VERSION 1.0

09/08/2023 15:16

DRIVERDISH

CONTENTS

INTRODUCTION

DriverDish is a software component within the EA3HMJ tracking suite that facilitates the tracking of astronomical objects such as celestial bodies and spacecrafts such as artificial satellites and space probes using an Earth-based motorized antenna system. Additionally, the program is suitable for pointing the antenna system to a specific fixed position.

DriverDish functions as a central hub for communication with the hardware responsible for controlling the antenna position, various necessary programs (e.g., ephemeris servers, trajectory calculation programs, etc.) and other devices like an optional dedicated weather station.

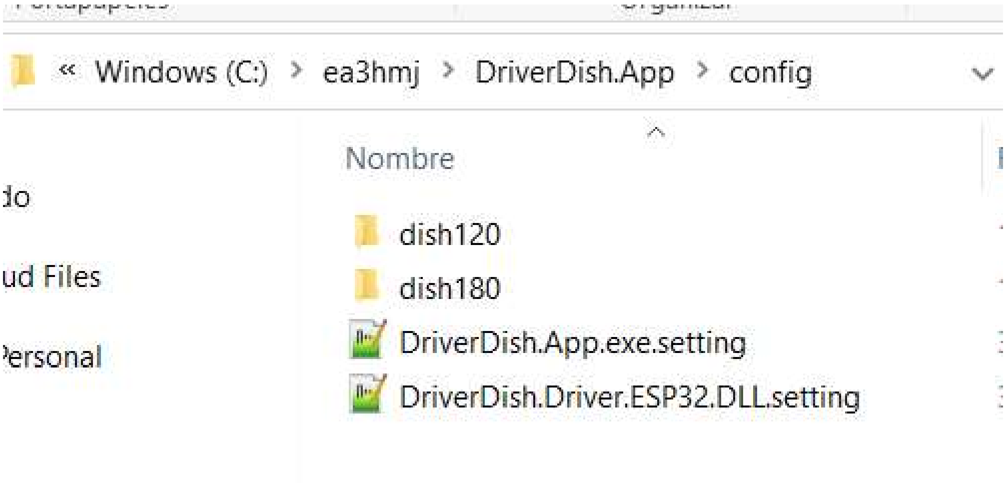
The program allows for the use of multiple instances, each tailored to different hardware setups. To achieve this, a parameter must be passed to the program.

DriverDish.exe <instance name>

Examples:

"C:\ea3hmj\DriverDish.App\DriverDish.App.exe" dish120

"C:\ea3hmj\DriverDish.App\DriverDish.App.exe" dish180



In this way, it will create a subdirectory with the provided name and store the configuration we define within it. This allows to run multiple instances of the program without any interference between them. This is particularly useful when dealing with multiple antenna systems.

MAIN SCREEN

The main screen is divided into two parts horizontally. The upper part shows the following:

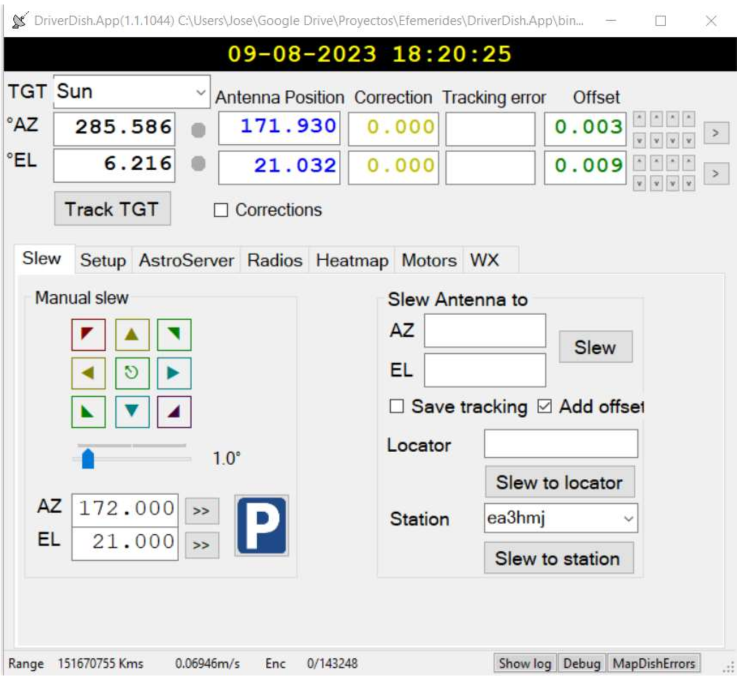
- **Target object**
  This is the object to be tracked with the antenna system
- **Start-stop tracking button**
  Click this button to initiate or terminate antenna tracking. Tracking is only enabled when the object is visible (above the horizon) from the antenna location
- **Object's position display**
  Displays the calculated target object azimuth and elevation coordinates respectively.
- **Antenna's position display**
  Shows the current AZ/EL antenna pointing coordinates
- **Correction display**
  Shows the adjustment made while tracking, provided a file containing such information is defined.
- **Tracking Error display**
  During tracking mode, it presents the offset and discrepancy between the location of the tracked object and the antenna's pointing coordinates
- **Offset display**
  Shows the antenna pointing offset, manually added by the user

The lower section presents seven tabs, primarily for configuring settings. These tabs include:

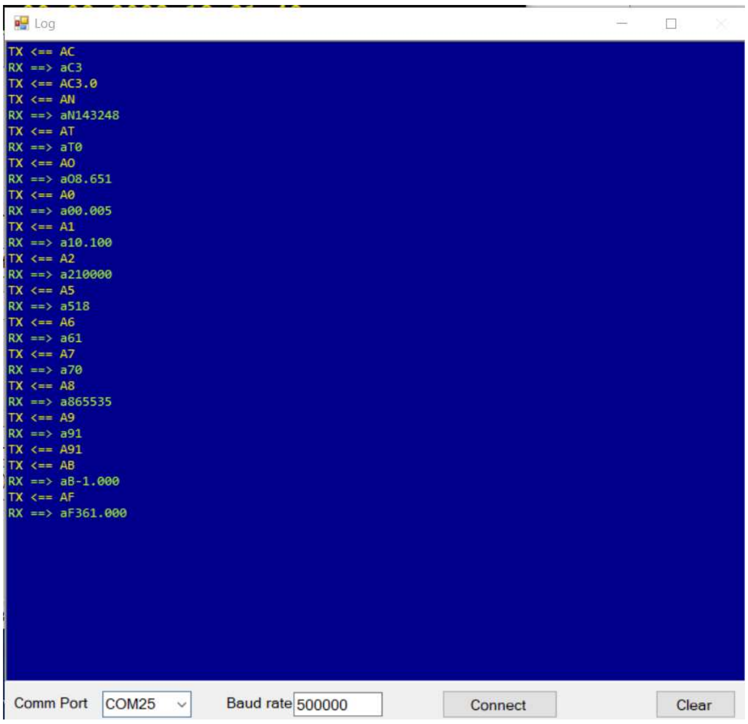
- **Slew**
  Various antenna movement options
- **Setup**
  Controller card configuration
- **AstroServer**
  Data server configuration
- **Radios**
  Radio configuration if connected to the system
- **Heatmap**
  Noise map acquisition, position autocalibration, and signal-to-noise ratio (SN).
- **Motors**
  Motor data settings (Voltage and Amperage), dependent on the used driver
- **WX**
  Weather Station, retrieval of data from the mini weather station if connected to the controller

The **status bar** in the bottom displays real-time details about the target object, such as its distance (range) and velocity of movement (m/s). It also shows position values reported by encoders. It also features three buttons that turn green upon activation:

