slip rings

#### 3.1.3 Dimension

The detailed dimensions along with weight and electrical power rating of the single axis table with thermal chamber & control console must be furnished along with the offer, preferably supported by necessary drawings.

Maximum outer dimension shall be limited to 2500 mm x 2500 mm

#### 3.1.4 Mechanical axes specifications

- a. Axis of rotation : Vertical
- b. Angular freedom : continuous
- c. Wobble :  $< \pm 5$  arcsec

### 3.2 Position & Rate table performance specifications

Sl. No.	Parameter	Unit	Specification
1	Position accuracy	arcsec	$< \pm 5$
2	Position repeatability	arcsec	$< \pm 2$
3	Position range	deg	User configurable as (0 to 360 or -180 to +180)
4	Position resolution	deg	0.00001
5	Rate range	deg/sec	$\pm 0.001$ to $\pm 3000$
6	Rate resolution	deg/sec	0.001
7	Rate accuracy (averaged over one revolution for 10 revolutions)	ppm	10 or better
8	Rate stability (averaged over one revolution for 10 revolutions)	ppm	1 or better
9	Acceleration range	deg/sec <sup>2</sup>	$\pm 0.1$ to $\pm 720$
10	Small signal bandwidth at a Nominal Inertia of 0.25 Kgm <sup>2</sup> With 1 deg/sec With 0.1 deg/sec	Hz Hz	$> 50$ $> 75$
11	Flatness of frequency response in the pass band	dB	$< \pm 1$ dB upto 20 Hz, $< +2$ dB over the rest

In addition to the above, the following points must be addressed clearly in the offer.

- a) The peak and the continuous torque of axis.
- b) The offer must include system inertia, torque capability etc to permit assessment of the system under different UUT inertias.
- c) Frequency response:- It is to be ensured that the response is as flat as possible in the pass band (not exceeding  $\pm 1$  dB up to 20 Hz and  $+2$  dB over the rest of the range). Necessary servo settings to be optimized and demonstrated during FAT & CAT.

- d) The small signal bandwidth (with 30% to 40% of peak acceleration) figures given are on the basis of -3dB gain or - 90 deg phase lag, 'Whichever occurs earlier'.

### 3.3 Thermal Chamber performance specifications

Sl. No.	Parameter	Specification
1	Thermal Chamber Configuration	Mechanically isolated from the Position/Rate Table
2	Chamber Cooling	Mechanical Refrigeration
3	Chamber Heating	Electrical Heaters
4	Temperature Range	-20° C to 80° C
5	Heating Rate	Upto 3°C/Min Programmable
6	Cooling Rate	Upto 3°C/Min Programmable
7	Dehumidifier	Built-In provision shall exist to avoid condensation on the UUT during heating phase at lower temperature
8	Temperature Controller Operation	Through Front Panel & Software
9	Temperature Resolution	0.1° C
10	Temperature Accuracy	± 1°C
11	Temperature Stability	± 1° C
12	UUT Access Port (On Topside)	Dia 50 mm port
13	UUT Viewing Window	200 mm x 200 mm, Anti condensation
14	Lighting	Incandescent Lamp Lighting
15	Temperature Controller Protection	Built-In alarm relays with Low & High Temperature Trip
16	Secondary Thermal protection	Secondary Protective device with independent sensor & Low-High Trip (Programmable)
17	Thermal Chamber Dimension	400 mm (w) x 400 mm (d) x 500 mm (h) (Internal)
18	Integration to the Position/Rate Table	Through the bottom side

19	Shaft Heater	Provision shall exist with interlock to the Position/Rate Table to heat the shaft at low temperatures
20	Thermal Chamber Software	Operation, Programming and Data Logging

#### 4.0 Controller Operating modes

The following modes of operation shall be provided by the controller.

##### 4.1 Position Mode

For moving to a fixed position, the system must take the shortest route to the new position. The system must accelerate to a constant rate and decelerate to the commanded position without any overshoot. The rate and acceleration limits must be user programmable.

