ProjectSoft®

Astronomical institute of the Czech Republic

Control of Danish 1.54m telescope

USER MANUAL

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visualization: **TomPack 2.10**
version: **1.2.3**

www.projectsoft.cz

ProjectSoft HK a.s.
Eliščino nábřeží 375
500 03 Hradec Králové
Czech republic

CONTENT

1 INTRODUCTION

These OPERATING INSTRUCTIONS provide basic information necessary to operate the control and visualization system of the telescope. Before starting any operation, the personnel assigned to operate the system must be trained and familiar with these INSTRUCTIONS.

2 DESCRIPTION OF THE VISUALISATION SYSTEM

A control computer equipped with visualization software is used for the operation of the controlled technological unit. Using this control computer, operators have visual information on the condition of the technology and control the technological process by running individual program sequences, setting parameters (such as required set values of controlled variables, minimum and maximum values of two-stage controls etc.) or simply controlling individual actuating devices in manual mode. The visualization software has been designed on the TomPack platform by the company ProjectSoft.

The controlling of the technological unit is performed by a PLC that processes data collected by sensors located on the unit and executes necessary interventions to the process via actuating devices (relays, drives and motors) according to the control program.

3 OPERATION OF THE CONTROL COMPUTER

The visualization software is installed on the control (PC) computer. The monitor of the control computer displays the actual condition of the controlled process to operators.

3.1 Putting the system into operation

Conditions for turning on the telescope motion servo drives:

- The control voltage is on.
- The safety Stop button circuit is not activated.
- The hardware blocking circuit is not activated. This circuit includes the following safety switches: wire safety system, PLC output contact, which is activated in the case of a serious alarm, checked by the software. If any of these elements is active, the safety circuit is activated.
- On the front panel of the monitor press the main switch; a green light indicates power on.
- On the front panel of the computer, press the main switch; the green light indicates power on.
- After the monitor and computer have been switched on, procedures necessary to start the TomPack visualization software will start.

When these procedures are completed, the **Main control screen (CONTROLS)** will appear on the monitor.

3.2 System controls

Use the keyboard or mouse to control the system. The monitor shows information of the controlled process.

If you want to be able to print from the system, a local printer must be connected to the computer or the computer must be connected to a computer network and have an access to the network printer.

To start operation, log in to the system first!

3.2.1 Departments

Departments are groups of users. Only one group can operate the telescope at one time to prevent chaos during sharing of the telescope across the world.

Currently there are seven departments – La Silla (LS), Prague (P1), Copenhagen (C1), Ondrejov NEOS (O1), Ondrejov Gaia (O2), Brno (B1) and ProjectSoft (PS). Each department has its unique sign which is always part of the user name from the department. For example user “O1_Operator” is operator from department Ondrejov NEOS.

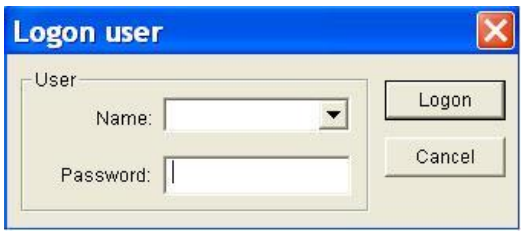
Only one department can be logged to the system at one time and only users from currently logged department can log in. When no department is logged in, the user can log in to the system and its department is automatically logged in too. After finishing work, some of the users from the currently logged department have to log off the department. Than the system will be ready for the next user/department. Only administrators from each department have the right to log off other departments. Currently logged department is also logged off approximately at noon (UT) automatically by the control system.

This is possible for users out off the currently logged department to log in the system, but they can not operate the telescope.

3.2.2 Logging on and off

Only authorized persons, logged on using their user name and password can access the software. Follow these steps to log on:

- select and press the "Logon/Logoff button" on the right on the upper bar
- the "Logon/off” panel will appear



- click inside the **User** field and type in the user name
- then click inside the **Password** field, type in the required password and press Enter or click OK to confirm. If the procedure was successful, the name of the logged user will appear in the upper bar. If the procedure was not successful, click to the Password field again and re-enter the password
- **to log off**, press the **“Logoff”** button at this panel

Individual authorized persons have the following access levels and corresponding restrictions to activities within the software (this can be modified on-site according to specific needs of the customers):

- **PROJECTSOFT** no restrictions
- **TECHNOLOGIST** authorized to change selected set values and parameters
- **OPERATOR** the basic level of operation, no authorization to change the above-mentioned parameters

After job completion, the operator must log off to prevent an unauthorized usage!

3.2.3 Screens – overview

There are several groups, each group consists of one or more screen.

Group **CONTROLS**:
Screen **CONTROLS**
Screen **TECHNOLOGIES**
Group **ALARMS**:
Screen **CURRENT ALARMS**
Screen **ALARM HISTORY**
Group **TRENDS**:
Screen **TRENDS**
Group **PARAMETERS**:
Screen **PARAMETERS1**
Screen **PARAMETERS2**
Screen **PARAMETERS3**
Screen **POINTING MODEL**
Screen **POINTING RESTRICTIONS**
Group **SERVICE**:
Screen **SERVICE**

3.2.4 Description of the upper and bottom bar

Each screen contains the appropriate drawing or scheme and the upper and bottom bar containing set of control buttons and displayed information.

Upper bar

The following information can be found on the **upper bar**:

- the name of the screen
- the field showing the **name of the logged on department and operator**
- the field showing type of control – **LOCAL/REMOTE**
- the field showing server **date and time** (should be UTC)
- the field showing client **date and time**
- the lower red line displays information about the last active alarm

Buttons from the left:

- the **SHOW** button shows the application frame
- the **HIDE** button hides the application frame
- the **DAY/NIGHT** button reduces the brightness of a screen
- the **LANGUAGE** button switches between English and Czech language
- the **HELP** button opens this document
- the **USER LIST** button opens a dialog where user can edit user accounts
- the **USER LOGON** button
- the **DEPARTMENT LOGOUT** button logs out the user and its department

Bottom bar

The following items can be found on the **bottom bar**:

Buttons on the left side from the left:

- the **CONTROLS** button to move to the control screen
- the **TECHNOLOGIES** button to move to the technologies screen

Buttons on the right side from the left:

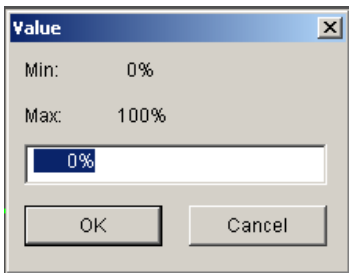
- the **CONTROLS** button to move to control screens with the control elements
- the **ALARMS** button to display the screens with current and historical alarms
    - This button also servers as an indicator signaling an alarm in the system. In case if no alarm is active, the indicator is blue. If it is orange-flashing, there is a non-acknowledged (non-confirmed) alarm in the system. If it is solid orange, there is an acknowledged (confirmed) alarm in the system.
- the **TREND** button to display the screen with the graph of the selected technological variables
- the **PARAMETERS** button to display the screens with technical parameters
- the **SERVICE** button to display the screen used to reach the documentation/ manual files and job termination

3.2.5 Changing the value

- **only the authorized users with specified access levels can change** parameter values, alarm limits etc.
- use navigation buttons or mouse to move the pointer to the **field of the variable value (light blue)**

the field will be highlighted

- press **ENTER** or **click the left mouse button** to display the **"Value"** input window



- use the keyboard to enter the value and press **ENTER** to confirm
- the value entered must be within the range set by the Min and Max values; values outside this range shall not be entered

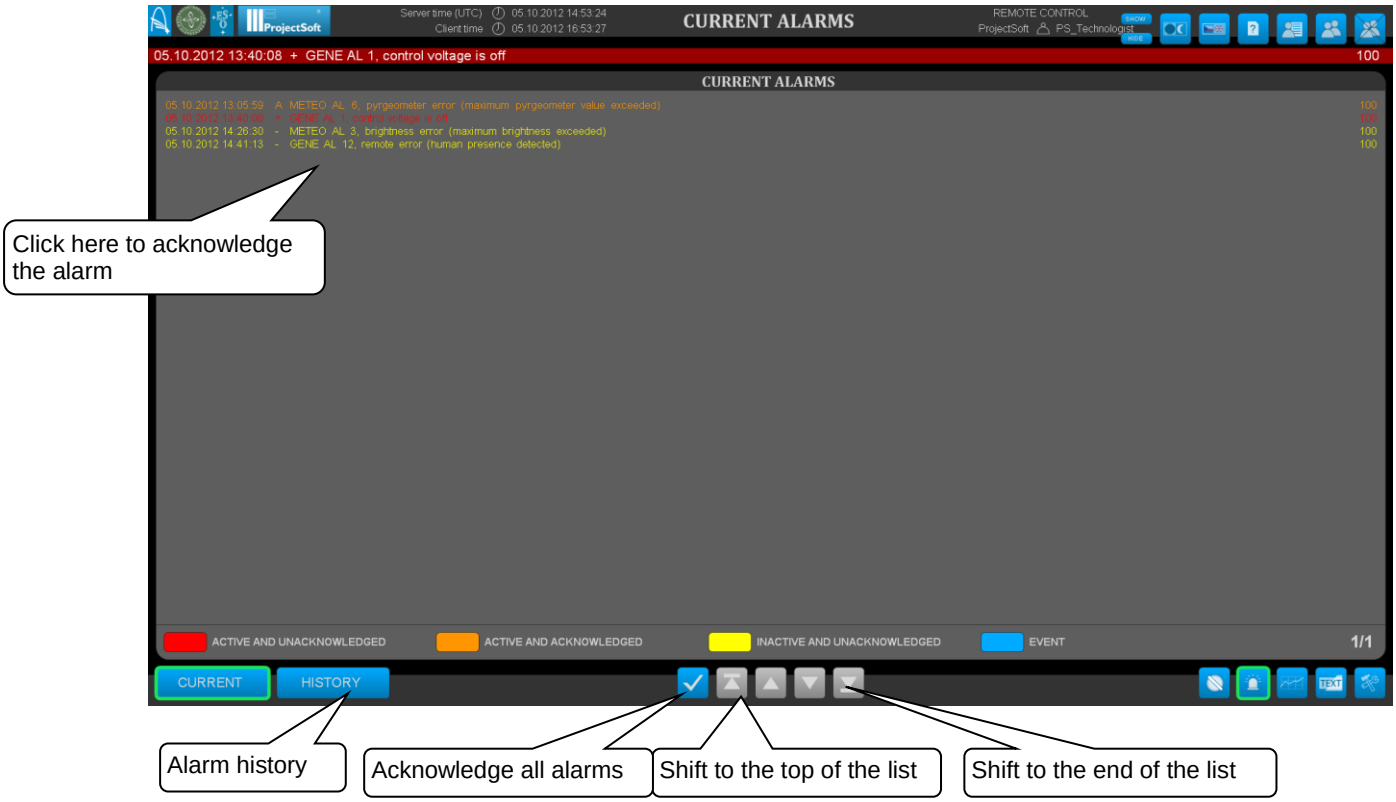
3.3 Alarm messages

Alarm messages notify the operator of the control system of existing non-standard conditions in the controlled technology such as drive failures, monitored variables outside working limits, operation stopped due to exceeding of set parameters etc.

- in case a new alarm occurs in the controlled technology, it is indicated by the **flashing indicator** in the Upper bar

3.3.1 Actual alarms

- select the **ALARM** button in the upper bar and click to open the "**Actual alarms"** screen
- **actual alarms (i.e. new or persisting alarms) and so-called events** are displayed on this screen



individual columns of the table have the following meaning:

- date and time of the fault activation
- alarm status (A - active, + alarm activation, - alarm end)
- description of the fault
- location in the technology where the fault occurred
- value of the alarm variable

lines are color coded according to their status:

- active non-acknowledged alarms: red
- active acknowledged alarms: orange
- inactive non-acknowledged alarms: yellow

In case a new alarm is generated, operators are obliged to check the reason and acknowledge (confirm) it.

There are two possibilities how to acknowledge alarms:

1. acknowledge **all alarms in the system at one time** - click on the **"Acknowledge all"** button located on the bottom bar. The upper bar indicator stops flashing but turns red, to indicate that acknowledged faults (operators are aware of them) are persisting in the system

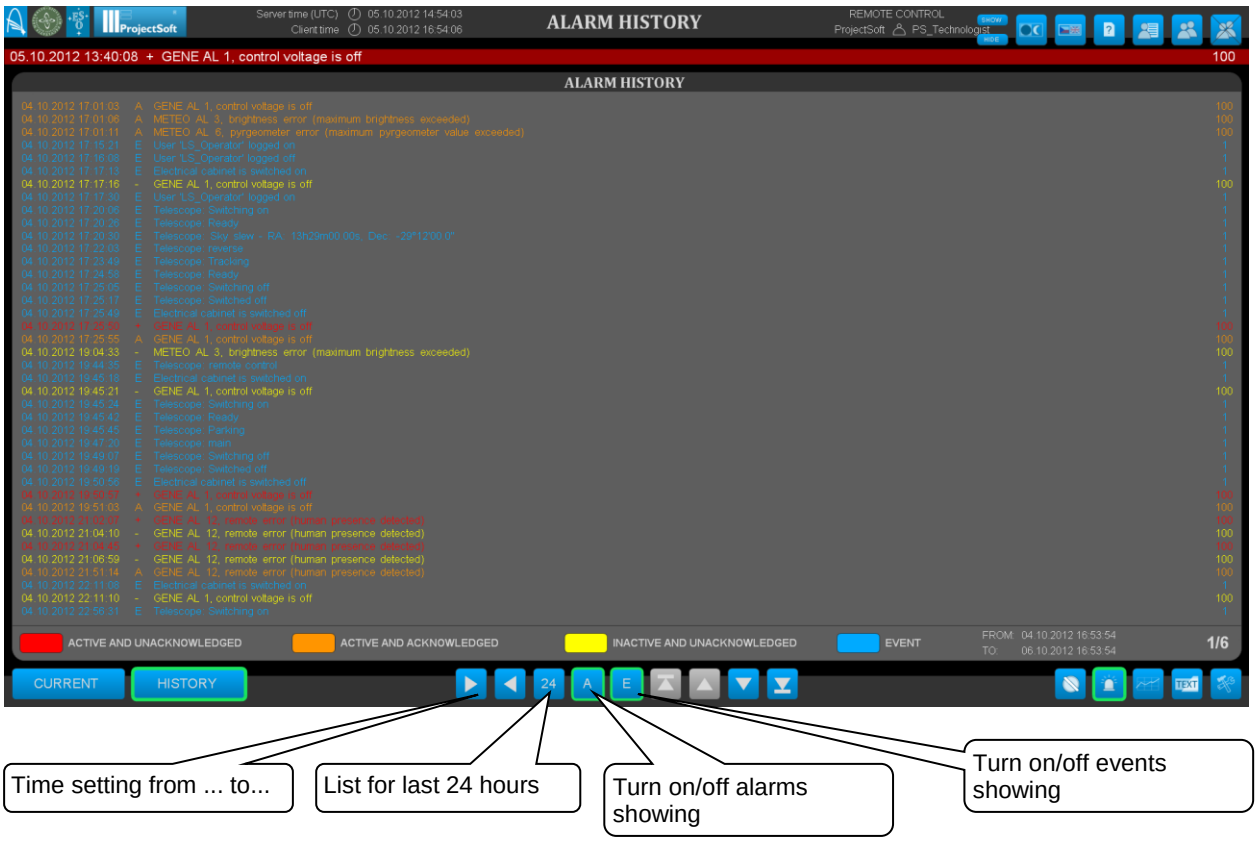
Remark: if the fault is resolved/removed indicator turns from red to blue

