HARPS

Use and Maintenance Manual

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Applicable documents

id.	Document code	Title	Source	Date	Issue
		Tip-Tilt Engineering Requirements Rev 4(2)	ESO	April 15, 2009	
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Reference documents

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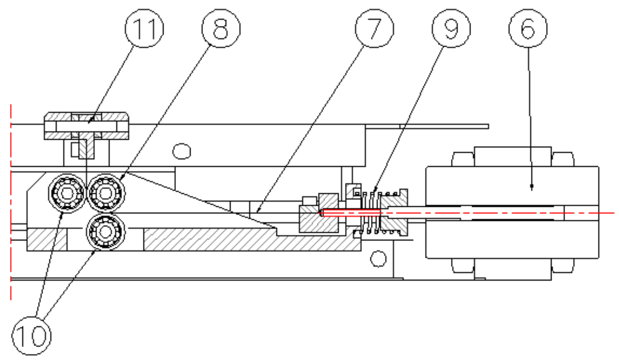
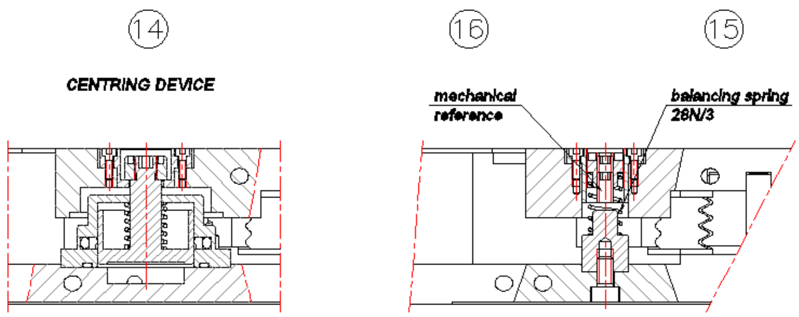
This Use and Maintenance Manual shall be read before any operation with the Harps Guiding Upgrade.

1. SCOPE

The scope of the Use and Maintenance Manual is to give all information for a good use of Harps and give instructions for the intervention in case of malfunctioning.

2. DDESIGN DESCRIPTION





1. Base
2. Table
3. Glass windows
4. Linear actuator coil
5. Linear actuator magnet
6. LVDT
7. Strip
8. Ball Bearing
9. Spring
10. Ball bearings for strip preloading
11. Pivot point for strip on the table
12. Flexure plate
13. Connection between flexure plate and table
14. Centring device
15. Balancing spring

16. Mechanical reference
17. Connection between flexure plate and base
18. Bellows

Follows a brief description of the Tip-Tilt Table.
The base (1), is realized in anodized black aluminum and fixed to the ADC flange by means of three screws, while the table (2), realized in anodized black aluminum, bears the glass (3) into the window by means of a adjustable frame.
These two parts are mechanically connected by means of three flexure steel plates (10) that allow the axial adjustment and the Tip-Tilt movement of the table around the pivot point that is in the plane of the three flexures.
The Coils (4) of the three Linear Actuators are fixed to the base in order to allow a better heat transmission, while the Magnets (5) are fixed to the table.
The axial displacement of the table is measured by means of three accurate LVDT absolute transducers (6). Due to their length, the LVDTs are placed horizontally and the connection to the axial movement of the table is realized by three strips (7) and ball bearings (8), preloaded by springs (9). The strip, which shape is assured by two bearings (10), is connected to the table in the plane of the three flexures plates, and are pivoting in order to accept the tip and the tilt angles.
The compensation of the table weight is realized by means of three springs which balancing force is equal to the average value of the axial component of the weight between the two orientation angles of the table, 0° and 70°.
The stable centering and safe condition of the table, when the actuators are not supplied, is obtained by means of three centering devices (18) that go in contact and lock the table when the table is not supplied, while they don’t touch the table when the cylinder is not supplied by the air.
Between the voice coils it is foreseen a connection by holes that avoid the air of the voice coils gets in the beam area, and also to reduce the force reaction due to pressure change inside the voice coil housing.
The heating of the surface of the base and of the table is low because of the low power consumption of the Linear Actuators and of the low thermal resistance between the coils and the ADC flange. The temperature close to the voice coil is measured by a transducer.
The amplifier for the Linear Actuators, the Tip-Tilt Control System and the Interface to the RS232 are located inside a cabinet, while all connection are realized by means of connectors.