Data entry shall be either manual in local mode, loading a profile file or by computer in remote mode.

Rate and acceleration must be contained to programmable limits so that smooth motion trajectories are maintained.

Provision must exist to save and restore this setting for each UUT configuration in a single file

##### 4.2 Rate Mode

This mode is for moving the axis at a constant angular velocity. The system must accelerate at a constant acceleration until the commanded rate is achieved. The actual rate must not overshoot the commanded rate. The maximum rate that can be commanded and acceleration limits must be user programmable.

Data entry shall be either manual in local mode, loading a profile file or by computer in remote mode.

Provision must exist to save and restore this setting for each UUT configuration in a single file

##### 4.3 Sinusoidal Oscillation Mode

The axis oscillates at a commanded amplitude of position and frequency. Provision shall exist to sweep either amplitude or frequency or both. The sweep rate for amplitude and frequency shall be user programmable. The sweep mode shall be user selectable between logarithmic and linear.

The rate and acceleration limits must be user programmable.

Data entry shall be either manual in local mode, loading a profile file or by computer in remote mode.

Provision must exist to save and restore this setting for each UUT configuration in a single file

#### 4.4 Analog Input Mode

The analog input port on the I/O panel must be enabled for position or for rate control from a function generator or other analog source. The resolution of the analog input shall be of 16 bits for an input range of  $\pm 10$  volts.

Position and rate scale factors and bias must be user programmable so that  $\pm$  analog input range can correspond to any desired full-scale range.

Provision must exist to save and restore this setting for each UUT configuration in a single file

#### 4.5 Controller Manual

Detailed controller manual illustrating all the demanded features and provisions shall be attached along with the offer. If required, soft copy of the same is also sufficient. If available, a demo version of the controller software shall be made available to the user, in order to validate the features and provisions claimed in the offer.

### **5.0 Axis Servo Configuration**

Provision shall exist to configure the direction sense of axis (increasing angle as either CW or CCW), offset the position by any angle within the range.

The settings must be user programmable.

Provision must exist to save and restore this setting for each UUT configuration in a single file

### **6.0 Data readout**

#### 6.1 Absolute position readout system

Outputs from the position transducer must be accessible both at local GUI display and by a computer via the defined computer interfaces. The output display must include absolute angles in degrees and the rate at any instant. The display parameters shall be user configurable between any of the system variables like axis position, rate, acceleration, axis control card temperature, output torque command values, analog input values

#### 6.2 Analog outputs



It should be possible to view the position or rate as analog outputs on an oscilloscope / recorder.

Position and rate scale factors and bias must be user programmable so that  $\pm$  analog output range can correspond to any desired full-scale range of position or rate.

The resolution of the analog output shall be of 16 bits for an output range of  $\pm$  10 volts.

Provision must exist to save and restore this setting for each UUT configuration in a single file

Angle should be configurable for analog output range as multiples of  $360^\circ$  by providing appropriate user defined scaling.

### 6.3 Event pulses

A termination must be provided for monitoring of the event pulses, which are position dependent TTL pulses triggered at equally spaced positions over the full range of the motion travel. It should be possible to select the number of pulses per revolution.

Number of pulses per revolution must be user programmable.

Provision must exist to save and restore this setting for each UUT configuration in a single file

## 7.0 Data logging

Provision shall exist to log the system variables. The list of the variables, number of variables, logging interval and length of logging shall be clearly spelt out in the offer. The start of the data logging shall be either manual or event triggered. In case of event trigger, provision shall exist to configure the event such as threshold parameter value, +ve or -ve triggering. Provision shall exist to configure pre-trigger event also in terms of no of samples or percentage of total number of samples configured.

Provision shall exist to store the acquired data either in the local operator interface PC / controller or other locations with user defined file names.

## 8.0 Computer interfaces

It should be possible to control the system through any of the computer interface listed below in remote mode. All the functional modes must be available to the system user in the remote mode through the computer interface.