2. **acknowledge only selected alarms** - click to the appropriate alarm line
   - **UP ARROW** and **DOWN ARROW** buttons in the middle of the bottom bar are used for navigation through the alarm list
   - **LEFT** ARROW on the left of the lower bar is used to move back to the previous screen
   - **RIGHT** ARROW on the left of the lower bar is used to move to the screen of alarm history

3.3.2 Alarm history

- in the alarm history screen, all alarms and events can be displayed along with current alarms
- **event** is an issue that **does not have the character of a fault** (change of operator, change of important parameters etc.), however, it is advisable to monitor it

Note: acknowledging is not possible in alarm history.



lines are color coded according to their status:

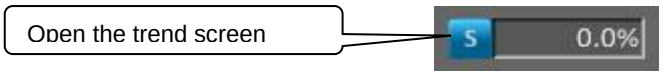
- active non-acknowledged alarms: red
- active acknowledged alarms: orange
- inactive non-acknowledged alarms: yellow
- events: blue

3.4 Historical trends

The system of historical trends is used to archive measured technological values and present them in the chart.

There are two ways of displaying historical trends in TomPack:

- to display the **trend of a specific measured variable**, click on the symbol of the controlled value (the left black section of the box).

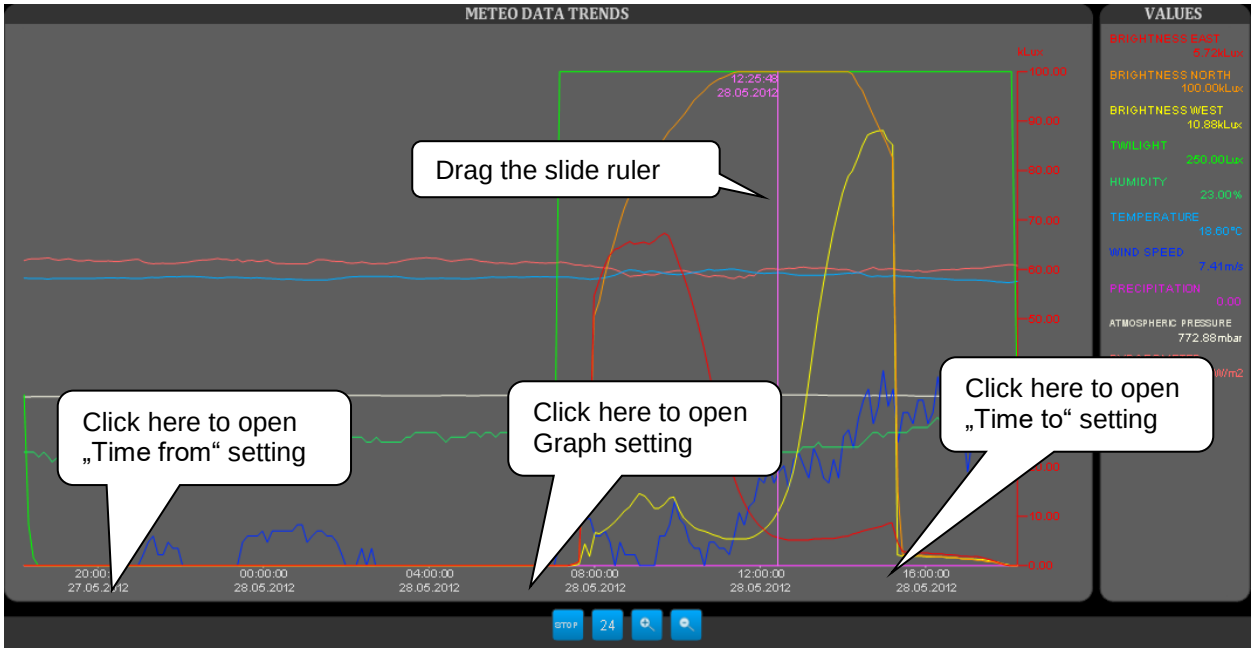


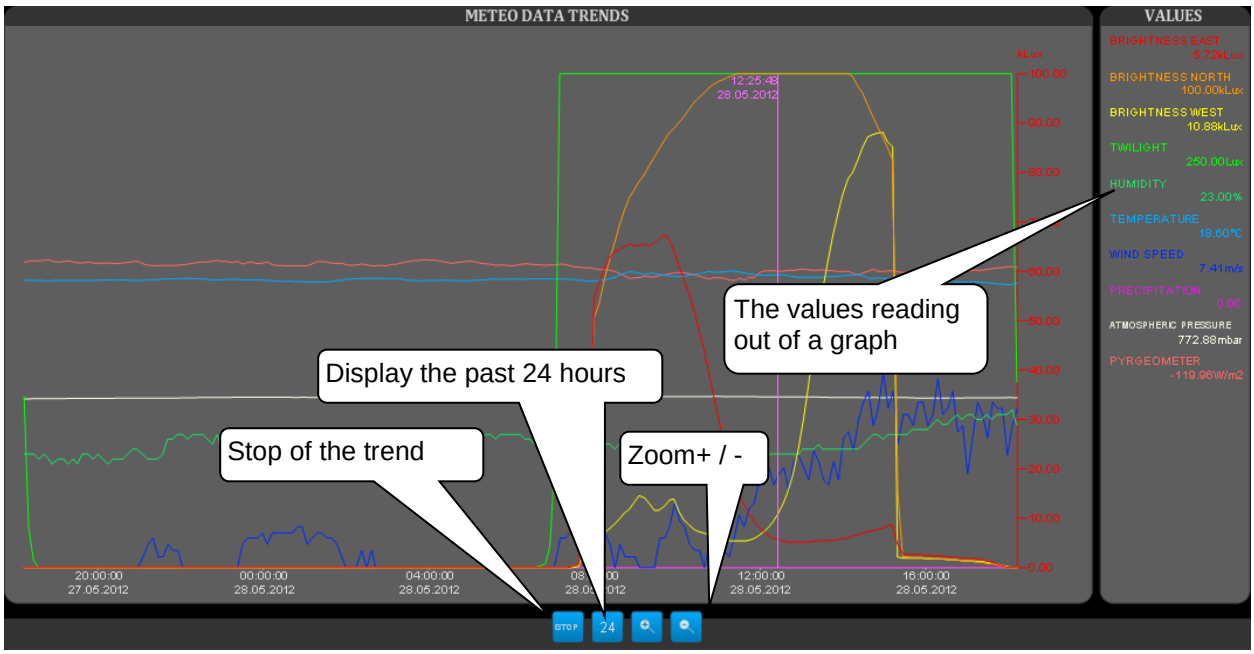
- to display the **summary trend of multiple measured inter-related variables**, click on the **TRENDS** button located on the bottom bar

- when first opening the trend screen, the **real-time trend** is always displayed, i.e. the course of the measured variable is continuously updated in real-time

3.4.1 Reading out of graph

- on the **right** side, next to the graph, **trend variables values are listed**; value of each trend variable is updated according to the slide ruler position
- how to **read out values from the graph using the slide ruler**: position the pointer to the "Y" axis, press the left mouse button, hold it and drag to the left (back in time)
- date and time is displayed above the ruler and listed variable values are displayed on the right, as it was already mentioned

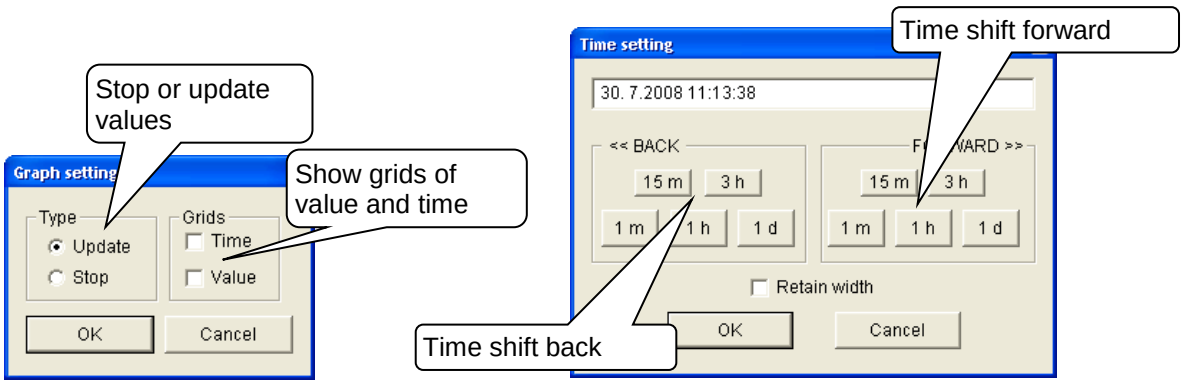




3.4.2 Movements in time

1. viewing of real-time course
   - if you want to change the time range of the displayed variable in real time, you can use the following buttons located on the right of the graph:
   - the **ZOOM+**, button used to enlarge the time range
   - the **ZOOM-**, button used to reduce the time range
   - the **24h** button to display last 24 hours
   - the **STOP OF TREND** button is used to stop updating of the graph
   - alternatively, the following steps can be used:
   - click on the "X" axis, as shown on the picture, to open the **"Time from setting"** control panel for the time shift
   - in this control panel, set the start time of the course either directly by filling in the date and time or by usage of the buttons for shifting the time
   - in this way, the graph will be extended from the current time to the past

2. viewing the course in past
   - use **STOP OF TREND** button to stop updating of the graph
   - as previously, click on the "X" axis, as shown on the picture, to open the **"Time from setting"** control panel for the time shift and set the start time of the course
   - in this way, the graph will be extended to the past
   - however, if you want to shift the course back in time while maintaining the same width of the graph, the **"Retain width"** box should be checked
   - similarly, if the course has already been shifted to the past and you want to adjust its end, click on the "X" axis to open the **"Time to setting"** control panel for the time shift and set the end time of the course



3.4.3 Setting graph properties

- click on the "X" axis, as shown on the picture, to open the "**Graph setting**" control panel for changing of graph properties
- in the left part "**Type**", graph updating can be stopped (the same function as the **STOP OF TREND** button)
- in the right part "**Grid**", an auxiliary grid can be displayed for both axes by marking the appropriate checkbox

3.5 Service screen

- use this screen to close the application or open “The User Manual” or “The Electrical Design Manual”
- to open the screen, click to the **SERVICE** button located on the bottom bar

4 CONTROL

4.1 Telescope

4.1.1 Telescope states

Off

The oil system and servo-amplifiers are switched off in this state. The motors stand and they are not electrically braked. The position sensors are working, so the automaton always knows the current position.

Switching on

The oil system has started. The servo-amplifiers are switched on and the system waits for about 2 sec for their initialization.

Switching off

The telescope is halted and the servo-amplifiers are still switched on for about 10 sec. The telescope is in the state of possible braking at this time period.

Ready

The oil system and servo-amplifiers are switched on. The motors stand, but they are "held" in their actual position by regulators of the control system. The axes can be rotated by using the manual telescope movement function.

Condition for turning on:

- serious alarm is not activated
- serious alarm is activated, but safety bypass (SA1) is on

Tracking

The control system uses actual right ascension and declination as required position values and it calculates appropriate mechanical coordinates. This calculation is rectified by aberration, precession, nutation, refraction and pointing model. The regulators maintain the telescope position in this requested position. It is possible to rotate the axes by manual control.

Sky Slew

This mode is used for slewing to the new coordinates – right ascension and declination. The appropriate mechanical coordinates of the target position are calculated before the slewing and they are rectified by aberration, precession, nutation, refraction and pointing model. The speeds in both axes are calculated so that both axes arrived to the target destination at the same time. A minimum altitude above the horizon is checked during the slewing. In the case of moving close to the horizon limit the alternative path is calculated.

After the slewing to the target position, the telescope control system is switched to the **Tracking** mode.

After setting of the RA and DEC coordinates, click on the **SLEW** button and the telescope automatically slew to the set position.

Condition for slew:

- the target must be above the horizon limit

- H.A. and D.A. axes must be calibrated
- less serious alarm is not activated
- safety bypass must be switched off
- hand movement of the telescope is not activated

It is possible to break slewing to the target position by the **STOP** button.

In dependence on the direction of the movement, the offset defined by the TELE parameter 28 is added to the DEC axis at the start of the Sky slew command. The direction for applying the offset is when the declination axis is moving in the minus direction in the mechanical coordinates. The offset is reset when the telescope reaches the position. The reason for this is to ensure that the telescope reaches the destination always from the same direction in the DEC axis and that the gear´s backlash is removed.

Mechanic Slew

This mode is used for the slewing to the new mechanical coordinates. Before the slewing, the target position is checked. The speeds in both axes are calculated so that both axes arrive to the target destination at the same time. A minimum altitude above the horizon is checked during the slewing. In the case of moving close to the horizon limit the alternative path is calculated.