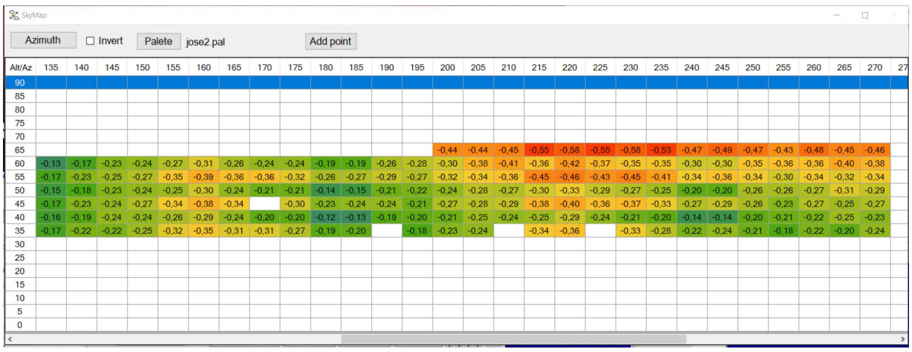
- **Show log**
  Click here to open a new window displaying information about the controller's current operation. To use this feature, the "**Debug**" button must be active, and the controller board microprocessor should be connected to the host computer via USB
- **Debug**
  Selects the output mode for the controller's information
- **MapDishError**
  Click to display the error map, provided it has been chosen in the setup screen



‘Show log’ window



MapDishError window

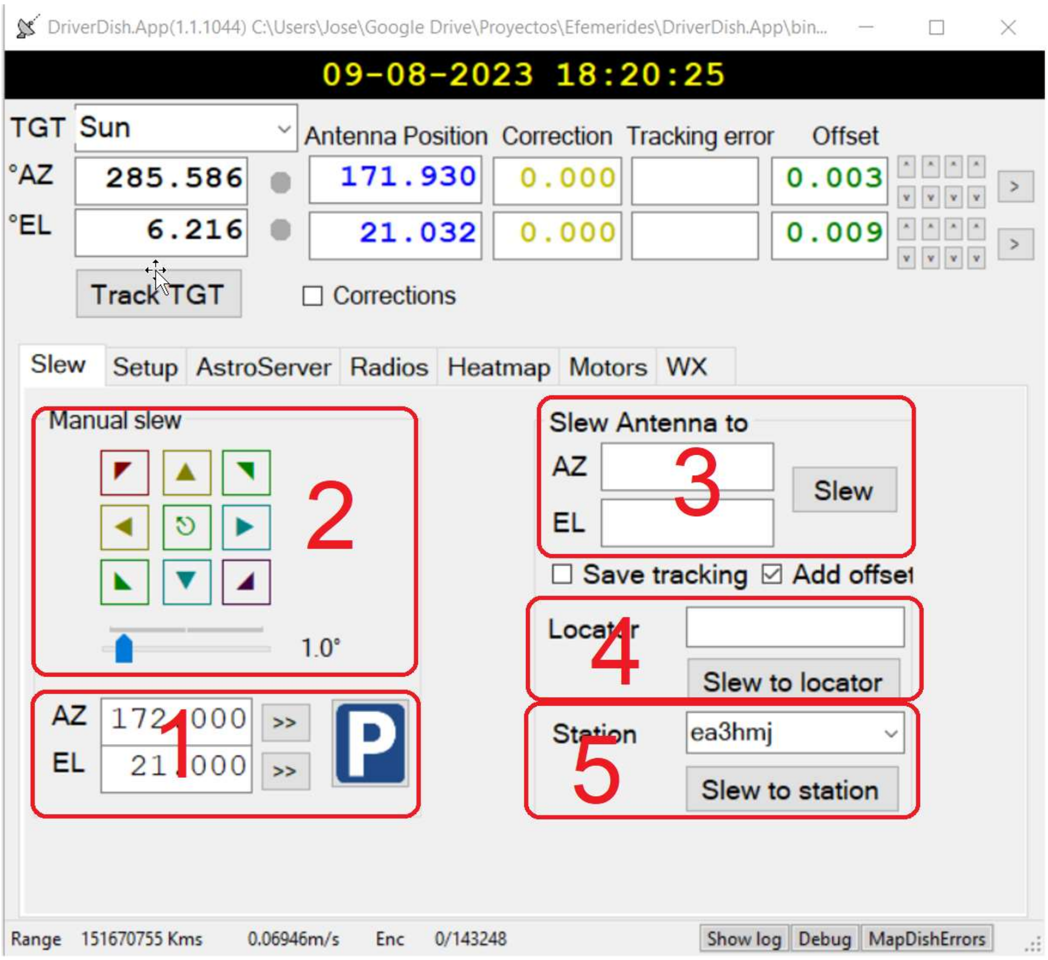


Alt/Az	135	140	145	150	155	160	165	170	175	180	185	190	195	200
90														
85														
80														
75														
70														
65														-0,44
60	-0,13	-0,17	-0,23	-0,24	-0,27	-0,31	-0,26	-0,24	-0,24	-0,19	-0,19	-0,26	-0,28	-0,30
55	-0,17	-0,23	-0,25	-0,27	-0,35	-0,39	-0,36	-0,36	-0,32	-0,26	-0,27	-0,29	-0,27	-0,32
50	-0,15	-0,18	-0,23	-0,24	-0,25	-0,30	-0,24	-0,21	-0,21	-0,14	-0,15	-0,21	-0,22	-0,24
45	-0,17	-0,23	-0,24	-0,27	-0,34	-0,38	-0,34		-0,30	-0,23	-0,24	-0,24	-0,21	-0,27
40	-0,16	-0,19	-0,24	-0,24	-0,26	-0,29	-0,24	-0,20	-0,20	-0,12	-0,13	-0,19	-0,20	-0,21
35	-0,17	-0,22	-0,22	-0,25	-0,32	-0,35	-0,31	-0,31	-0,27	-0,19	-0,20		-0,18	-0,23
30														
25														
20														
15														
10														
5														
0														

Alt/Az	205	210	215	220	225	230	235	240	245	250	255	260	265	270
90														
85														
80														
75														
70														
65	-0,44	-0,45	-0,55	-0,58	-0,55	-0,58	-0,53	-0,47	-0,49	-0,47	-0,43	-0,48	-0,45	-0,46
60	-0,38	-0,41	-0,36	-0,42	-0,37	-0,35	-0,35	-0,30	-0,30	-0,35	-0,36	-0,36	-0,40	-0,38
55	-0,34	-0,36	-0,45	-0,46	-0,43	-0,45	-0,41	-0,34	-0,36	-0,34	-0,30	-0,34	-0,32	-0,34
50	-0,28	-0,27	-0,30	-0,33	-0,29	-0,27	-0,25	-0,20	-0,20	-0,26	-0,26	-0,27	-0,31	-0,29
45	-0,28	-0,29	-0,38	-0,40	-0,36	-0,37	-0,33	-0,27	-0,29	-0,26	-0,23	-0,27	-0,25	-0,27
40	-0,25	-0,24	-0,25	-0,29	-0,24	-0,21	-0,20	-0,14	-0,14	-0,20	-0,21	-0,22	-0,25	-0,23
35	-0,24		-0,34	-0,36		-0,33	-0,28	-0,22	-0,24	-0,21	-0,18	-0,22	-0,20	-0,24
30														
25														
20														
15														
10														
5														
0														

SLEW TAB

The controls for slewing the antenna can be found within this tab. These controls are systematically organized into five distinct clusters, as illustrated in the figure below.



Antenna Movement Control Clusters

Cluster 1, Parking

Within this section, the predefined position for parking the antenna is established. By clicking the designated ‘**P**’ button, the antenna moves to this set position. These values are then stored by the controller for future reference.