- (a) RS 232/485/422
- (b) LAN Interface - (TCP/IP)
- (c) USB Interface

It should be possible to readback the current position and rate through the computer interface at a speed of 1 KHz with full resolution / accuracy of the table.

## **9.0 Servo loops**

The Servo loops should be software configurable for easy adaptation for varying test loads in position and rate modes. The servo gain/compensation adjustments due to inertia variation through software are very important requirements for operational convenience and trouble free operation and must be provided as a standard feature.

Provision shall exist for either auto tune or manual tune of the servo. In both cases the detailed procedure for tuning shall be specified in the offer and shall be included in the instruction manual.

In any of the case, the maximum rate and acceleration imparted on the axis shall be user configurable, so as to take care of the UUT dynamic capability and shall not exceed the limits in any case.

The rate and acceleration limits must be user programmable.

Provision must exist to save and restore this setting along with tuned servo parameters for each UUT configuration in a single file

## **10.0 Safety provisions and Interlocks**

The following safety provisions and interlocks must be provided.

### **10.1 Rate trip**

These are self-latching interlocks, which disconnect power to the motors when the pre-selected rate is exceeded in any mode of operation. This shall be possible through settings in the controller through GUI. It must be possible for the user to configure this setting. Provision must exist to save and restore this setting for each UUT configuration in a single file.

### **10.2 Manual clamps**

The system shall be provided with manual clamp to manually arrest the axis at any angular position rigidly. In this case interlock switches shall be provided to prevent energizing the torquer motor, when the axis is clamped.

### **10.3 Rate clamp**

Necessary rate clamps shall be provided for the safety of the UUT in rate mode of operation. When the commanded rate exceeds the set rate limit value, the system must clamp to the set value of rate. This shall be possible through settings in the controller through GUI. It must be possible for the user to configure this setting. Provision must exist to save and restore this setting for each UUT configuration in a single file.

### **10.4 Rate and Acceleration limits**

It shall be possible to program and control the rate and acceleration limit for each mode of operation of the system namely Position mode, Rate mode, Sinusoidal Oscillation mode. Provision shall exist to ensure that these setting doesn't exceed the extremes of the system capability. These limits shall be in force during the servoed operation of the axis including servo tuning. This shall be possible through settings in the controller through GUI.

Each mode of operation shall have independent setting. It must be possible for the user to configure this setting.

Provision must exist to save and restore this setting for each UUT configuration in a single file.

#### 10.5 Position limiting provision

Necessary provision shall be made to limit the axis position over the entire dynamic range. This shall be possible through settings in the controller through GUI. It must be possible for the user to configure this setting. Provision must exist to save and restore this setting for each UUT configuration in a single file.

#### 10.6 Servo disable

A disable button must be provided on the front panel of controller which when pressed stops motion in the axis and disables the servo as a safety feature.

#### 10.7 Emergency off

An emergency off push button with latch must be provided on the front panel of controller rack which when pressed disables the power to the motor/power amplifier as a safety feature.

#### 10.8 Servo loop component temperature

Torque motor temperature, power amplifier temperature and axis control card temperature monitoring and interlock must be provided. In the event of temperature exceeding design limits of any of the sub system, the rate table and thermal chamber must shut down.

#### 10.9 User Disable Jumper

**A jumper shall be provided either at the base of the table or on the tabletop which when opened makes the servo to open and come to rest with preprogrammed deceleration defined by the user and then the power to the drives and thermal chamber shall be removed.**

### 11.0 Installation and other requirements

11.1 The system shall have compliance to 'CE'.

11.2 System Power requirements

The system power requirements shall be clearly spelt out in the offer. The system shall be compatible to Indian power conditions. The peak power and nominal power requirement also shall be included in the offer. Any specific requirement for the electrical safety device for the incoming supply to the system shall be clearly spelt out in the offer. The peak power of the system should be less than 10kW.