The telescope control system is switched to the **Ready** mode after slewing.

After setting of mechanical coordinates, click on the **SLEW** button and the telescope automatically slew to the set position.

Condition for slew:

- target must be above horizontal limit
- H.A. and D.A. axes must be calibrated
- less serious alarm is not activated
- safety bypass (SA1) must be switched off
- hand movement of the telescope is not active

It is possible to break slewing to the target position by the **STOP** button.

Mechanic Flip

This mode is similar to the **Mechanic Slew** mode. The telescope moves to the reverse position.

The telescope control system is switched to the **Ready** mode after slewing.

Sky Flip

This mode is similar to the **Sky Slew** mode. The telescope moves to the reverse position; after the movement, the rectascension and declination remain the same.

Initializing

The short movement of the telescope is performed, with the aim to cross calibration points of incremental position sensors, installed on both the hour and declination axis. In the calibration point the corresponding source coordinates are set, according to the absolute sensor. This calibration must be done after every power off of the control switchboard. Mode of calibration is shown on the screen **CONTROL**.

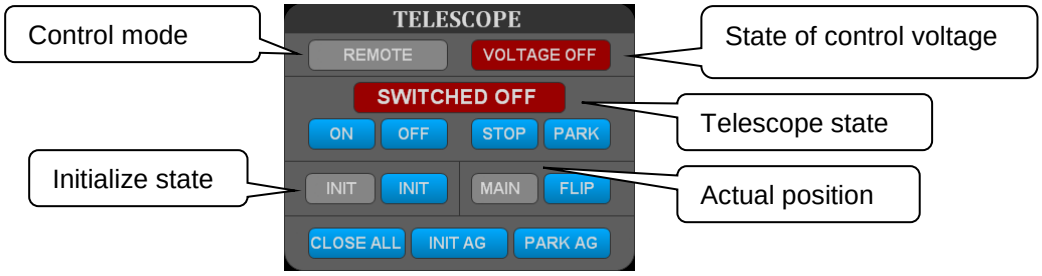
Condition for initialize:

- less serious alarm is not activated
- safety bypass must be switched off
- hand movement of the telescope is not active
- telescope must not exceed the horizon boundary 0

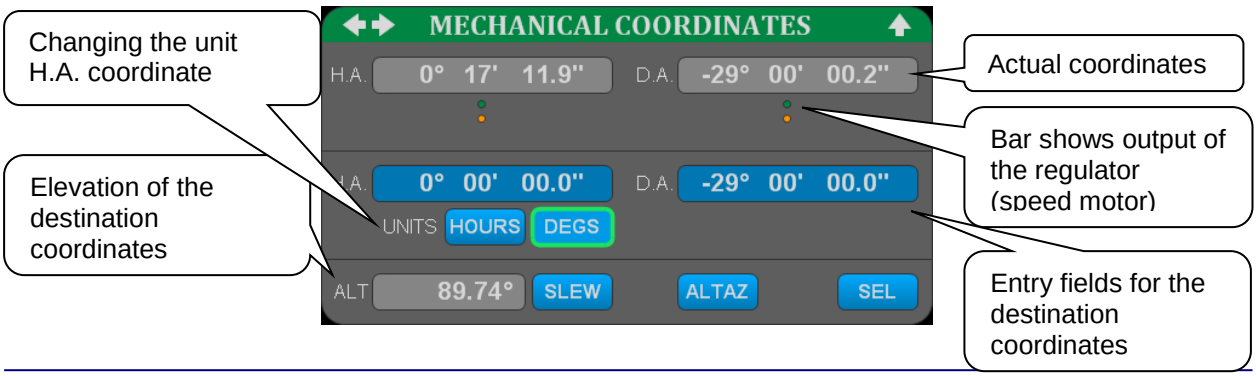
Parking

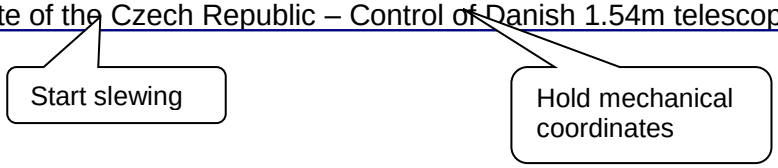
This mode is similar to the Mechanic Slew mode. The telescope goes on the position given in the parameters. The telescope control system is switched to the **Off** mode after slewing.

4.1.2 Description of controls



- **ON** button turns the telescope to the mode **Ready**. It works for the state **Switched off**.
- **OFF** button turns the telescope to the state **Switched Off.** It works for all modes.
- **STOP** button stops the movement of the telescope and the telescope turns to the mode **Ready**.
- **PARK** button parks the telescope to the parking position defined in parameters and switches the telescope off.
- **INIT** button turns on the state **Initializing** where the main encoders are initialized. It works for the state **Ready**.
- **FLIP** button turns on the state **Mechanic Flip** or **Sky Flip**, depending on whether the current state is **Ready** or **Tracking**.
- **CLOSE ALL** button closes all what is possible to close, parks the telescope and switches it off. It is highly recommended to use the **CLOSE ALL** button when finishing the observation night rather then to close and park everything individually!
- **INIT AG** button initializes all axes of the autoguider.
- **PARK AG** button parks all axes of the autoguider.





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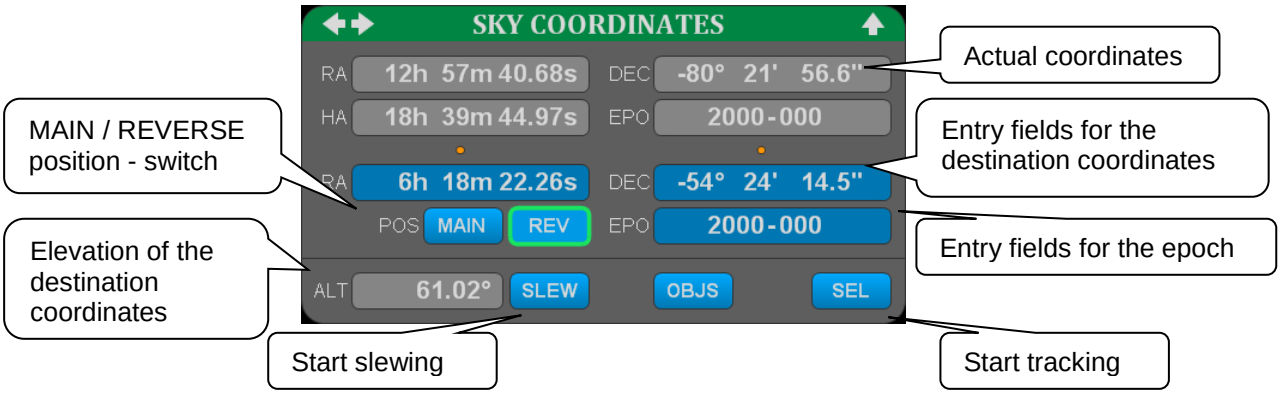
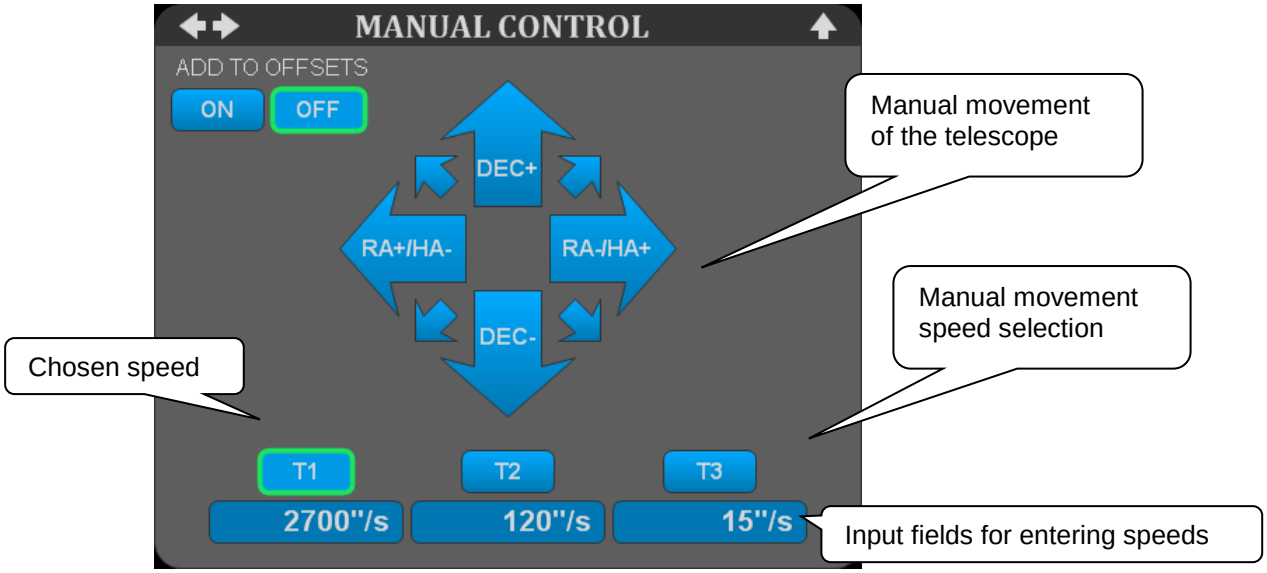
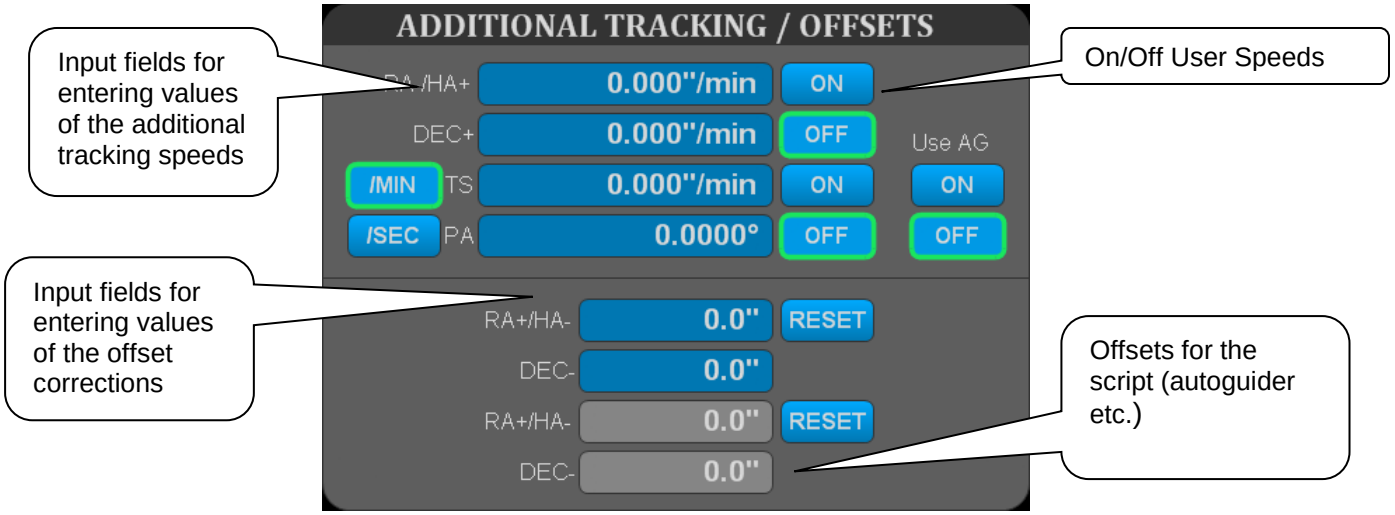
- **SLEW** button starts the slew to the new target position (Mechanic Slew), given in mechanical coordinates setting box.
- **SEL** button turn back to **Ready** mode from **Tracking**.
- **ALT** data field shows the height of the telescope above the horizon for the assigned target coordinates. If the assigned target location of the telescope is below the horizon, the field will have an orange background and **Mechanic Slew** mode will be disabled.



- **SLEW** button starts the slew to the new target position (**Sky slew**), given in topocentric coordinates setting box.
- **SEL** button starts **Tracking** mode.
- **MAIN / REV** button switches the required position of the telescope mount.
- **ALT** data field shows the height of the telescope above the horizon for the assigned target coordinates. If the assigned target location of the telescope is below the horizon, the field will have an orange background and **Sky Slew** mode will be disabled.

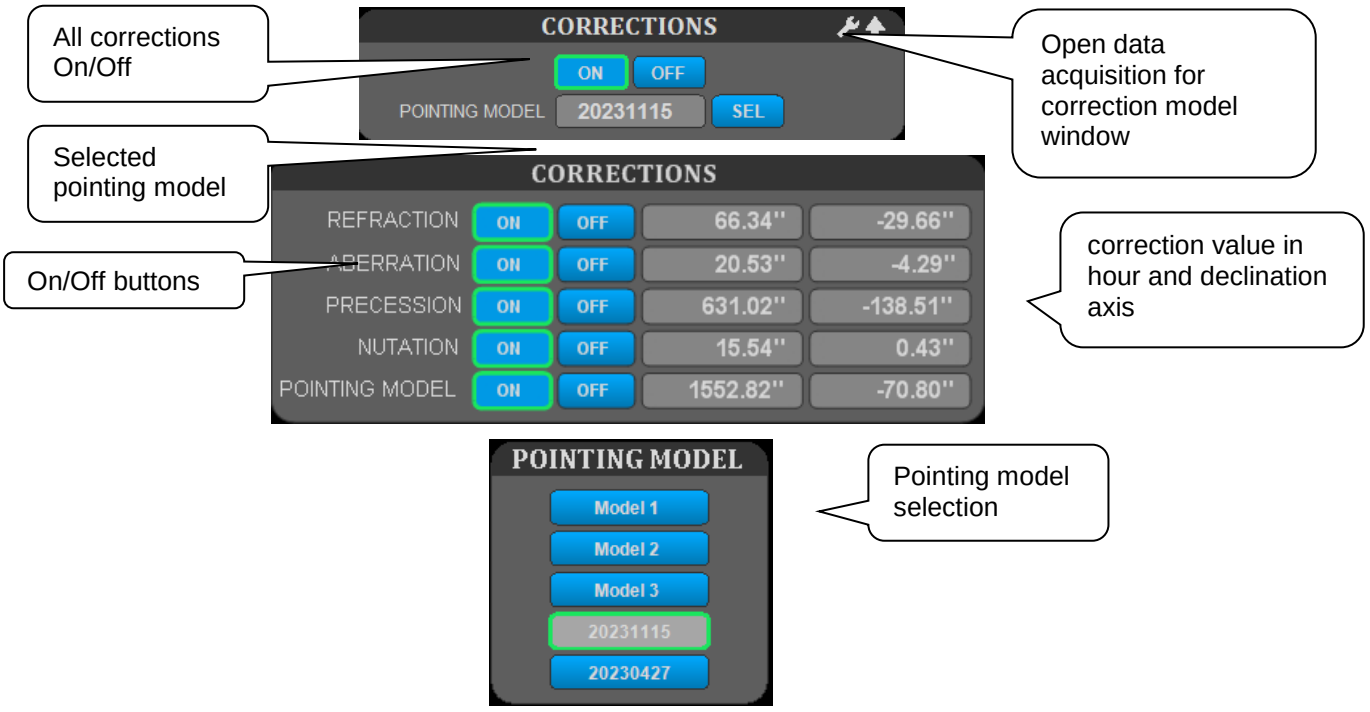


- **RA+/HA-, RA-/HA+, DEC+, DEC-** buttons are used for manual movement of the telescope in modes **Ready** and **Tracking**.
- **T1, T2, T3** buttons are used to the selection of hand movement speed.