Cluster 2, Manual Slew

This feature enables movement in any direction, as determined by the step size selected on the lower scroll bar, ranging from 0.1 to 10 degrees. The central button serves as the "STOP" control, halting both ongoing movement and tracking. It offers a convenient option for terminating motion during operations.

Cluster 3, Slew Antenna to AZ/EL

The desired azimuth and elevation coordinates for antenna pointing can be introduced in this section.

Note that double-clicking on either the AZ or EL field will automatically populate the field with the current position. This is particularly handy when adjusting a single axis.

The "**Slew**" button initiates movement, which can be halted using the "**STOP**" button in cluster #2.

Cluster 4, Slew Antenna to Locator

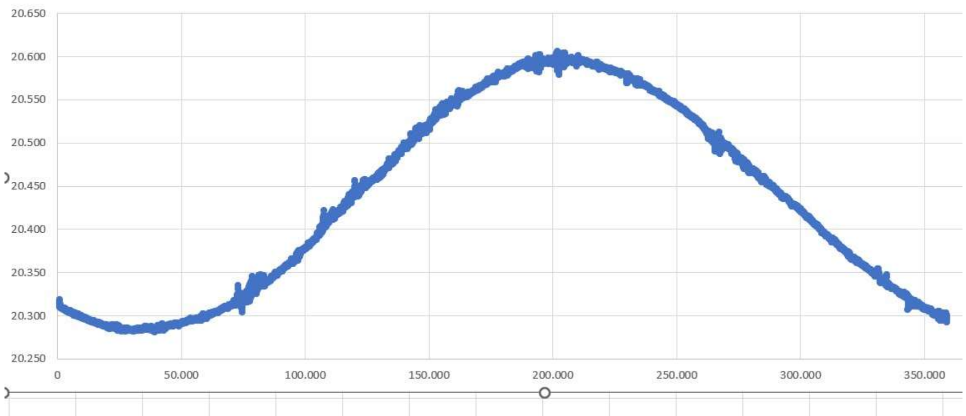
A locator can be introduced here, and the program will convert it into an azimuth position without initiating any movement.

Cluster 5, Slew Antenna to Station

When AstroServer is employed, access to stations with defined kernels is provided, enabling the selection of their locations.

Save Tracking Checkbox

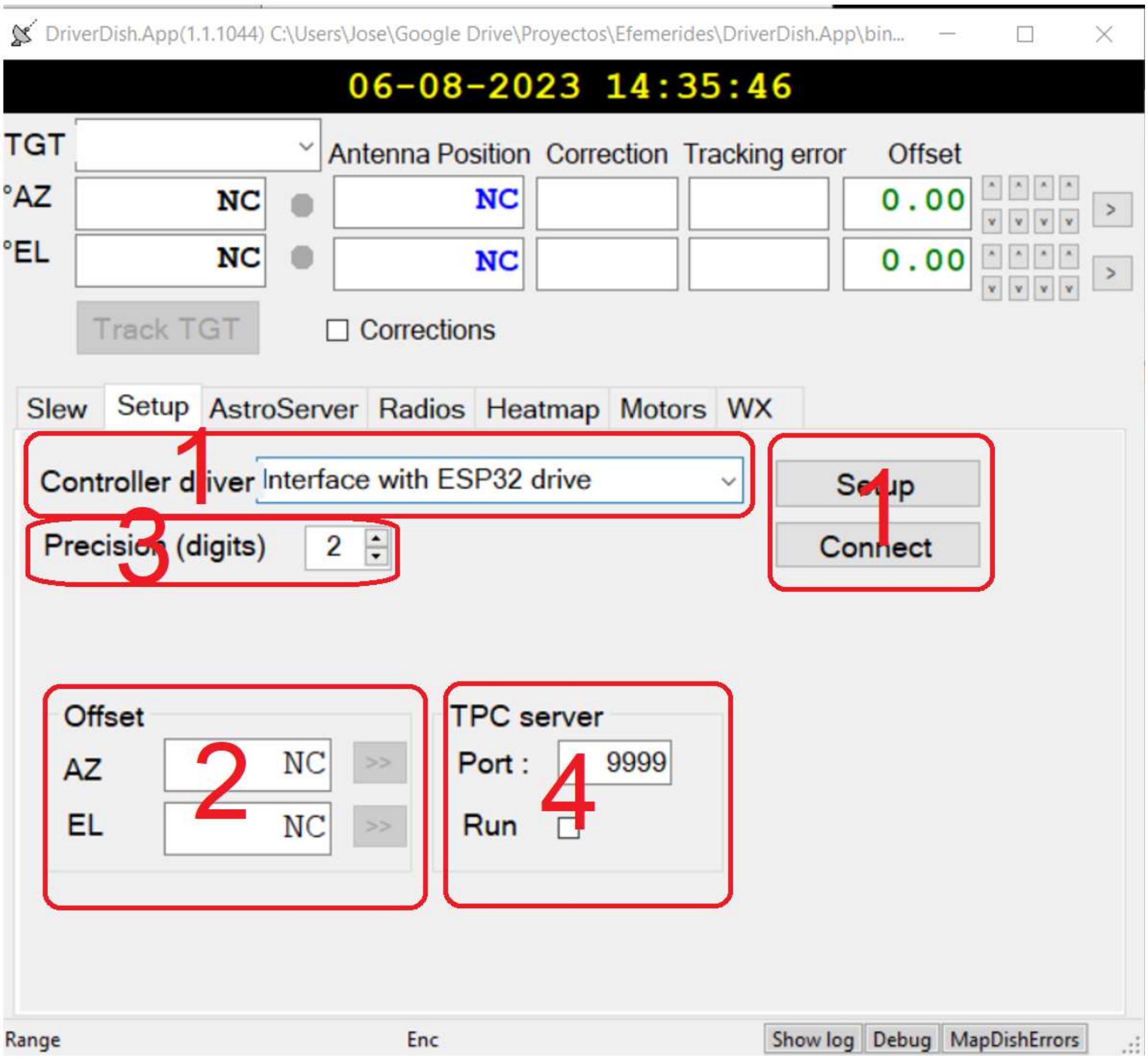
The 'Save tracking' checkbox is utilized to record the antenna's positions in a text file until it's deselected. This feature proves valuable when conducting an azimuth sweep at a fixed elevation. With the captured data, we can analyze the antenna's deviation over time.



Add Offset Checkbox

El checkbox Add offset es para añadir el valor de offset que figura en la parte superior derecha (color verde) a la posición que hemos definido que queremos movernos.

SETUP TAB



Cluster 1, Controller Driver Selection, Setup and Connect

This is where the board controller is specified. At program start, it automatically attempts to establish a connection with the controller. If it doesn't find the controller, we need to access the setup. Additionally, we can also disconnect and reconnect to the controller using the button provided.

Cluster 2, Offset

In this section, we establish the necessary compensation for the controller to align the physical antenna position accurately. After antenna installation, discrepancies between the actual antenna position and encoder readings can occur (for instance, the antenna might physically point to 180 degrees azimuth while the encoder reports 170 degrees). To rectify this, a compensation offset value of 10 degrees in this example is applied for precision. The controller stores these values for future use.

Cluster 3, Precision Digits

Introduce the number of decimal digits displayed. The controller performs calculations with this level of precision, and the value is stored by the controller itself.

Cluster 4, TCP Server

The program can initiate a Telnet server on the designated port, enabling access to information and the execution of various options. Below is a screenshot displaying the defined choices.