Enclosed mechanical drawings:

- Dwg. ESO.01.00A.0
- Dwg. ESO.01.00B.0
- Dwg. ESO.01.00C.0
- Dwg. ESO.01.00D.0

Electrical drawings:

- Dwg. DRW_NUMB.1
- Dwg. DRW_NUMB.2
- Dwg. DRW_NUMB.3

3. CONNECTION AND START-UP

The Harps shall be mechanically fixed to the ADC while the electrical cabinet shall be fixed to a suitable support as close as possible to Harps taking into account of the cable length.

Making sure to connect together the two power connectors that have black colour and to connect together the signal connectors that have the same red colour. In case of mistake it is possible to damage seriously the Harps.

The air to supply of the pneumatic circuit shall have pressure equal to 3 bars, and shall be realized through an electro valve that gives pressure when Harps is active and gives no pressure when Harps is deactivated.

One green-yellow cable is foreseen for connection of ground, but it is necessary to verify if the connection will close a possible loop with possible increasing of disturbances.

Before start-up verify the voltage is 230 V, and the maximum current available is equal to 1 A.

The start-up can be done by means of the general switch.

4. CALIBRATION

4.1. Rest position

The adjusting of the rest position can be done by means of the screws shown in the Dwg. ESO.01.00C.0. The adjusting the position shall be done by means of the screws 54 and the locking screw 57, until the table is parallel to the base as required.

4.2. First start-up

- Switch on the general switch and after activate the Controller Galil.
- Connect the air supply.
- Connect the RS232 serial port to a PC, and open the connection to Harps following the Galil Manual.
- The main parameters are saved on Galil, and they are the following:

Proportional gain	KP 0.25,0.25,0.25
Integrative gain	KI 0.0195,0.0195,0.0195
Derivative gain	KD 3.5,4,4
Acceleration	AC 35000000,35000000,35000000
Deceleration	DC 35000000,35000000,35000000
Velocity	SP 10000000,10000000,10000000

It is possible to adjust better the parameters by means of the RS232 port.

- Move the table following the Galil instructions.

4.3. Air flow for cooling

Verify that when the Harps is activated, the air flows to cool the upper surface of the table.

5. MAINTENANCE

No preventive maintenance is foreseen, but in case of failure the following intervention shall be foreseen:

5.1. Voice coil change

In case of intervention for changing of the voice coil the Harps shall be completely dismounted following these operations:

- Making sure the table is not supplied
- Unscrew the 3x3 M4 screws of the three flexures on the table side
- Unscrew the 3x4 M3 screws of the voice coil protection
- Unscrew the 3x4 M2 screws that connect the strip of the LVDT to the table
- Pull the strip of one LVDT and dismount the upper pin and repeat this operation for the other two LVDTs (take care to sign each part in order to remount it in the same position).
- Slowly lift the table
- Change the Voice coil as required.
- Slowly lower the table on its position
- Screw the 3x4 M3 screws of the voice coil protection
- Pull the strip of one LVDT and remount the upper pin and repeat this operation for the other two LVDTs.
- Screw the 3x4 M2 screws that connect the strip of the LVDT to the table
- Screw the 3x3 M4 screws of the three flexures on the table side
- Connect all cable making sure the blue cables are connected together as the red cables
- Supply the air to the pneumatic circuit