- User Speed **ON** / **OFF** buttons turns on / off the user speeds.
- Use AG **ON / OFF** buttons turns on / off.
- Correction **RESET** button sets the zero correction.

4.1.3 Corrections



Any correction is possible to turn on/off by the appropriate button. The calculated value is displayed for both axes.

Turning on the corrections (aberration, precession and nutation, refraction and corrections model) and selecting the index of corrections model is only possible when the control is in a **Ready** state.

4.1.4 User Corrections

These corrections are used for compensation of error, which is not removed by the error model and which must be corrected by the observer. He must slightly manually move the telescope to the exact target position. It is possible to make a small hand change of RA and DEC. The offset correction is a pair of values, which are added to the other corrections and only these corrections are changed during the final precise manual setting. RA and DEC values remain correct and moreover, it is possible to determine the value of the mistake.

4.1.5 User Speeds

The user's speeds serve for moving the telescope with the selected speed in **Track** mode. This function is useful for tracking comets and objects moving in the sky.

This function is switched on and off by buttons **ON** and **OFF** on the screen **CONTROL**. The speeds of movement are set in the settings box.

4.2 Correction model

4.2.1 Introduction

A couple of astronomical corrections are implemented in the PLC software. It is mainly annual aberration, precession and nutation when sky coordinates are used. Actual precession correction values depend on the epoch of coordinates entered.

The actual local apparent sidereal time is computed from actual UTC time. To be able to use the UT1 time for more precise sidereal time, manually entered DUT1 correction is necessary to regularly update.

Refraction correction is computed from measured outside temperature and pressure.

Inaccuracies of the mount are corrected using these steps:

1. Measuring the inaccuracies

The user has to create a measurement database. It is accomplished by pointing the telescope to stars, fixing the telescope to the reference point of the camera and storing the actual difference in to text file. Both Main and Reverse positions should be used, but they will result in only one set of coefficients. To speed-up data collection, part of the delivery is a star database, which includes uniformly selected stars of equal magnitude with lowest amount of neighborhood's stars. There is also screen where user can enter X/Y coordinates of measured star on the CCD camera and control system computes required correction.

2. Computation of the coefficients

Next step is computation of the coefficients, using command line program TeleModel. It uses the least square fit of the measured data to compute values of the coefficients. User can choose text file with measured data and set of computed coefficients. Selection of the coefficients is important for the correct and effective computation.

3. Transfer coefficient values into control system

The next step is simple - the user fills in the parameter screen with computed coefficients values. It is possible to use 5 sets of parameters. The selection can be done by "1-5 Selection index" buttons. During obtaining the coefficients all other corrections must be switched on.

4. Test of the model

The last step should prove the validity of the data. The method is the same as step 1, but the necessary correction to reach reference point of camera should be in expected range of the model.

There is possible to merge data from different measurements, but all conditions must be the same! Even the small change of the full optical or mechanical part disallows data merging.

The different measurement and coefficients computation has to be done for different optical configuration of the telescope. It is also common that different optical configurations have different set of coefficients, not only different values.

It is suitable to perform the preliminary setting of error model at first step, so that the deviations are measured for twenty objects only and the error model is used with these preliminary coefficients. The entire process is then repeated, as described in the preceding paragraph, with the preliminary error model turned on.

The following terms could be currently used:

1. Inaccurate setting of zero position of hour axis in respect of south, HS
2. Inaccurate setting of zero position of declination axis in respect of equator, DS
3. Non-perpendicularity of declination and optical axis, TD
4. Non-perpendicularity of hour and declination axis, DH
5. The inclination of polar axis to the east-west direction (in respect to the equator), EW
6. The inclination of polar axis to the south direction, NS
7. Deflection of the tube (deflection of polar axis respectively), TF
8. Deflection of the fork, FF
9. Deflection of declination axis, DF

Name	Hour axis influence	Declination axis influence
HS (IH)	HS	0
DS (ID)	0	DS
TD (CH)	TD*1/cos(da)	0
DH (NP)	DH*tan(da)	0
EW (MA)	-EW*cos(ha)*tan(da)	EW*sin(ha)
NS (ME)	NS*sin(ha)*tan(da)	NS*cos(ha)
TF (TF)	TF*cos(lat)*sin(ha)/cos(da)	TF*[cos(lat)*cos(ha)*sin(da)-sin(lat)*cos(da)]
FF (FO)	0	FF*cos(ha)
DF (DAF)	-DF*[cos(lat)*cos(ha)-sin(lat)*tan(da)]	0

4.2.2 The procedure for calculating of the coefficients

Step1 - Measuring of the inaccuracies, collecting data

The coordinates can be entered manually on the screen **CONTROL,** or the selected objects can be loaded from a text file, prepared in advance. The pathname of the file can be entered in the correction model window, usually c:\model\stars.dat.

Example of the line data format:

The first six characters represent the identification number

RA (hours, minutes, seconds, degrees, arc minutes, arc seconds)

Dec

RA proper motions (seconds and arc seconds per year)

Dec proper motions

equinox

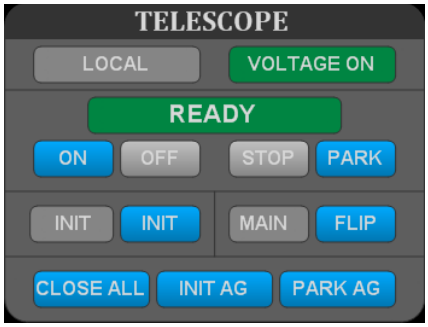
The file is terminated by the word "END".

Example:

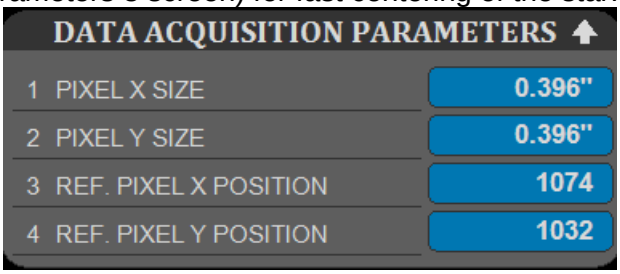
```
000001  01 33 13.030  -79 55 35.70   +.0126  +.011  2000.0
END
```

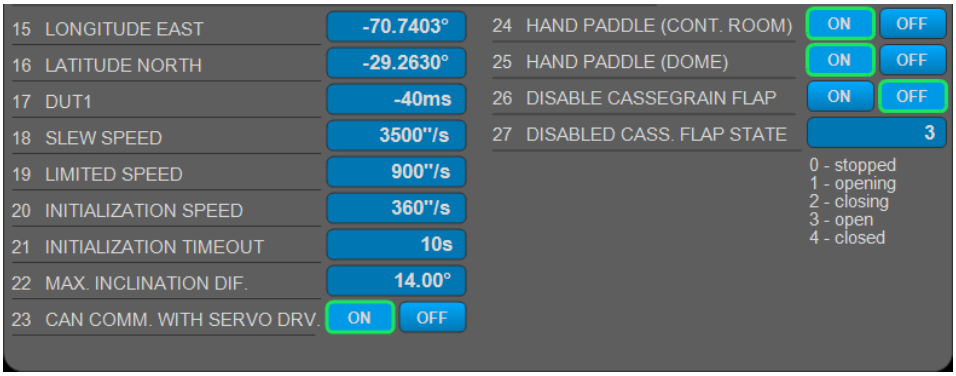
The procedure for data acquisition is following:

1. Switch telescope to READY mode.

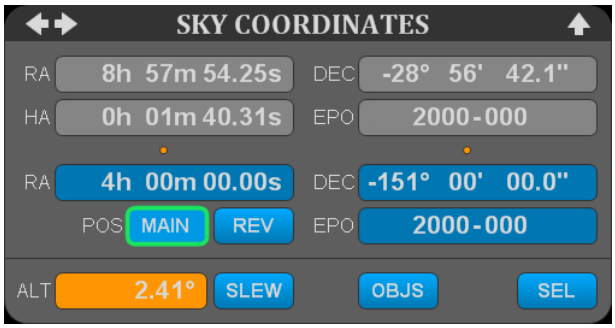


Check or update the DUT1 value in parameters 1 screen. Source of this value is in IERS BULLETIN - A, for example here: https://datacenter.iers.org/data/latestVersion/bulletinA.txt, section COMBINED EARTH ORIENTATION PARAMETERS, column UT1-UTC, value from the most recent date. The value can be also negative. Check also data acquisition parameters (on the parameters 3 screen) for fast centering of the star.

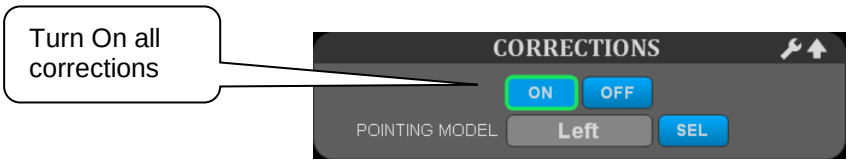




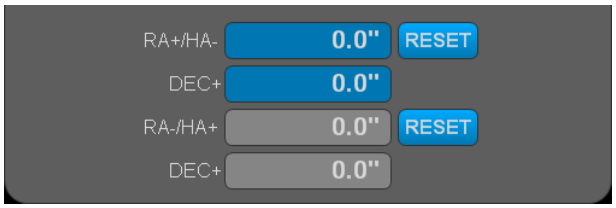
2. Select the position of the telescope (for example MAIN), enter Epoch 2000-000.



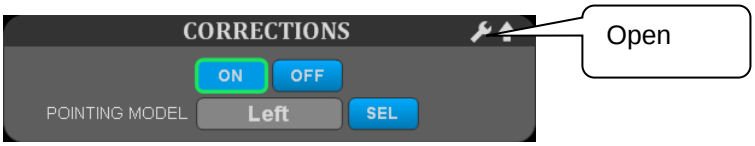
3. Open Corrections dialog. Turn on all corrections and select appropriate correction model if there is any. Check the focus setting for selected configuration.

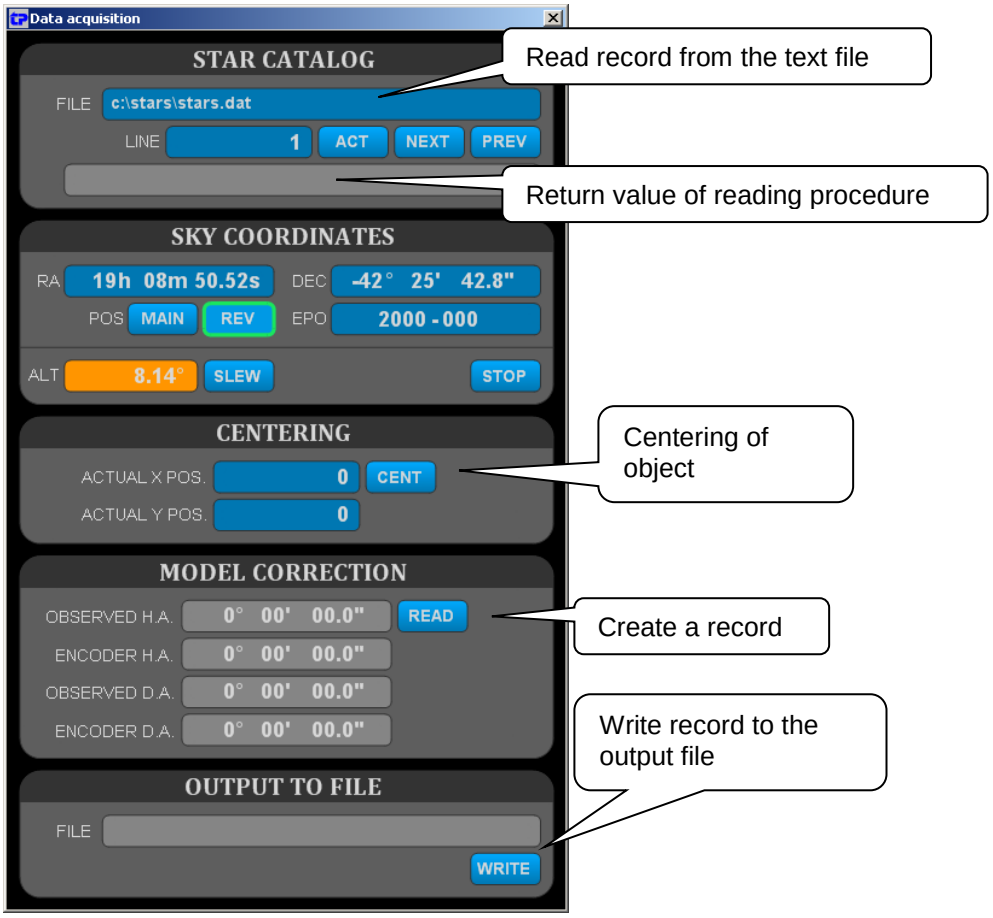


4. Reset user and script corrections.



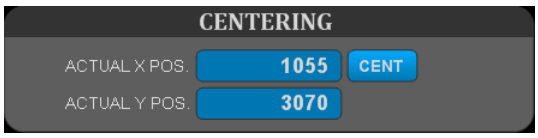
5. Open Correction model dialog.
6.