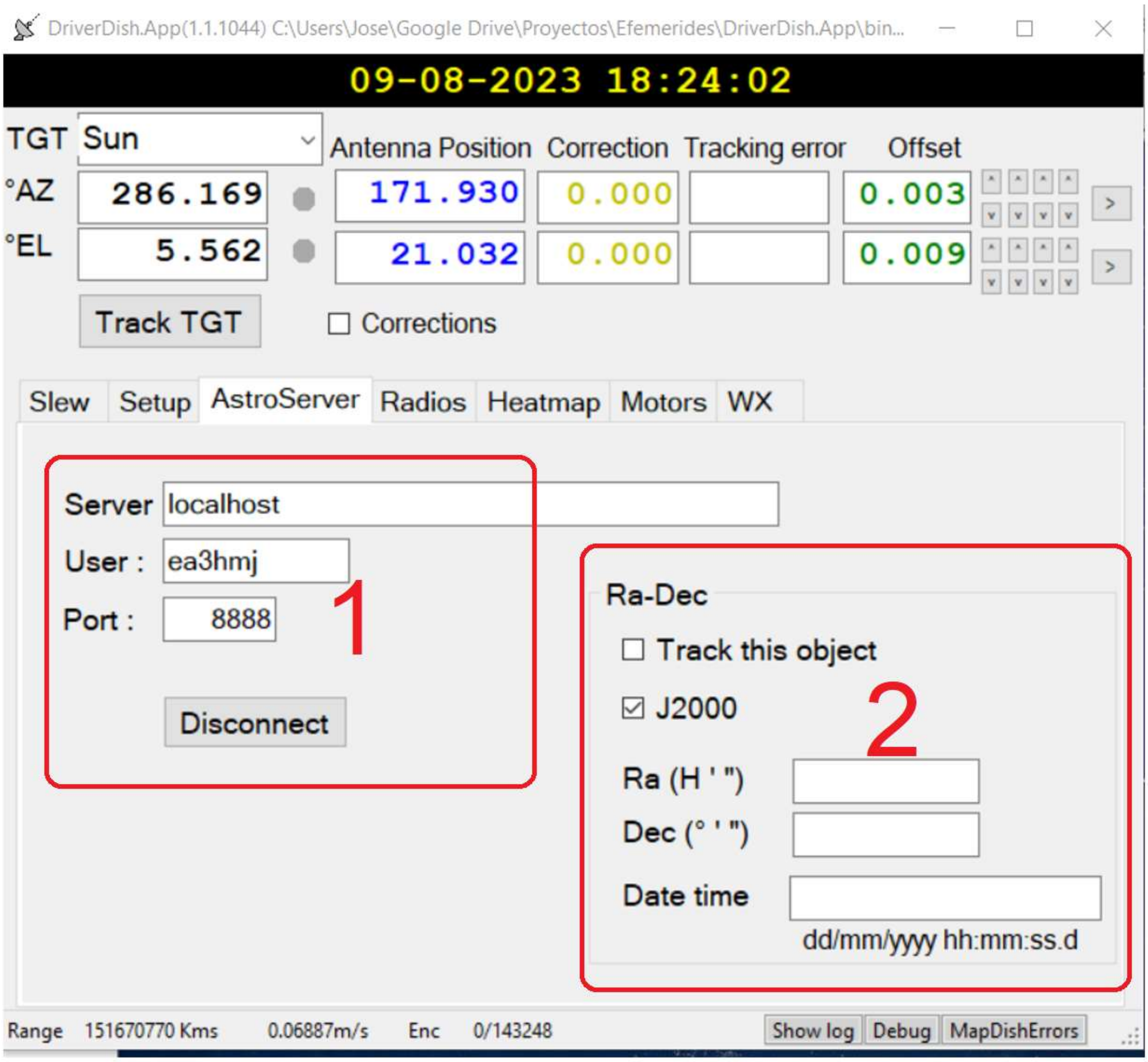
```
Connected to 192.168.1.144.
Escape character is '^]'.
DriverDishServer (c) ea3hmj 2.022
'help' to list options

help

DriverDishServer (c) ea3hmj 2.022

Commands:
help           = this page
astro          = if tracking on=astro
az             = Azimuth dish
el             = Altitude dish
eq             = Sky temperature
[az][el]+xx    = Move to axis(az or el) dish + xx degrees
[az][el]-xx    = Move to axis(az or el) dish - xx degrees
ao             = Azimuth offset dish
eo             = Altitude offset dish
[ao][eo]+xx    = Add +xx degrees to offset
[ao][eo]-xx    = Add -xx degrees to offset
moving         = Return if dish is moving
traking        = Return if tracking on
traking on     = Start tracking
traking off    = Stop tracking
stop           = Abort moviment
status         = status program
exit           = End
```

ASTROSERVER TAB



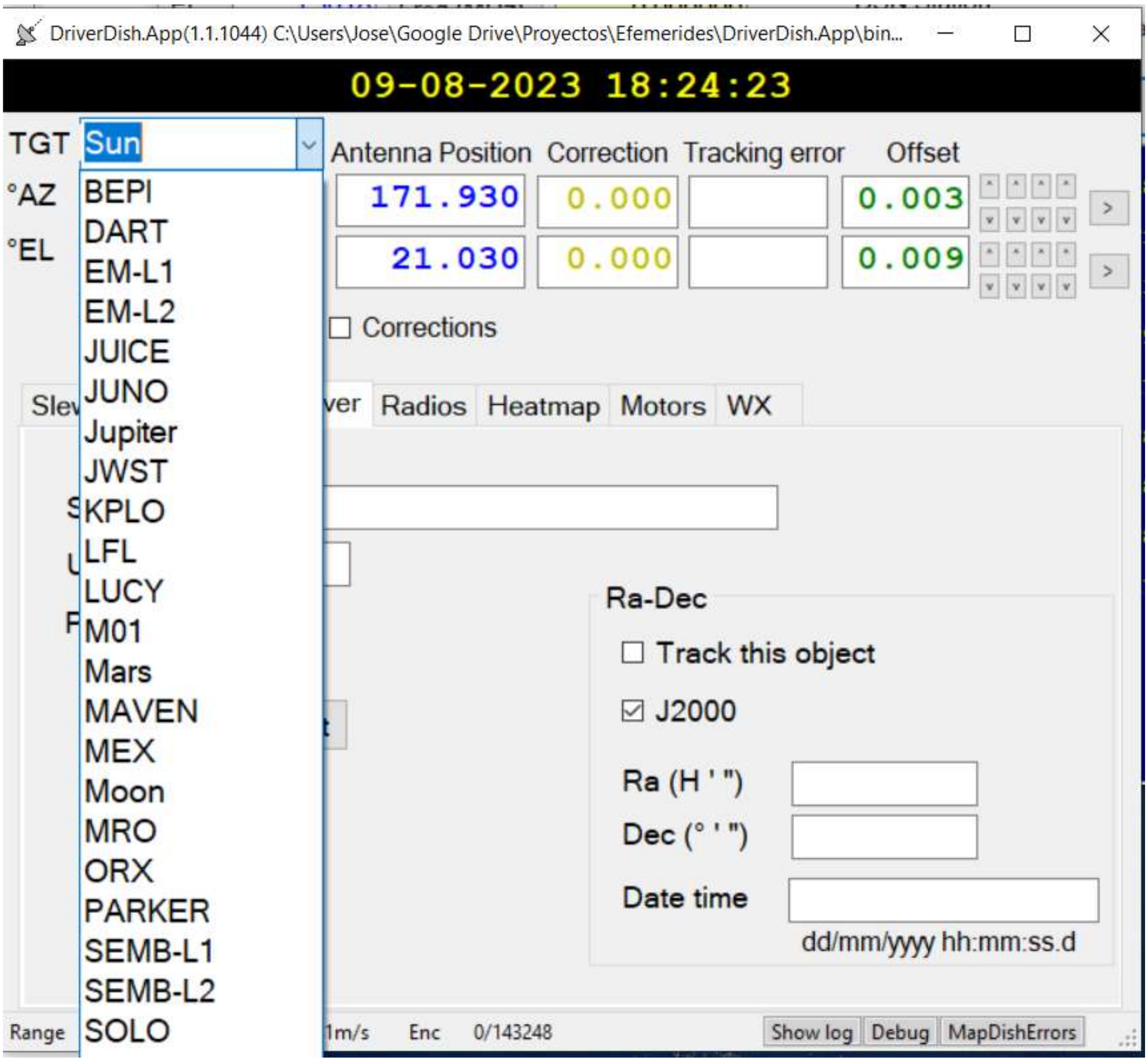
From this tab, we can establish a connection to an ephemeris server. Three servers are available and only one is used at a time:

- AstroServer, which offers enhanced features but demands kernel maintenance.
- AstronomyServer, a straightforward server covering only the planets within the solar system.
- JPLAstroServer, the most versatile server, remarkably easy to configure.