5.2. LVDT change

- Making sure the table is not supplied
- Unscrew the 3x3 M4 screws of the three flexures on the table side
- Unscrew the 3x4 M3 screws of the voice coil protection
- Unscrew the 3x4 M2 screws that connect the strip of the LVDT to the table
- Pull the strip of one LVDT and dismount the upper pin and repeat this operation for the other two LVDTs (take care to sign each part in order to remount it in the same position).
- Slowly lift the table
- Change the LVDT and adjust roughly the position in the same position of the previous inside the hole
- Slowly lower the table on its position
- Screw the 3x4 M3 screws of the voice coil protection

- Pull the strip of one LVDT and remount the upper pin and repeat this operation for the other two LVDTs.
- Screw the 3x4 M2 screws that connect the strip of the LVDT to the table
- Screw the 3x3 M4 screws of the three flexures on the table side
- Connect all cable making sure the blue cables are connected together as the red cables
- Switch on the table on without the air pressure.
- Read the position of the three LVDT
- Adjust the axial position of the LVDT until the signal gives the same amplitude as the others.
- Supply the air to the pneumatic circuit

6. TIP-TILT TABLE COMMAND SIGNALS

The height of each LVDT transducer is in closed loop within the Galil Controller with the input X1, X2, X3, received from the external Control System via RS232.
These input shall take into account of the tip and tip angles αtip $\alpha tilt$, of the X01, X02, X03 offsets of the LVDTs and of the pivot point position by means of the value Atip and Atilt.
The general relations are the followings

$X1 = X01 + K*(1+Atip)*\alpha tip$
$X2 = X02 - K*0.5*(1-Atip)*\alpha tip + K*0.866*(1+Atilt)*\alpha tilt$
$X3 = X03 - K*0.5*(1-Atip)*\alpha tip - K*0.866*(1-Atilt)*\alpha tilt$

The relations that take into account of the effective distance of the transducer from the centre equal to 94 mm, the angle in microradiant, and the displacement with step of 0.1 micron, are

$X1 = X01 + 0.94*(1+Atip)*\alpha tip$
$X2 = X02 - 0.47*(1-Atip)*\alpha tip + 0.814064*(1+Atilt)*\alpha tilt$
$X3 = X03 - 0.47*(1-Atip)*\alpha tip - 0.814064*(1-Atilt)*\alpha tilt$

With no offset of the pivot point and no offsets the relations are

$X1 = 0.94*\alpha tip$
$X2 = - 0.47*\alpha tip + 0.814064*\alpha tilt$
$X3 = - 0.47*\alpha tip – 0.814064*\alpha tilt$

Thus with a tip angles equal 200 μrad and a tilt angle -4100 μrad, and offsets X01, X02, X03 equal to zero, the displacements are

$X1 = 0.94*(200)$ $= 188 = 18.8$ micron
$X2 = – 0.47*(200) + 0.814064*(-4100)$ $= -3427 = - 342.7$ micron
$X3 = – 0.47*(200) – 0.814064*(-4100)$ $= 3243 = 324.3$ micron

The resolution of the translation of the voice coils is 0.1 micron, while the maximum admitted amplitude of the input is from – 9000 up to 9000, that correspond to a displacement from – 900 micron up to 900 micron on each transducer.

The pivot point is in the centre of the triangle, the tip axis is orthogonal to the x axis and the tilt axis is aligned with the x axis oriented from the centre toward the actuator 1.

With tip=0 and tilt=0 the value X01, X02, X03 are chosen in order to have the table horizontal and placed at the desired height with three degree of freedom.

It is also possible to change the pivot point by appropriate changing of Atip and Atilt.
When Atip is 0.001 the pivot point displaces of 0.094 mm toward the x axis, while if Atilt is 0.001 the pivot point displaces toward the y axis of an amount equal to 0.094 mm.
The changing of the Atip coefficient of 0.00001 moves the pivot point along the x direction of 0.94 micron, while the changing of the Atilt coefficient of 0.00001 moves the pivot point along the y direction of 0.94 micron. The versus depends from the sign.

X1, X2, X3 are the input to the Galil Controller, that take into account that the number has a resolution equal to 0.1 micron.