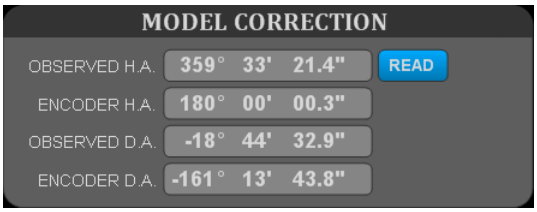


- Enter the path to the file with TeleModel database of stars (c:\model\stars.dat).
- Start with line 1 (enter 1 to the box LINE).
- To read data from the selected line click on READ ACTUAL button.
- To read data from the next line click on READ NEXT button. The line number will increase automatically.
- If the line is read successfully (green) than the coordinates and epoch of the star are transferred to Sky coordinates.

- If the coordinates of the star are above horizon (ELEV. is not yellow), click on SLEW button.
- If the telescope is at the desired position, take an exposure.



- If the star is not at the reference pixel, enter the actual pixel position and click on button CENT. Calculated corrections will be added to actual User corrections and the telescope will immediately change its position. Another possibility is the manual entry of the desired correction into CORRECTION values or movement of the telescope using T3 speed and correction mode of the movement.
- Take an exposure.
- Repeat this procedure until the actual position of the star corresponds with the reference pixel. Sufficient accuracy is reached when the star is closer than approximately 1 arcsec to the reference pixel.



- If the actual position of the star corresponds with the reference pixel click on the READ button.

- If the system is ready (grey) click on the WRITE RECORD button to write data to the output file. The name of the file is generated automatically in the format model_YYYY_MM_DD.dat. Check if data were successfully written to the file.
- Repeat this procedure by pressing the button READ NEXT until all visible stars from the database are measured.

Repeat the whole procedure (using the same stars) for the reverse position of the telescope.

2. Computation of the coefficients

Command line program TeleModel.exe should be used for coefficients computation. Its first parameter is the name of the text file with measured data, the next parameters are coefficient names to compute.

The result is splitted into two parts. The first part shows the measured data with the following columns:

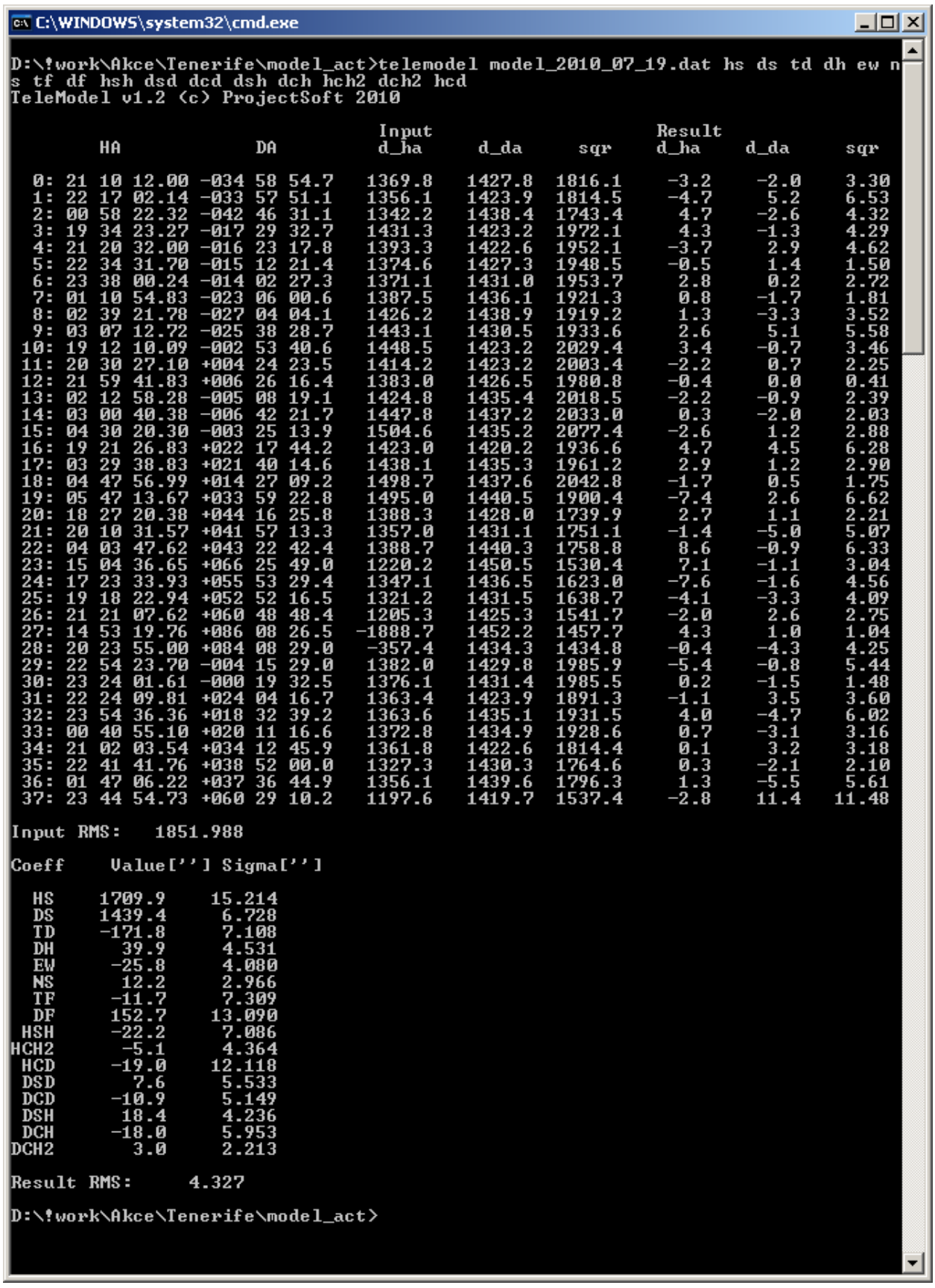
HA	Hour axis angle of measured star
DA	Declination axis angle of measured star
Input d_ha	Measured difference in hour axis
Input d_da	Measured difference in declination axis
Input sqr	Total measured difference (magnitude of the error)
Result d_ha	Resulted difference in hour axis
Result d_da	Resulted difference in declination axis
Result sqr	Total result difference (the expected remaining error)

Second part includes coefficients:

Input RMS	Root mean square of input data
Coeff	Coefficient name
Value	Computed coefficient value
Sigma	Deviation of coefficient value
Result RMS	Root mean square of resulted remaining error

HA values are in hours, minutes and seconds, DA in degrees, arcminutes and arcseconds. The rest are in arcseconds.

example:

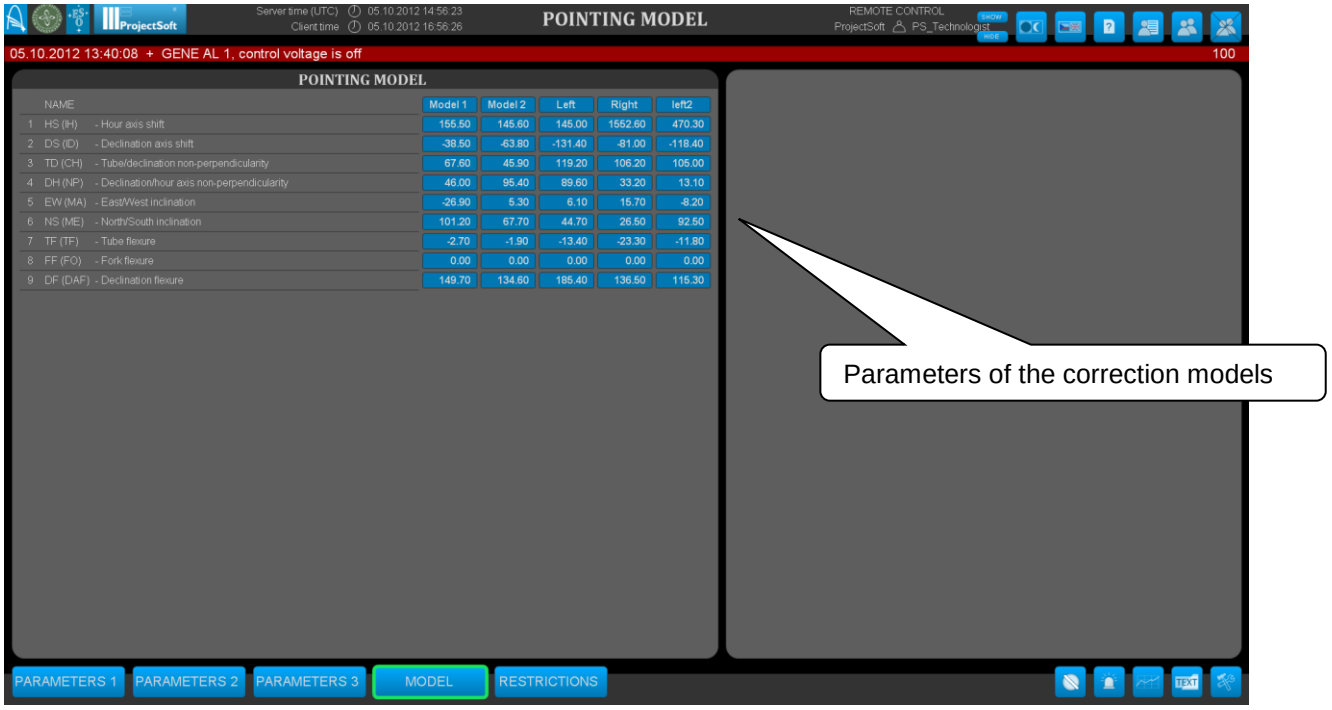


C:\WINDOWS\system32\cmd.exe

```
D:\!work\Akce\Tenerife\model_act>telemodel model_2010_07_19.dat hs ds td dh ew n
s tf df hsh dsd dcd dsh dch hch2 dch2 hcd
TeleModel v1.2 (c) ProjectSoft 2010

                                  Input                          Result
        HA              DA        d_ha      d_da      sqr       d_ha      d_da      sqr

  0: 21 10 12.00 -034 58 54.7    1369.8    1427.8    1816.1      -3.2      -2.0      3.30
  1: 22 17 02.14 -033 57 51.1    1356.1    1423.9    1814.5      -4.7       5.2      6.53
  2: 00 58 22.32 -042 46 31.1    1342.2    1438.4    1743.4       4.7      -2.6      4.32
  3: 19 34 23.27 -017 29 32.7    1431.3    1423.2    1972.1       4.3      -1.3      4.29
  4: 21 20 32.00 -016 23 17.8    1393.3    1422.6    1952.1      -3.7       2.9      4.62
  5: 22 34 31.70 -015 12 21.4    1374.6    1427.3    1948.5      -0.5       1.4      1.50
  6: 23 38 00.24 -014 02 27.3    1371.1    1431.0    1953.7       2.8       0.2      2.72
  7: 01 10 54.83 -023 06 00.6    1387.5    1436.1    1921.3       0.8      -1.7      1.81
  8: 02 39 21.78 -027 04 04.1    1426.2    1438.9    1919.2       1.3      -3.3      3.52
  9: 03 07 12.72 -025 38 28.7    1443.1    1430.5    1933.6       2.6       5.1      5.58
 10: 19 12 10.09 -002 53 40.6    1448.5    1423.2    2029.4       3.4      -0.7      3.46
 11: 20 30 27.10 +004 24 23.5    1414.2    1423.2    2003.4      -2.2       0.7      2.25
 12: 21 59 41.83 +006 26 16.4    1383.0    1426.5    1980.8      -0.4       0.0      0.41
 13: 02 12 58.28 -005 08 19.1    1424.8    1435.4    2018.5      -2.2      -0.9      2.39
 14: 03 00 40.38 -006 42 21.7    1447.8    1437.2    2033.0       0.3      -2.0      2.03
 15: 04 30 20.30 -003 25 13.9    1504.6    1435.2    2077.4      -2.6       1.2      2.88
 16: 19 21 26.83 +022 17 44.2    1423.0    1420.2    1936.6       4.7       4.5      6.28
 17: 03 29 38.83 +021 40 14.6    1438.1    1435.3    1961.2       2.9       1.2      2.90
 18: 04 47 56.99 +014 27 09.2    1498.7    1437.6    2042.8      -1.7       0.5      1.75
 19: 05 47 13.67 +033 59 22.8    1495.0    1440.5    1900.4      -7.4       2.6      6.62
 20: 18 27 20.38 +044 16 25.8    1388.3    1428.0    1739.9       2.7       1.1      2.21
 21: 20 10 31.57 +041 57 13.3    1357.0    1431.1    1751.1      -1.4      -5.0      5.07
 22: 04 03 47.62 +043 22 42.4    1388.7    1440.3    1758.8       8.6      -0.9      6.33
 23: 15 04 36.65 +066 25 49.0    1220.2    1450.5    1530.4       7.1      -1.1      3.04
 24: 17 23 33.93 +055 53 29.4    1347.1    1436.5    1623.0      -7.6      -1.6      4.56
 25: 19 18 22.94 +052 52 16.5    1321.2    1431.5    1638.7      -4.1      -3.3      4.09
 26: 21 21 07.62 +060 48 48.4    1205.3    1425.3    1541.7      -2.0       2.6      2.75
 27: 14 53 19.76 +086 08 26.5   -1888.7    1452.2    1457.7       4.3       1.0      1.04
 28: 20 23 55.00 +084 08 29.0    -357.4    1434.3    1434.8      -0.4      -4.3      4.25
 29: 22 54 23.70 -004 15 29.0    1382.0    1429.8    1985.9      -5.4      -0.8      5.44
 30: 23 24 01.61 -000 19 32.5    1376.1    1431.4    1985.5       0.2      -1.5      1.48
 31: 22 24 09.81 +024 04 16.7    1363.4    1423.9    1891.3      -1.1       3.5      3.60
 32: 23 54 36.36 +018 32 39.2    1363.6    1435.1    1931.5       4.0      -4.7      6.02
 33: 00 40 55.10 +020 11 16.6    1372.8    1434.9    1928.6       0.7      -3.1      3.16
 34: 21 02 03.54 +034 12 45.9    1361.8    1422.6    1814.4       0.1       3.2      3.18
 35: 22 41 41.76 +038 52 00.0    1327.3    1430.3    1764.6       0.3      -2.1      2.10
 36: 01 47 06.22 +037 36 44.9    1356.1    1439.6    1796.3       1.3      -5.5      5.61
 37: 23 44 54.73 +060 29 10.2    1197.6    1419.7    1537.4      -2.8      11.4     11.48

Input RMS:   1851.988

Coeff    Value['']  Sigma['']

  HS     1709.9     15.214
  DS     1439.4      6.728
  TD     -171.8      7.108
  DH       39.9      4.531
  EW      -25.8      4.080
  NS       12.2      2.966
  TF      -11.7      7.309
  DF      152.7     13.090
 HSH      -22.2      7.086
HCH2       -5.1      4.364
 HCD      -19.0     12.118
 DSD        7.6      5.533
 DCD      -10.9      5.149
 DSH       18.4      4.236
 DCH      -18.0      5.953
DCH2        3.0      2.213

Result RMS:     4.327

D:\!work\Akce\Tenerife\model_act>
```

3. Transfer coefficient values into control system

The resulted values should be then typed into corresponding boxes on the parameter screen. Unused coefficients have to be zeroed.