All of these servers provide data via Telnet on the defined port.

Cluster 1, Server, User and Port

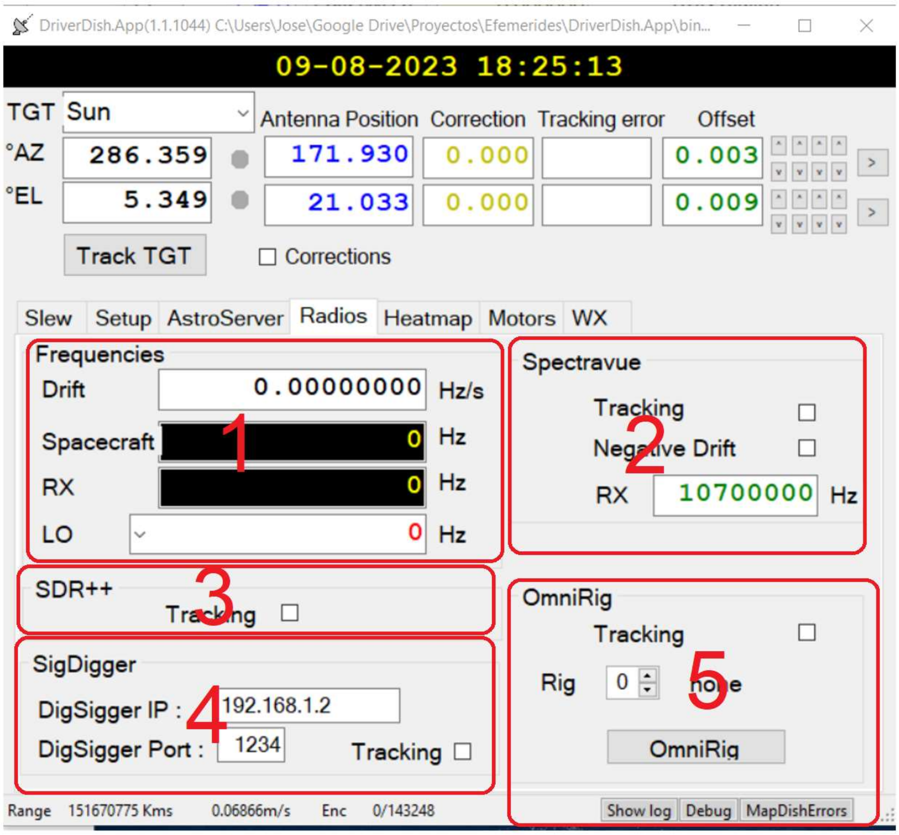
The server's address, user (if using AstroServer, a kernel for the user created during program installation is required) and port are defined in this entry. When the program starts, it automatically attempts to connect to the server. While connected, the available objects are displayed in the Target (**TGT**) list.



Cluster 2, Ra-Dec

There is the possibility to track an object using equatorial coordinates (Right Ascension and Declination) in the currently-used standard epoch "J2000", which should be included in the Date Time field. Upon defining this data, you can activate the "Track this object" checkbox. The program then converts the equatorial coordinates into AZ/EL coordinates, which it uses for tracking purposes.

RADIOS TAB



The primary function of this tab is to allow DiverDish to fine-tune the receiving frequency of SDR devices or hardware CAT receivers in order to counteract the Doppler shift.

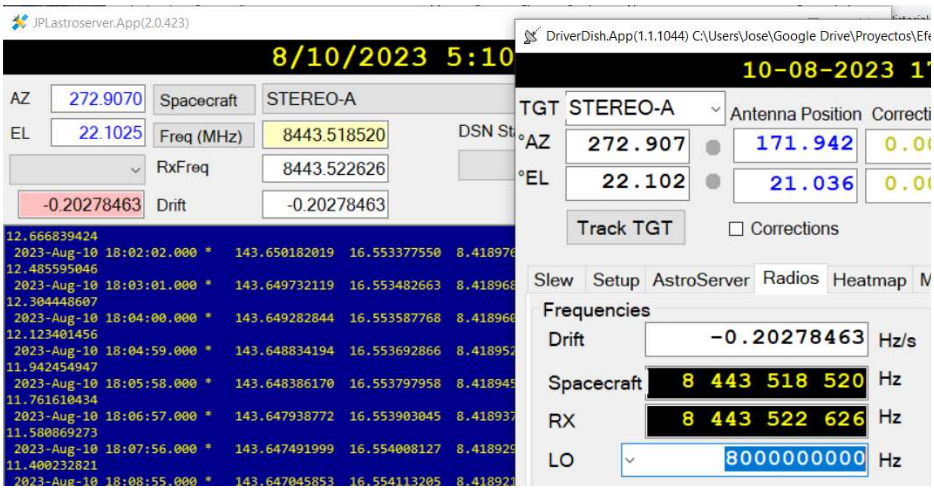
For frequency tracking there are three software options (SpectraVue, SDR++ and Sigdigger) used with SDR devices and for hardware CAT controlled rigs there is the OmniRig option.

In many instances, these receivers are tuned to the Intermediate Frequency (IF) of the receiving chain, which is why the initial adjustment involves the Local Oscillator (LO) frequency.

Cluster 1, LO Frequency setting

When a probe that includes reception frequency is selected in the JPLAstroserver, this information is transferred to the program along with the Doppler and drift values.

All that's required is to set the LO frequency of the transverter or downconverter to align the intermediate frequency (IF) with the probe's frequency. From there, the program handles the remaining adjustments.



Cluster 2, Spectravue settings

When the drift value becomes extremely high, certain receivers do not handle well the excessive data traffic. In such scenarios, if SpectraVue is being used, a potential solution could involve tuning the Intermediate Frequency (IF) within SpectraVue to correct the Doppler shift.

By enabling the **Tracking** option, the Intermediate Frequency (IF) will be fine-tuned in SpectraVue to correct for the Doppler effect. If there's a need to revert the adjustment, the **Negative Drift** checkbox is chosen.