### 11.3 Pre-shipment testing and acceptance (FAT)

Pre-shipment testing of the system shall be conducted at manufacturer's facility by the manufacturer (in presence of ISRO representative) to verify all the system specifications in full system configuration and the test results shall be shared with the IISU focal point. All the performance specifications shall be demonstrated during the pre-shipment testing. The manufacturer shall prepare an acceptance test plan and procedure, which shall address comprehensively to all aspects and have it reviewed and approved by the customer. Testing shall include verification of performance over sustained periods. Spares supplied along with the system shall be tested for functionality by substituting into the system. **Detailed acceptance test plan and procedure to be submitted along with the offer.**

Clearance to ship the item to IISU will be provided only after the successful review and acceptance of the test results by IISU focal point.

### 11.4 Installation, commissioning and acceptance testing at customer's site (CAT)

The manufacturer must install and commission the system at customer's site. Acceptance test shall be carried out after installation to demonstrate the system performance and shall be as comprehensive as the FAT. The customer acceptance testing must include critical test like Position accuracy, wobble, rate stability, bandwidth test, slipring noise etc. Any impracticability in this regard must be specifically addressed and agreed by the customer. **Detailed acceptance test plan and procedure to be submitted along with the offer.**

### 11.5 Documentation

The documentation shall include system parameters and ratings including maximum torque value for continuous operation, mechanical configuration drawings, electrical schematics, circuit diagrams, interconnection diagrams, operational manuals, service cum troubleshooting manuals, part list, software manuals, procedure for transducer calibration, calibration and acceptance test procedures and results. The instruction manual, technical details and manufacturer's certificate of brought out items like power amplifier, motor and slip ring must also be supplied. All documents shall be in English and supplied to the customer in duplicate.

### 11.6 Warranty

All items shall be under warranty for a period of at least three years from the date of successful installation and commissioning at customer's site. Service support and

availability of the spares must be ensured even after the expiry of the warranty for a period of at least 10 years.

All hardware/software updates on controller that are brought out during the warranty period shall be installed in the system free of charge together with the necessary documentation.

#### 11.7 Insurance

Warehouse to warehouse transit insurance to be borne by the supplier.

#### 11.8 Customer's List

**Detailed list of indian customers for similar configuration systems along with the P.O date & date of supply** should be provided along with the offer.

#### 11.9 Service Support

- a. The details of the service support available for the offered system shall be clearly mentioned in the offer.
- b. The methodology of providing the service support during warranty and post warranty shall be clearly spelt out in the offer.
- c. The details of the service center along with the competency of the personal within the country shall be clearly spelt out in the offer.

### 12.0 Submission of Technical and Commercial price bids

12.1 This is a **two part tender** enquiry. The quotations are invited in **two parts in separate sealed covers**.

**Part 1** :- This sealed cover shall contain technical details covering all the technical aspects with necessary technical attachments, literature, supporting documents, catalogues, data sheets, **compliance statements of each point of the RFP**, commercial terms and conditions **without mentioning the cost. Unpriced Bill of Material shall be made available in this sealed cover.**

**Part 2** :- This sealed cover shall contain only the commercial bid with cost.

12.2 The quotation should be accompanied by a test results of the quoted rate table. It should mandatorily give

(1) Frequency response plots at 100% load capability and 25% load capability.

(2) Digital readout of position and rate over RS232/485/422, LAN interface, USB at speed of 1kHz or above over sustained period (at least 2Hrs).

12.3 The following details to be supplied along with the Technical bid. Further changes to these parameters will not be allowed.

Sl No	Parameter	Value/Detail
1	Outer Dimension of product	
2	Total Mass of the equipment	
3	Total Power Requirement and power interface (Peak and Nominal)	
4	Angular Acceleration Capability	
5	-3dB Bandwidth with 0.25kgm <sup>2</sup> @1°/Sec	
6	Type of mounting provision required	