4. Test of the model

The last step should prove the validity of the data. User should repeat the same method as in case of collection data for model. However, the measured corrections should be approximately in the expected range of the model resulted RMS. The new created database could be then also used for new computation of the coefficients.

4.3 Main focus

4.3.1 Main focus states

Focus states are visible in the indication field on the right and has following meaning:

STOPPED

Focus drive is off.

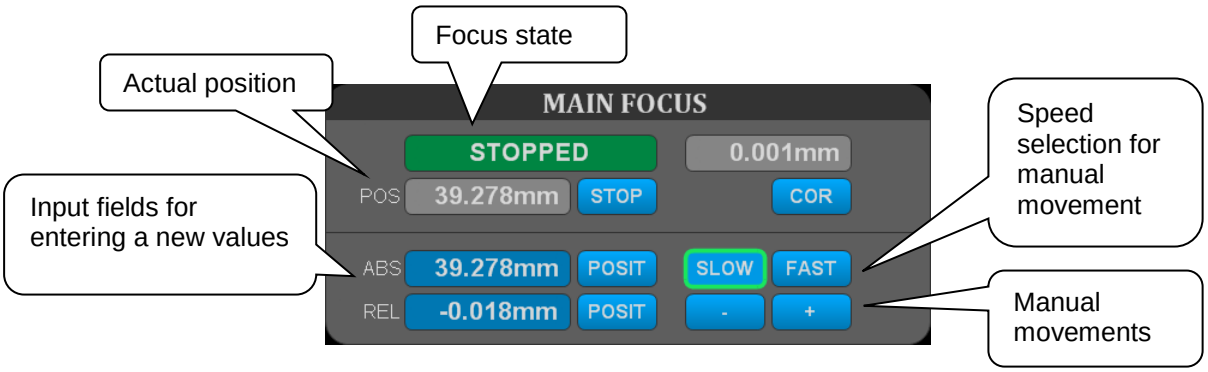
MANUAL +, MANUAL -

Manual focusing**.**

POSITIONING

Automatic movement to a preset position.

4.3.2 Description of control panel



Buttons and input fields meaning :

- **+ , -** - manual focusing
- **STOP** – stop the focusing movement.
- **SLOW / FAST** – switching between slow/fast focusing movement.
- ABS **POSIT** - Automatic focusing movement to an absolute preset position.
- REL **POSIT** - Automatic focusing movement - shift from the current position by the entered value.

4.4 Flaps

4.4.1 Flap states

States are visible in the indication field on the right and has following meaning:

STOPPED

Flap position is not defined (the end position signal is not received).

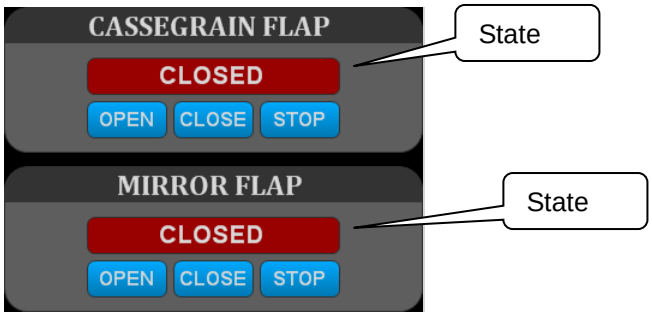
OPENING, CLOSING

Flap opening/closing is in progress.

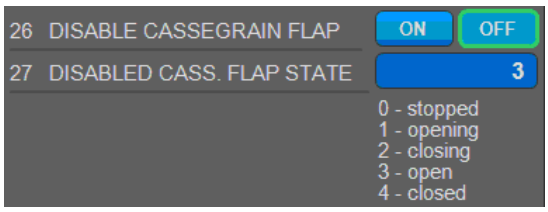
OPENED, CLOSED

Flap is in the Opened/Closed position.

4.4.2 Description of controls



- **STOP -** stop flap movement.
- **OPEN, CLOSE -** open/close flap.



The Cassegrain flap can be disabled in TELESCOPE PARAMETERS with parameter number 26. The TSC then behaves as if there was no Cassegrain flap – no CFLAP alarms, no blocking of other subsystems, etc.

With parameter number 27, the user can set the Cassegrain flap state which is disabled returned by ASCOL commands FCRS and displayed in the TCS client.

4.5 Dome

4.5.1 Dome states

STOPPED

The dome is stopped and ready to operate.

AUTO

The automatic movement of the dome. The slit of the dome follows the telescope position. This regime can be terminated by the STOP button.

AUTO +, AUTO -

The automatic movement to a new position is in progress. The slit of the dome follows the telescope position with a certain tolerance, which is specified by the parameters.

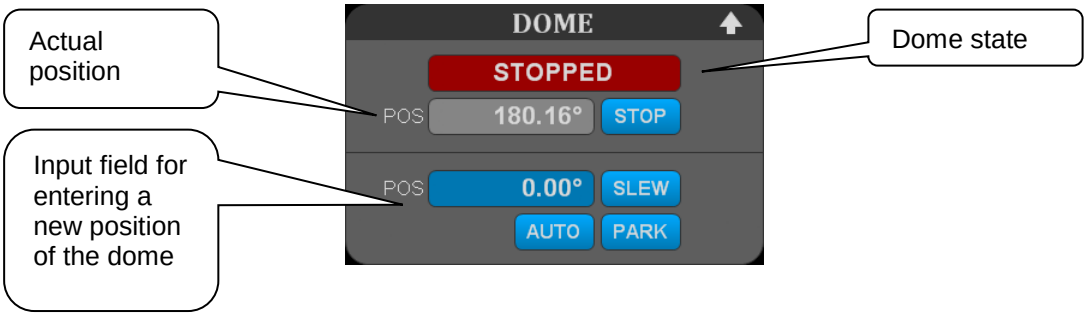
SLEW +, SLEW -

The automatic movement to a new position, determined by the azimuth, set by the operator is in progress.

PARKING, PARKING +, PARKING -

The dome is parking to the predefined parking position. After parking is finished, the slit is closed.

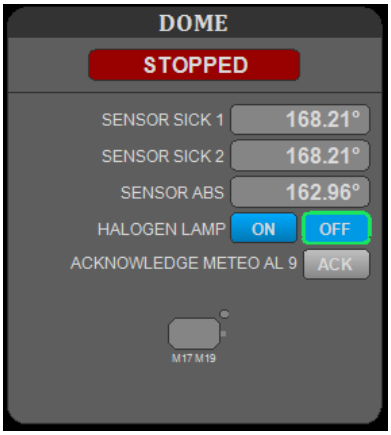
4.5.2 Description of control buttons



- **STOP** – stops AUTO, SLEW or PARKING regime.
- **SLEW** – turning on SLEW regime.
- **AUTO** - turning on AUTO regime.
- **PARK** – turning on PARKING regime.

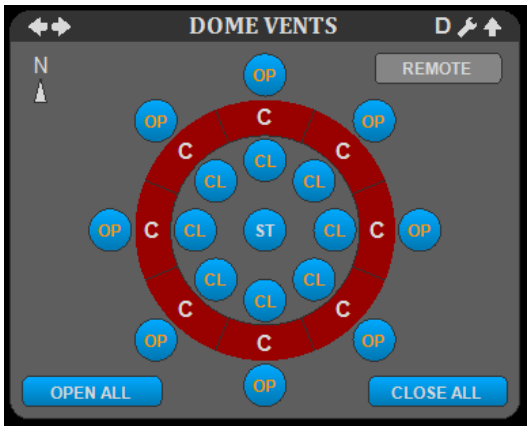
When the Meteo parameter 11 is exceeded, then METEO AL 9 gets triggered, a warning window will appear, and the rotation of the dome and opening slit is being blocked.

This state will continue until METEO AL 9 is no longer active and is manually acknowledged. This must be done by pressing the *ACK* button in the dome panel on the TECHNOLOGIES screen.



After the acknowledgement is done. The warning window will automatically disappear.

4.5.3 Remote control switch for dome vents (R6 SA1) indication



The indication shows the state of 3-way switch R6 SA1. The three states are *REMOTE*, *LOCAL* and *0.* Control of the vents is possible only in *REMOTE* mode.

4.6 Slit

4.6.1 Slit states

STOPPED

Slit position is not defined (the end position signal is not received).

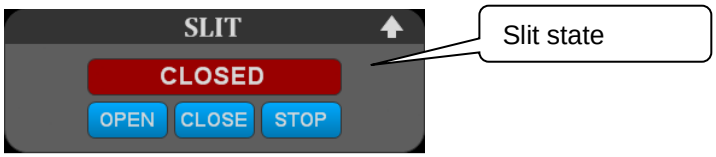
OPENING, CLOSING

Slit opening/closing is in progress.

OPEND, CLOSED

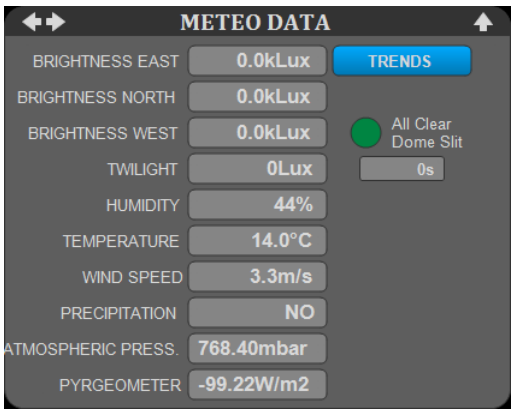
Slit is in the Opened/Closed position.

4.6.2 Description of controls



- **STOP -** stop slit movement.
- **OPEN, CLOSE -** open/close slit.

4.6.3 Meteo conditions



There is a “LED” and a time value in the METEO DATA panel.

If it is possible to open the slit the “LED” is green otherwise it is red.

The time value indicates the time that is necessary to wait until it will be possible to open the slit. But only if all meteo conditions are ok and it is only necessary to wait for running off-delays of meteo alarms.

There are two brightness limits in METEO PARAMETERS – HIGH and LOW.

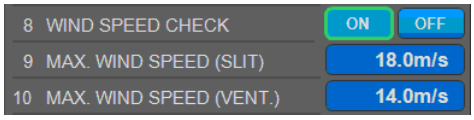
If the HIGH limit is exceeded all the ventilation windows are closed, the dome is parked, both flaps are closed and the slit is closed. Any attempt to open the ventilation windows or the slit is then blocked.

If the LOW limit is exceeded (but not HIGH) then:

- Before noon - the ventilation windows NE, E and SE are closed and the slit is closed if the dome azimuth is in the range of 30 to 150 degrees.
- After noon - the ventilation windows NW, W and SW are closed and the slit is closed if the dome azimuth is in the range of 210 to 330 degrees.

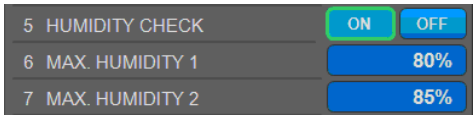
Any attempt to open ventilation windows or the slit during mentioned conditions is then blocked.

Local noon time is set as 16 hours UTC.



There are two wind speed limits in METEO PARAMETERS – for the slit and the ventilation windows.

If the limit is exceeded then the corresponding subsystem is closed and any attempt to open it is then blocked.



There are two humidity limits in METEO PARAMETERS – the first and the second.

The alarm occurs only when both limits are exceeded and disappears only when both limits are not exceeded. This alarm is evaluated without timers.

If the alarm is active all the ventilation windows are closed, the dome is parked, both flaps are closed and the slit is closed. Any attempt to open the ventilation windows or the slit is then blocked.