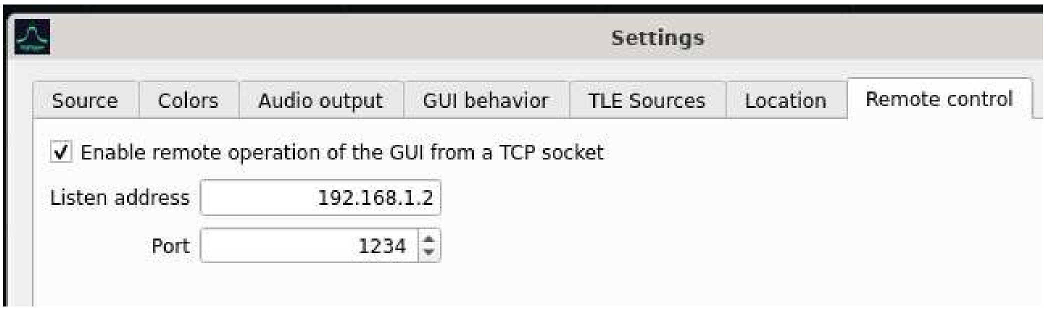
Cluster 3, SDR++ software

SDR receiver users utilizing the SDR++ (https://www.sdrpp.org) software can mark the **Tracking** option here to offset the Doppler shift.

Cluster 4, SigDigger software

SigDigger is a digital signal analyzer program that supports most SDR receivers. As with SpectraVue or SDR++, DriverDish can tune the received frequency on SigDigger to compensate for Doppler shift.

The IP address and Port should match the settings specified in SigDigger's Remote Control tab.

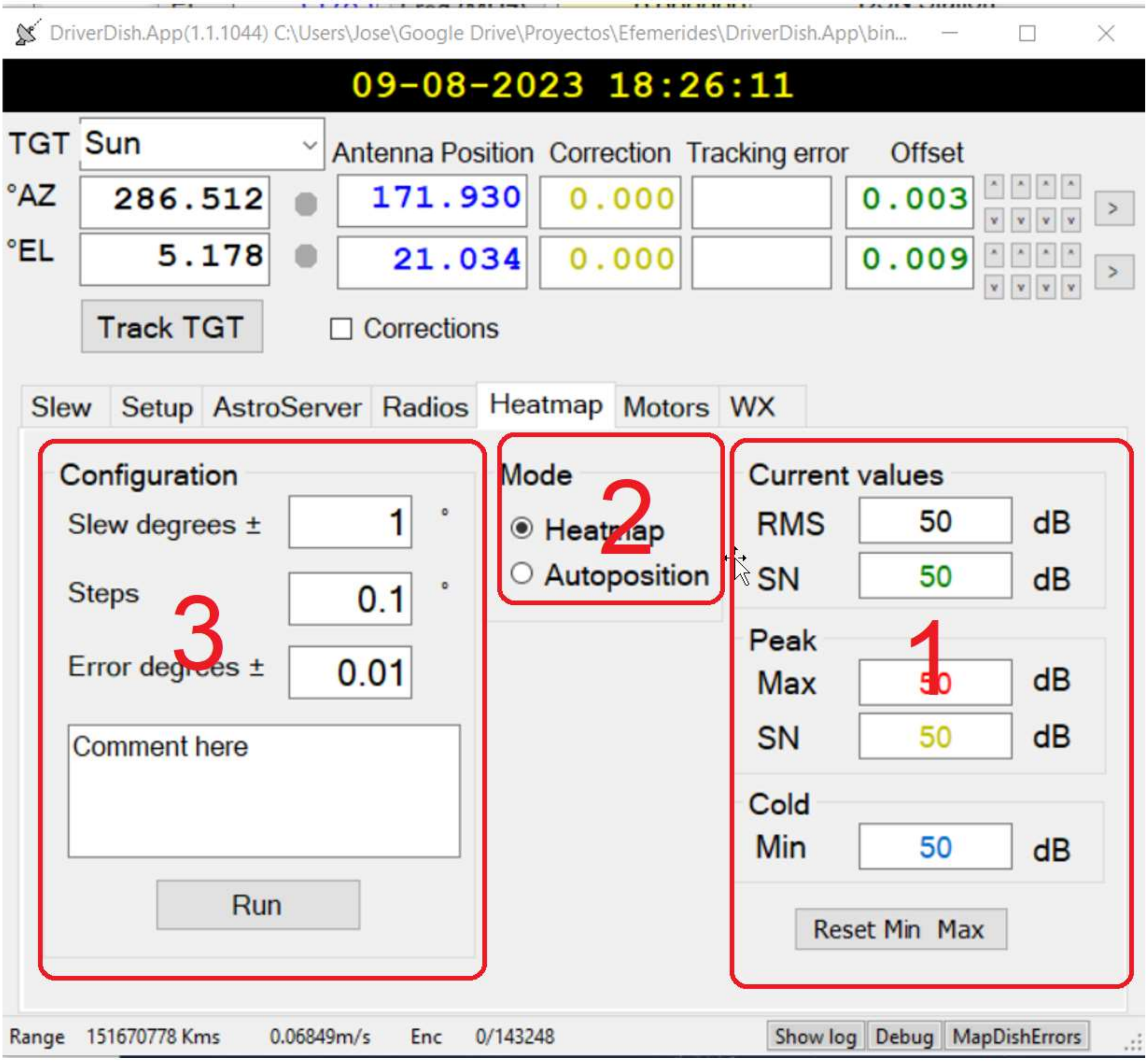


Mark the **Tracking** option here to offset the Doppler shift.

Cluster 5, OmniRig Settings

OmniRig is a receiver/transceiver CAT control engine. DriverDish can tune the frequency of any radio supported by OmniRig. Please note that DriverDish only supports the 2.1 version, that supports up to four receivers simultaneously, that can be downloaded at https://www.hb9ryz.ch/omnirig/.

After selecting the desired rig, remember to also enable the **Tracking** option.



With DriverDish it is possible to create a heatmap to graphically represent signal intensity levels while tracking a target, preferably the Sun or the Moon, and off-pointing the antenna where values are represented by colors to identify the signal intensity of the receiving system. The resulting graphic display helps to identify the antenna receiving pattern and to correct the pointing in order to maximize the signal received from the target object.

Within this tab, it is also possible to perform precise antenna alignment in order to optimize the Signal-to-Noise (SN) of the received signal from the target.

Cluster 1, Current Values, Cold Sky Calibration and Antenna Alignment

The data received from SNserver is displayed here. If no data is shown and SNserver is operational, press the "**Reset Min Max**" button to reconnect.

Cold Sky Calibration is primarily employed for Sun/Moon Signal-to-Noise (SN) analysis. To direct the antenna toward a Cold Sky region, use the **offset** function to position it at an elevation of at least 60 degrees and a few degrees away from the sun/moon location. At that point, press the "**Reset Min Max**" button, and the value of Cold Min will be set to zero.

Now, remove the offset, and it will indicate the SN value and the maximum peak received.

To align the antenna accurately, proceed to move (offset) to the right and left, as well as up and down, to achieve the maximum SN value. Once you're at that point, click on the "**>**" buttons on the right to confirm those values.

Cluster 2, Heatmap

Here, we can choose between creating a **Heatmap** or performing an automatic antenna alignment to the target object (**Autoposition**).

Autoposition mode routine:

1. The antenna azimuth is shifted according to the value specified in the **Slew degrees** field within Cluster 3.

2. The antenna is repositioned once again, this time in a stepped approach, at a distance equivalent to twice the value specified in the Slew degrees field. The step size corresponds to the values entered in the **Steps** field.
3. An azimuth offset to the detected maximum signal point is added.
4. Steps 1 to 3 are repeated in elevation.