5 MAINTENANCE AND SERVICE OF THE CONTROL COMPUTER

5.1 Fail-safe operation policy

To ensure fail-safe operation of the control computer, the following rules must be observed:

- only duly trained and instructed personnel can operate the control computer
- smoking is forbidden in the computer room
- carefully protect the computer and keyboard against contamination
- if not necessary, do not move the computer
- if you need to move it, store it in a clean, dust-free room with constant room temperature without excessive humidity and vibrations
- if you are planning not to use the computer for longer time, properly close the application first (see the Service screen) and then turn off the computer and monitor

5.2 Modifications of hardware and software of the control computer

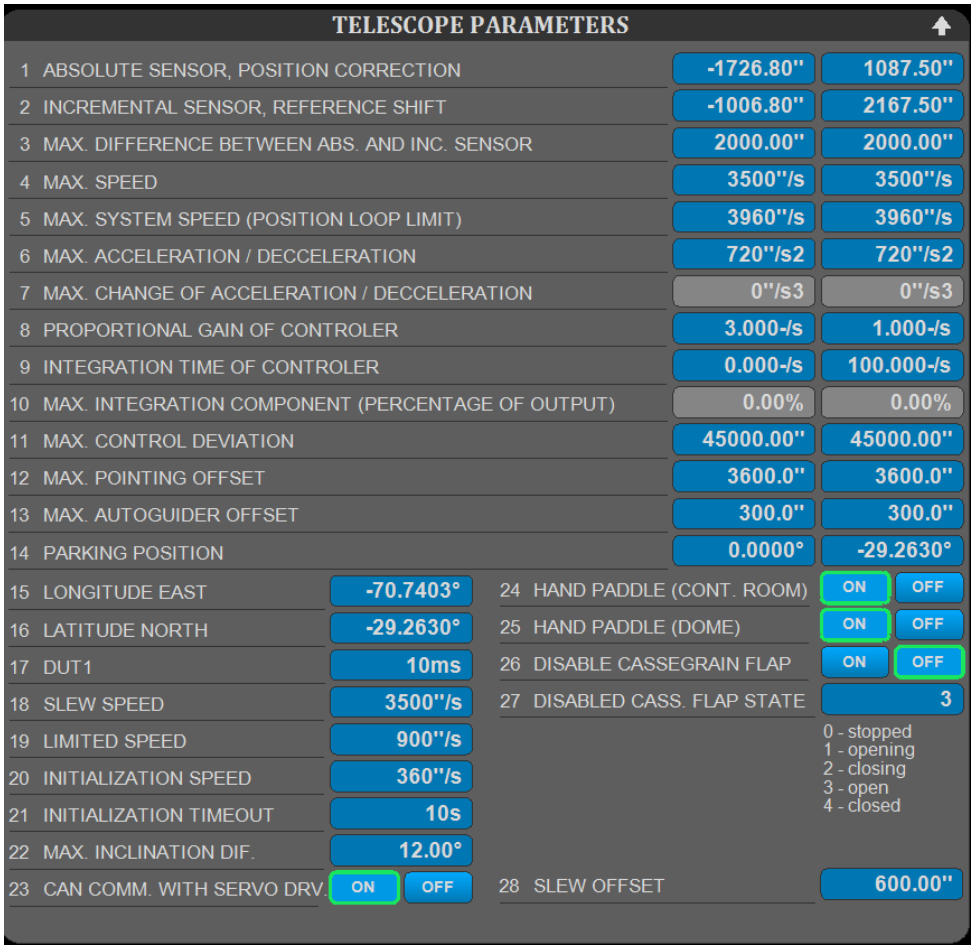
- any modifications of the control computer hardware and software, even after the warranty period, are recommended to be consulted with our technicians first
- our company is not responsible for potential functional problems of the control computer caused by non-consulted modifications
- in case of any non-consulted hardware or software modifications during warranty period, the warranty is void
- from this point of view, replacing the keyboard, mouse or monitor is not considered as the hardware modification

5.3 Maintenance and back-up

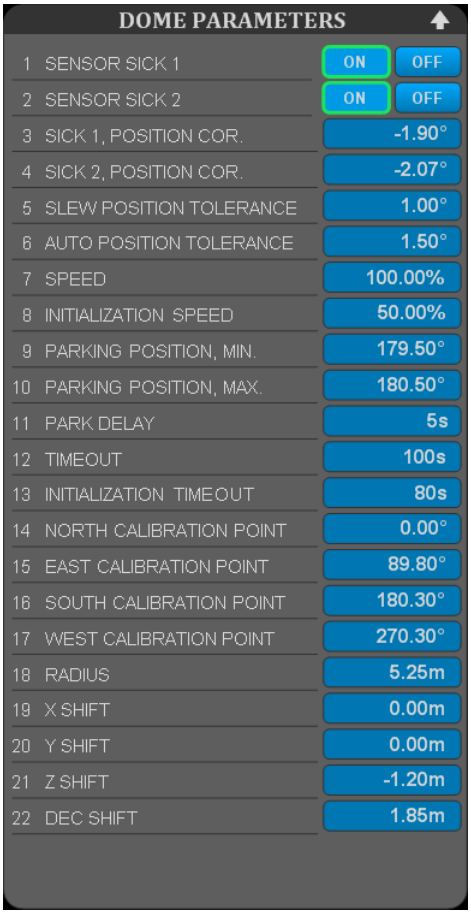
- no maintenance is necessary on the control computer, with the exception of cleaning the keyboard, mouse and monitor screen
- in case the computer is equipped with a back-up source (UPS), the battery must be replaced or recalibrated in intervals set by the manufacturer (see the supplier instructions)
- if you require archiving of alarm message and historical trend files for future purpose such as for inspection authorities, back up files regularly as described in chapters Alarm messages and Historical trends
- in all these cases, contact your IT department or administrator and discuss specific solutions

6 PARAMETERS

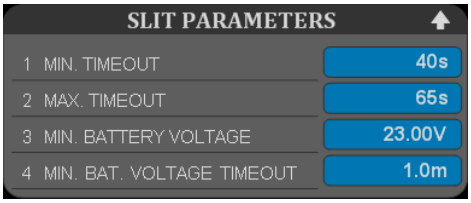
6.1 Telescope parameters



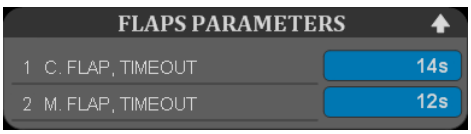
6.2 Dome parameters



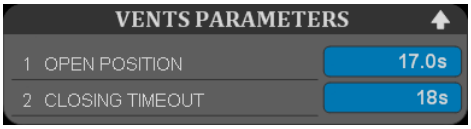
6.3 Slit parameters



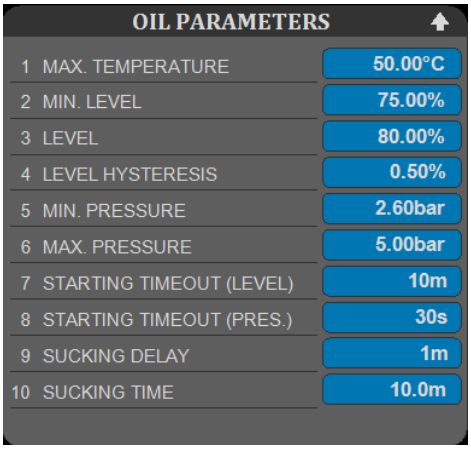
6.4 Flaps parameters



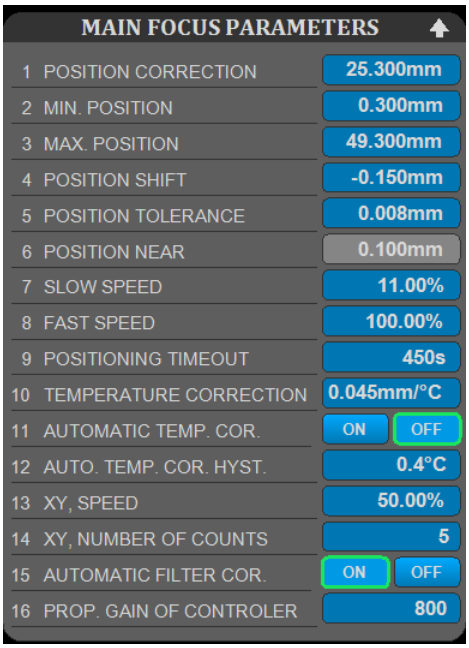
6.5 Vents parameters



6.6 Oil parameters



6.7 Main focus parameters



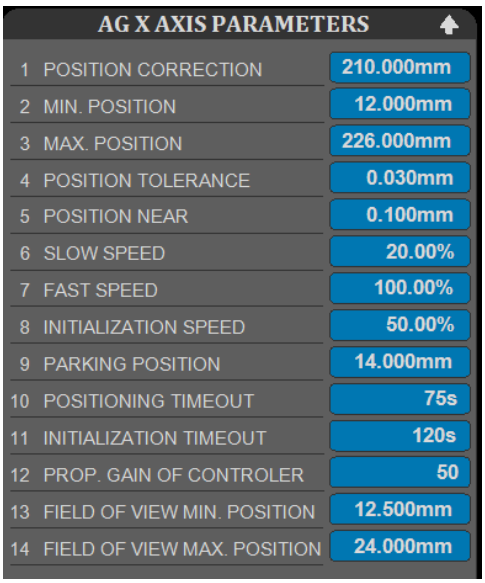
6.8 Filter wheels parameters

FILTER WHEEL A PARAMETERS	
1 SPEED	70.00%
2 POSITIONING TIMEOUT	13s
3 FOCUS CORRECTION	ON / OFF
4 0. POS. FOCUS CORRECTION	0.000mm
5 1. POS. FOCUS CORRECTION	0.100mm
6 2. POS. FOCUS CORRECTION	-0.330mm
7 3. POS. FOCUS CORRECTION	-0.330mm
8 4. POS. FOCUS CORRECTION	-0.330mm
9 5. POS. FOCUS CORRECTION	-0.230mm
10 6. POS. FOCUS CORRECTION	-0.330mm
11 7. POS. FOCUS CORRECTION	-0.330mm
12 AG FOCUS COR. FACTOR	0.0000
13 0. POS. NAME	empty
14 1. POS. NAME	Stromgr u
15 2. POS. NAME	Stromgr v
16 3. POS. NAME	Stromgr b
17 4. POS. NAME	Stromgr y
18 5. POS. NAME	CN
19 6. POS. NAME	g2
20 7. POS. NAME	OIII

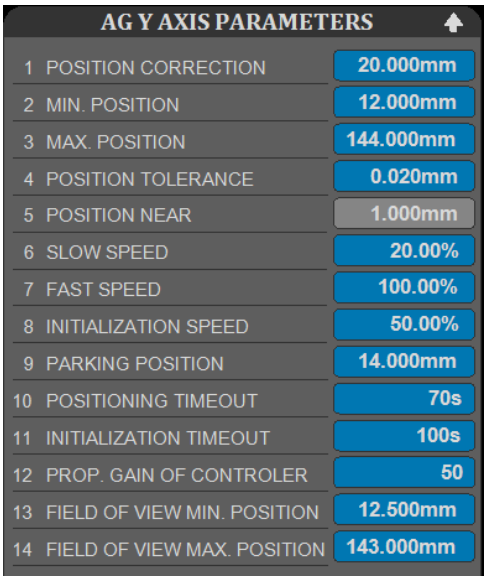
FILTER WHEEL B PARAMETERS	
1 SPEED	70.00%
2 POSITIONING TIMEOUT	18s
3 FOCUS CORRECTION	ON / OFF
4 0. POS. FOCUS CORRECTION	0.230mm
5 1. POS. FOCUS CORRECTION	-0.190mm
6 2. POS. FOCUS CORRECTION	0.000mm
7 3. POS. FOCUS CORRECTION	0.000mm
8 4. POS. FOCUS CORRECTION	0.000mm
9 5. POS. FOCUS CORRECTION	0.150mm
10 6. POS. FOCUS CORRECTION	-0.120mm
11 AG FOCUS COR. FACTOR	0.0000
12 0. POS. NAME	empty
13 1. POS. NAME	U
14 2. POS. NAME	B
15 3. POS. NAME	V
16 4. POS. NAME	R
17 5. POS. NAME	I
18 6. POS. NAME	Halpha

6.9 AG focus parameters

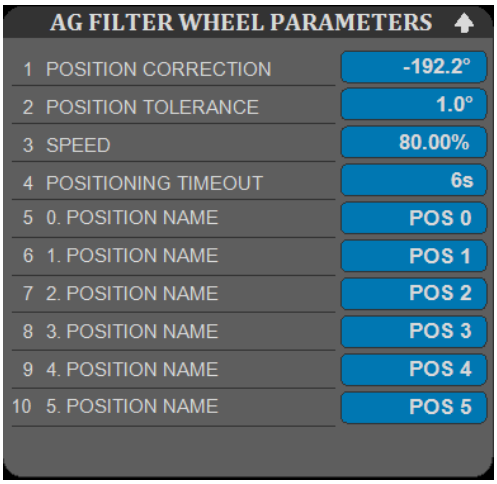
AG FOCUS PARAMETERS	
1 POSITION CORRECTION	20.000mm
2 MIN. POSITION	4.000mm
3 MAX. POSITION	34.000mm
4 POSITION TOLERANCE	0.015mm
5 POSITION NEAR	1.000mm
6 SLOW SPEED	50.00%
7 FAST SPEED	100.00%
8 INITIALIZATION SPEED	50.00%
9 PARKING POSITION	31.000mm
10 POSITIONING TIMEOUT	60s
11 INITIALIZATION TIMEOUT	80s



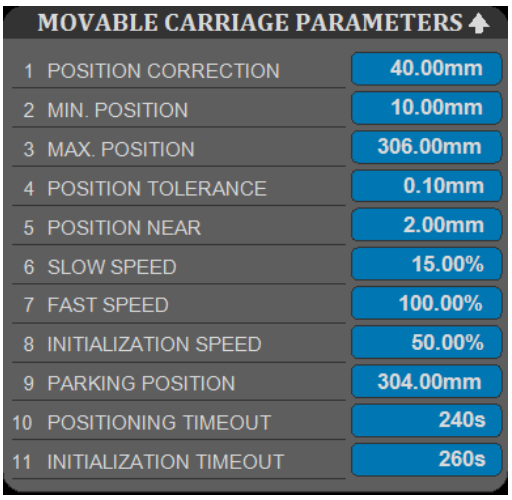
AG X AXIS PARAMETERS	
1 POSITION CORRECTION	210.000mm
2 MIN. POSITION	12.000mm
3 MAX. POSITION	226.000mm
4 POSITION TOLERANCE	0.030mm
5 POSITION NEAR	0.100mm
6 SLOW SPEED	20.00%
7 FAST SPEED	100.00%
8 INITIALIZATION SPEED	50.00%
9 PARKING POSITION	14.000mm
10 POSITIONING TIMEOUT	75s
11 INITIALIZATION TIMEOUT	120s
12 PROP. GAIN OF CONTROLER	50
13 FIELD OF VIEW MIN. POSITION	12.500mm
14 FIELD OF VIEW MAX. POSITION	24.000mm



AG Y AXIS PARAMETERS	
1 POSITION CORRECTION	20.000mm
2 MIN. POSITION	12.000mm
3 MAX. POSITION	144.000mm
4 POSITION TOLERANCE	0.020mm
5 POSITION NEAR	1.000mm
6 SLOW SPEED	20.00%
7 FAST SPEED	100.00%
8 INITIALIZATION SPEED	50.00%
9 PARKING POSITION	14.000mm
10 POSITIONING TIMEOUT	70s
11 INITIALIZATION TIMEOUT	100s
12 PROP. GAIN OF CONTROLER	50
13 FIELD OF VIEW MIN. POSITION	12.500mm
14 FIELD OF VIEW MAX. POSITION	143.000mm



AG FILTER WHEEL PARAMETERS	
1 POSITION CORRECTION	-192.2°
2 POSITION TOLERANCE	1.0°
3 SPEED	80.00%
4 POSITIONING TIMEOUT	6s
5 0. POSITION NAME	POS 0
6 1. POSITION NAME	POS 1
7 2. POSITION NAME	POS 2
8 3. POSITION NAME	POS 3
9 4. POSITION NAME	POS 4
10 5. POSITION NAME	POS 5



6.10 Meteo parameters

6.11 Correction model 1...5

HS - Hour axis shift

The constant shift between true hour axis direction and hour axis sensor direction.

DS - Declination axis shift

The constant shift between true declination axis direction and declination axis sensor direction.

TD - Tube/declination non-perpendicularity

Non-perpendicularity of declination and optical axis.

DH - Declination/hour axis non-perpendicularity

Non-perpendicularity of hour and declination axis.

EW - East/West inclination

The inclination of hour axis to the east-west direction (in respect to the equator).

NS - North/South inclination

The inclination of hour axis to the south direction.

TF - Tube flexure

Linear flexure of the tube.

FF - Fork flexure

Linear flexure of the fork (for form mount).

DF - Declination flexure

Flexure of the declination axis. (for german equatorial mount).

6.12 Pointing restrictions

Main

This is a list of fifty mechanical coordinates (hour / declination axis), which define the boundary of telescope horizon. This is the horizon limitation, below which the automatic modes of the telescope are switched off.

Reverse

This is the list of fifty mechanical coordinates (hour / declination axis), which define the boundary of telescope horizon. This is the horizon limitation, below which the automatic modes of the telescope are switched off.

HA MIN

The end of the horizon boundary on the hour axis.

HA MAX

The end of the horizon boundary on the hour axis.

DA MIN

The end of the horizon boundary on the declination axis.

DA MAX

The end of the horizon boundary on the declination axis.

GREEN DISTANCE

Below this inward distance from the blue line the telescope speed is limited.

RED DISTANCE

Beyond this outside distance from the blue line the telescope is switched off and can be only switched on again using safety bypass.

7 ALARMS

7.1 Types of the alarms

There are three types of alarms:

- Serious failures that lead to the turning off of the servo-amplifiers power (all main checks of the telescope location and servo-amplifiers failures).
- Less serious failures that lead to the shutdown of automatic modes of the telescope. Only manual movement by limited speed is possible (pointing restrictions, inclination check).
- Failures intended for information purposes only, not directly related with the telescope and restricted its operation (measuring loop of meteorological data for example).

It is possible to switch on the **ON** button on the **CONTROL** screen of the visualization if no serious failure exists. This turns on power of servo-amplifiers and the telescope is ready for operation. The warning message **Active alarm** appears if the alarm is activated and operator presses the **ON** button.

The operator must to use the key to switch on the safety bypass, if there the serious alarm is activated and he need to get the telescope from the accident position. **The safety bypass do not inhibit the safety loop.** The **ON** button is possible to switch on then and it is possible manually move the telescope on the responxsibility of the operator.

Critical system alarms which are blocking the slit or the telescope powering are signalized by sound on the control computer. The alarms triggering the sound warning are marked in the table below in the column “S” like sound.

7.2 List of alarms

Analog Inputs	**S**
AINPUTS AL 1, L1_L2 error (voltage between phases L1-L2 - error of analog input)	
AINPUTS AL 2, L2_L3 error (voltage between phases L2-L3 - error of analog input)	
AINPUTS AL 3, L1_L3 error (voltage between phases L1-L3 - error of analog input)	
AINPUTS AL 4, PI1 error (atmospheric pressure - error of analog input)	
AINPUTS AL 5, TI2 error (indoor temperature - error of analog input)	
AINPUTS AL 6, TI3 error (oil temperature - error of analog input)	x
AINPUTS AL 7, GU1 error (current - error of analog input)	
AINPUTS AL 8, GU2 error (current - error of analog input)	
AINPUTS AL 9, PI2 error (oil pressure - error of analog input)	x
AINPUTS AL 10, LI1 error (oil level - error of analog input)	x
AINPUTS AL 11, TI4 error (telescope temperature - error of analog input)	
AINPUTS AL 12, GI1_X error (inclinometer - error of analog input)	
General	
GENE AL 1, KA0 error (control voltage is off)	x
GENE AL 2, KA1 error (safety relay is open)	x
GENE AL 3, Q7 error (circuit breaker open)	
GENE AL 4, Q12 error (circuit breaker open)	x
GENE AL 5, Q13 error (circuit breaker open)	
GENE AL 6, Q14 error (circuit breaker open)	
GENE AL 7, Q15 error (circuit breaker open)	
GENE AL 8, Q46 error (circuit breaker open)	

GENE AL 9, Q8 error (circuit breaker open)	x
GENE AL 10, M15_M16 error (ventilator - feedback signal not corresponding with current state)	
GENE AL 11, CRC error (control checksum of pameters not corresponding with previous one)	
GENE AL 12, remote error (human presence detected)	x
GENE AL 13, power supply error (system is on UPS)	
GENE AL 14, Q54 error (circuit breaker open)	
Oil	
OIL AL 1, F5 error (circuit breaker open)	
OIL AL 2, F6 error (circuit breaker open)	
OIL AL 3, F7 error (circuit breaker open)	
OIL AL 4, M7 error (feed pump - feedback signal not corresponding with current state)	x
OIL AL 5, M8 error (suction pump 1 - feedback signal not corresponding with current state)	x
OIL AL 6, M9 error (suction pump 2 - feedback signal not corresponding with current state)	x
OIL AL 7, TI3 maximum (maximum oil temperature exceeded)	x
OIL AL 8, LI1 minimum (low oil level)	x
OIL AL 9, PI2 minimum (low oil pressure)	
OIL AL 10, PI2 maximum (maximum oil pressure exceeded)	x
OIL AL 11, starting timeout (level) (desired oil level not reached)	
OIL AL 12, starting timeout (pressure) (desired oil pressure not reached)	
Telescope	
TELE AL 1, HA absolute sensor error	x
TELE AL 2, DEC absolute sensor error	x
TELE AL 3, HA incremental sensor error	x
TELE AL 4, DEC incremental sensor error	x
TELE AL 5, HA abs. vs. inc. sensor error (maximum difference between sensors exceeded)	x
TELE AL 6, DEC abs. vs. inc. sensor error (maximum difference between sensors exceeded)	x
TELE AL 7, M1 error (HA motor - feedback signal not corresponding with current state)	x
TELE AL 8, M2 error (DEC motor - feedback signal not corresponding with current state)	x
TELE AL 9, KA2 error (safety bypass in on)	
TELE AL 10, safety switch	
TELE AL 11, inclination error (max. diff. between inclinometer and elevation calculation exceeded)	
TELE AL 12, HA control deviation error (maximum control deviation exceeded)	x
TELE AL 13, DEC control deviation error (maximum control deviation exceeded)	x
TELE AL 14, HA initialization timeout (time for initialization expired)	
TELE AL 15, DEC initialization timeout (time for initialization expired)	
TELE AL 16, pointing restrictions, abs slow (below green)	
TELE AL 17, pointing restrictions, abs stop (below blue)	
TELE AL 18, pointing restrictions, abs off (below green)	
TELE AL 19, pointing restrictions, inc slow (below green)	
TELE AL 20, pointing restrictions, inc stop (below blue)	
TELE AL 21, pointing restrictions, inc off (below green)	
Hand paddle	
HAND AL 1, hand paddle 1 error (loss of communication with hand paddle in control room)	
HAND AL 2, hand paddle 2 error (loss of communication with hand paddle in dome)	
Pointing Restrictions	
STG AL 1, pointing restrictions error (erroneous calculation of pointing restrictions)	
Meteo Station	
METEO AL 1, communication error (loss of communication with meteo station)	x
METEO AL 2, precipitation error	x
METEO AL 3, brightness error (brightness exceeded high limit)	x
METEO AL 4, humidity error (maximum humidity exceeded)	x
METEO AL 5, wind speed error (maximum wind speed for slit exceeded)	x

METEO AL 6, pyrgeometer error (maximum pyrgeometer value exceeded)	x
METEO AL 7, brightness error (brightness exceeded low limit)	
METEO AL 8, wind speed error (maximum wind speed for ventilation exceeded) METEO AL 9, wind speed error (maximum wind speed for dome exceeded)	
Dome	
DOME AL 1, sick 1 sensor error	
DOME AL 2, sick 2 sensor error	
DOME AL 3, absolute sensor error	
DOME AL 4, M17_M19 error (motor - feedback signal not corresponding with current state)	
DOME AL 5, moving timeout (time for moving expired)	
DOME AL 6, initialization timeout (time for initialization expired)	
Slit	
SLIT AL 1, communication error (loss of communication with slit)	x
SLIT AL 2, TIRK1 error (temperature in control cabinet - error of analog input)	
SLIT AL 3, BAT error (battery voltage - error of analog input)	
SLIT AL 4, PG1 error (pyrgeometer - error of analog input)	x
SLIT AL 5, end switches error (both end switches triggered)	
SLIT AL 6, open error (loss of end switches in open state)	
SLIT AL 7, closed error (loss of end switches in closed state)	
SLIT AL 8, moving timeout min error	
SLIT AL 9, moving timeout max error (time for moving expired)	
SLIT AL 10, meteo error (slit is open during bad meteo conditions)	
Cassegrain Flap	
CFLAP AL 1, F9 error (circuit breaker open)	
CFLAP AL 2, M11 error (motor - feedback signal not corresponding with current state)	
CFLAP AL 3, end switches error (both end switches triggered)	
CFLAP AL 4, moving timeout (time for moving expired)	
CFLAP AL 5, open error (loss of end switch in open state)	
CFLAP AL 6, closed error (loss of end switch in closed state)	
Mirror Flap	
MFLAP AL 1, F8 error (circuit breaker open)	
MFLAP AL 2, M10 error (motor - feedback signal not corresponding with current state)	
MFLAP AL 3, end switches error (both end switches triggered)	
MFLAP AL 4, moving timeout (time for moving expired)	
MFLAP AL 5, open error (loss of end switch in open state)	
MFLAP AL 6, closed error (loss of end switch in closed state)	
Filter Wheel A	
FWHEELA AL 1, moving timeout (time for moving expired)	
FWHEELA AL 2, locked error (loss of current position)	
Filter Wheel B	
FWHEELB AL 1, position error (signals not corresponding with any position)	
FWHEELB AL 2, moving timeout (time for moving expired)	
FWHEELB AL 3, locked error (loss of current position)	
Main Focus	
FOCUS AL 1, sensor error	
FOCUS AL 2, end switches error (both end switches triggered)	
FOCUS AL 3, positioning timeout (time for positioning expired)	
FOCUS_XY AL 1, x axis end switches error (both end switches triggered)	
FOCUS_XY AL 2, y axis end switches error (both end switches triggered)	
Movable Carriage	
MCARRIAGE AL 1, sensor error	
MCARRIAGE AL 2, end switches error (both end switches triggered)	

MCARRIAGE AL 3, positioning timeout (time for positioning expired)	
MCARRIAGE AL 4, initialization timeout (time for initialization expired)	
Autoguider Focus	
AGUIDER FOCUS AL 1, sensor error	
AGUIDER FOCUS AL 2, end switches error (both end switches triggered)	
AGUIDER FOCUS AL 3, positioning timeout (time for positioning expired)	
AGUIDER FOCUS AL 4, initialization timeout (time for initialization expired)	
Autoguider X axis	
AGUIDER X AL 1, sensor error	
AGUIDER X AL 2, end switches error (both end switches triggered)	
AGUIDER X AL 3, positioning timeout (time for positioning expired)	
AGUIDER X AL 4, initialization timeout (time for initialization expired)	
Autoguider Y axis	
AGUIDER Y AL 1, sensor error	
AGUIDER Y AL 2, end switches error (both end switches triggered)	
AGUIDER Y AL 3, positioning timeout (time for positioning expired)	
AGUIDER Y AL 4, initialization timeout (time for initialization expired)	
Autoguider Filter Wheel	
AGUIDER FWHEEL AL 1, sensor error	
AGUIDER FWHEEL AL 2, moving timeout (time for moving expired)	
AGUIDER FWHEEL AL 3, locked error (loss of current position)	
Shutter	
SHUTTER AL 1, opening timeout (time for opening expired)	
SHUTTER AL 2, power supply error	
Ventilation	
VENT N AL 1, closing timeout (time for closing expired)	
VENT N AL 2, closed error (loss of end switches in closed state)	
VENT NE AL 1, closing timeout (time for closing expired)	
VENT NE AL 2, closed error (loss of end switches in closed state)	
VENT E AL 1, closing timeout (time for closing expired)	
VENT E AL 2, closed error (loss of end switches in closed state)	
VENT SE AL 1, closing timeout (time for closing expired)	
VENT SE AL 2, closed error (loss of end switches in closed state)	
VENT S AL 1, closing timeout (time for closing expired)	
VENT S AL 2, closed error (loss of end switches in closed state)	
VENT SW AL 1, closing timeout (time for closing expired)	
VENT SW AL 2, closed error (loss of end switches in closed state)	
VENT W AL 1, closing timeout (time for closing expired)	
VENT W AL 2, closed error (loss of end switches in closed state)	
VENT NW AL 1, closing timeout (time for closing expired)	
VENT NW AL 2, closed error (loss of end switches in closed state)	
VE AL 1, meteo error (at least one ventilation window is open during bad meteo conditions)	
VE AL 2, local error (ventilation windows are in local mode)	