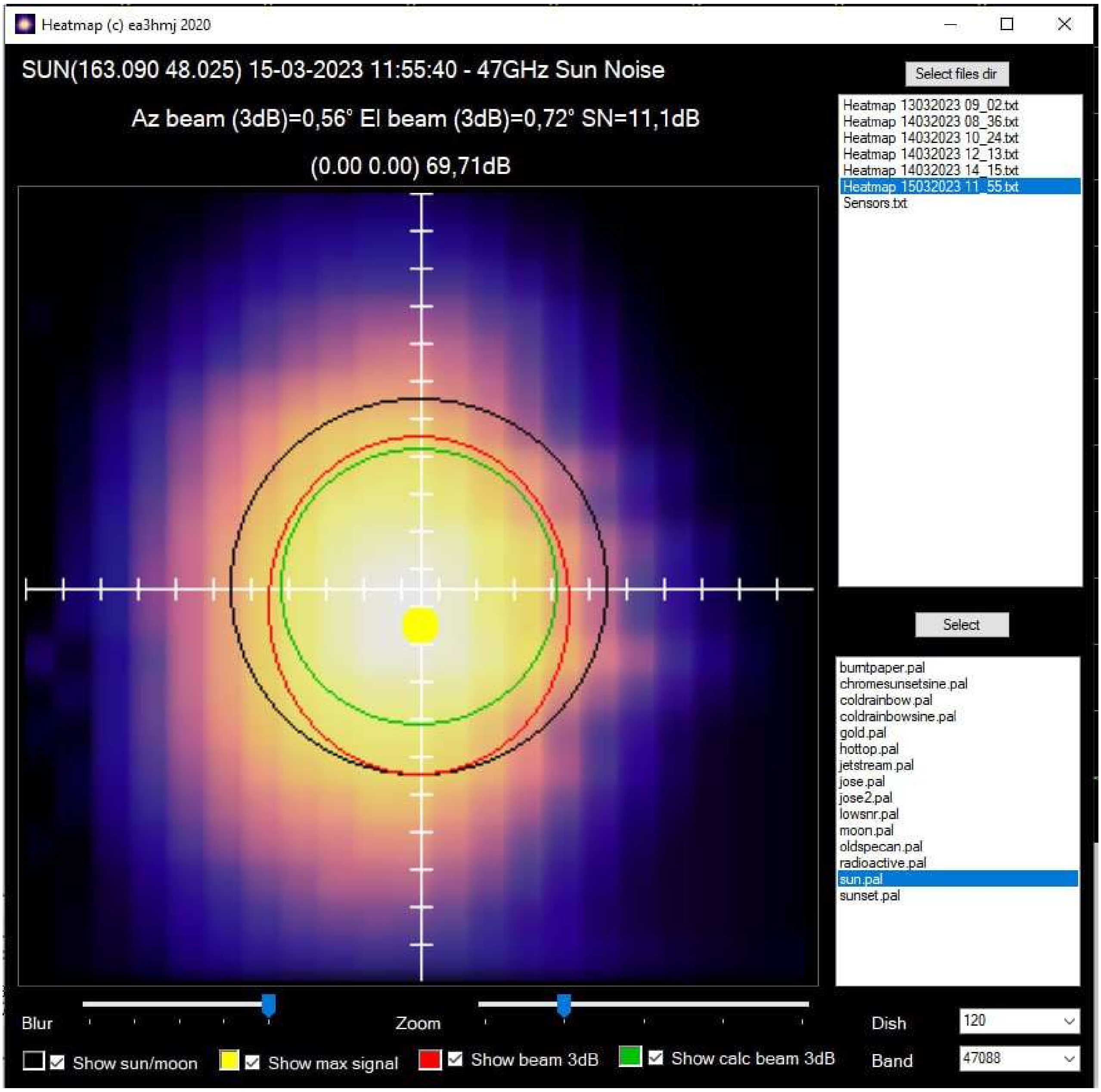
At the end, we will have offset values for the maximum signal, and it will be our decision whether to validate them.

Cluster 3, Configuration

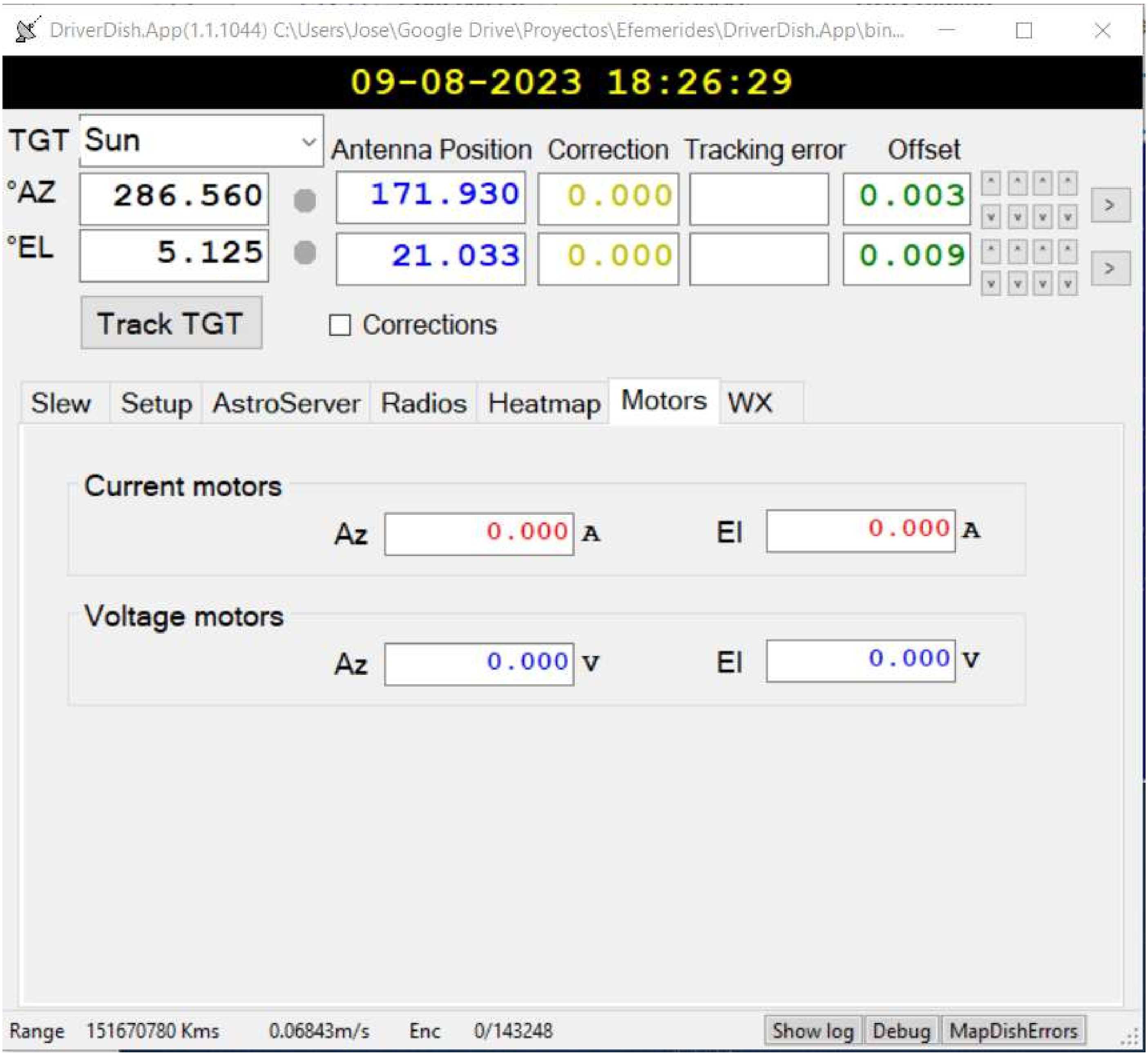
The operation is similar to Autoposition, but when clicking **Run** it performs a complete scan of the defined area.

The **Error degrees** field is the value used by the controller to determine when it's in position.

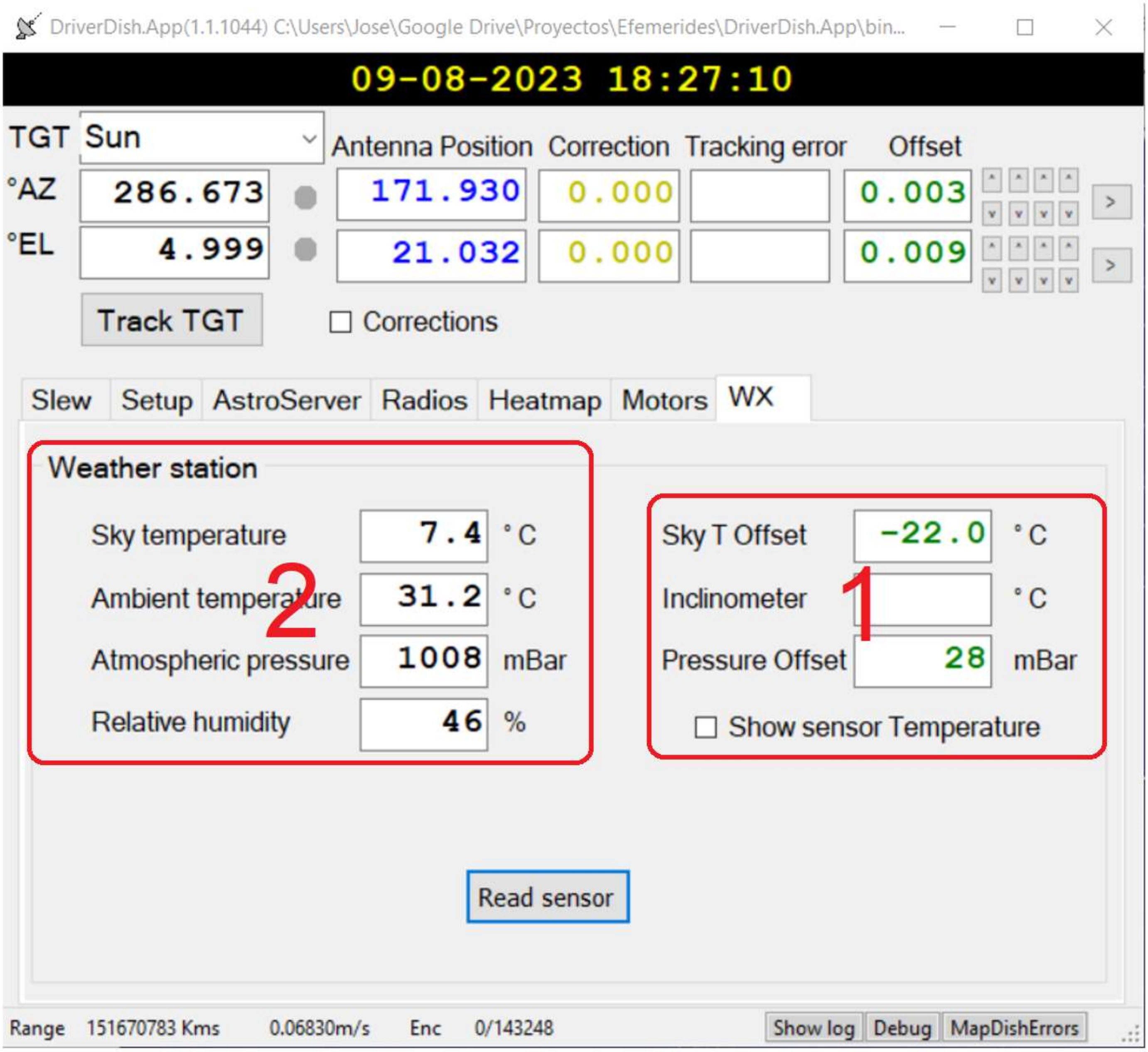
The result of a heatmap can be seen on the following screen capture.



MOTORS TAB



Depending on the motor driver used on the controller board, you can visualize the current and voltage at which the motors are operating at that moment. This information is solely for reference purposes.



The weather station parameters are shown if the optional weather station module is connected to the controller.

Cluster 1, Weather Offset Values

Offsets for sky temperature and barometric pressure are applied here to calibrate the sensor reading.

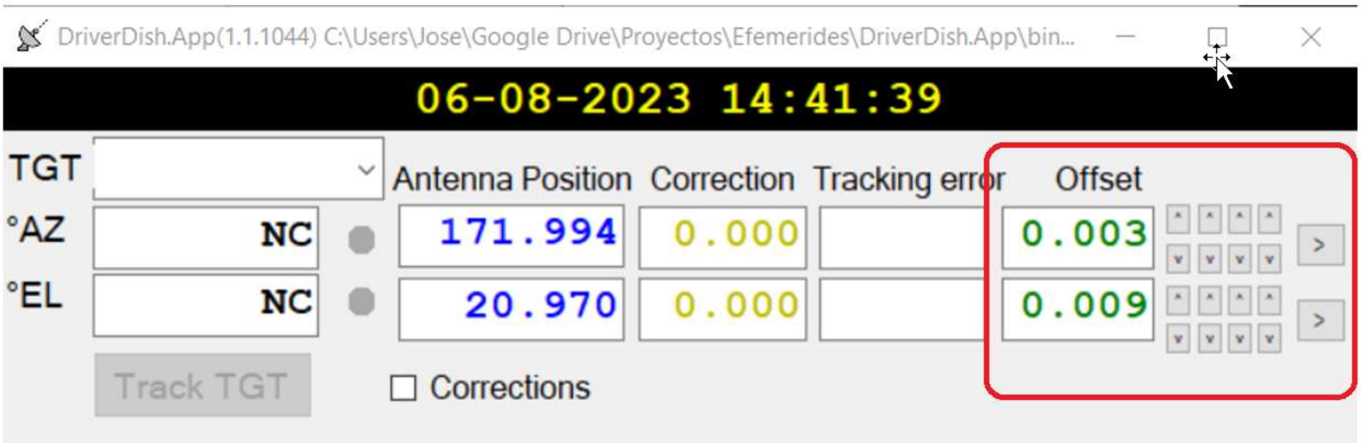
For users of the SOLAR-360 inclinometer, this device has a built-in temperature sensor that can be read by toggling the "**Show sensor Temperature**" checkbox.

Cluster 2, Weather Station

Click on the **Read sensor** button to retrive the Weather Station data.

TRACKING OFFSET MODE

Offset, defined as the difference between the antenna's position and the Encoder's reading is an important parameter when in tracking mode. It is possible to manually introduce offset values to make approximate corrections.



To accurately align these values, track the Sun and measure the SN of the signal. The correct position is at the maximum SN value.

For this purpose, we can adjust the antenna by moving it up and down, as well as right and left, until achieved. This will be done using the buttons that increase or decrease incrementally the offset value.

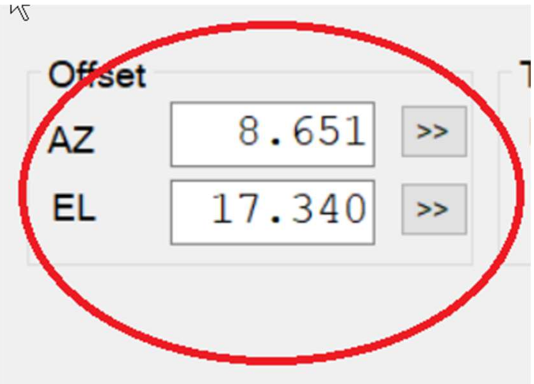
The first button on the left adjusts by 10 degrees.

The second button on the left adjusts by 1 degree.

The third button on the left adjusts by 0.1 degrees.

The fourth button on the left adjusts by 0.01 degrees.

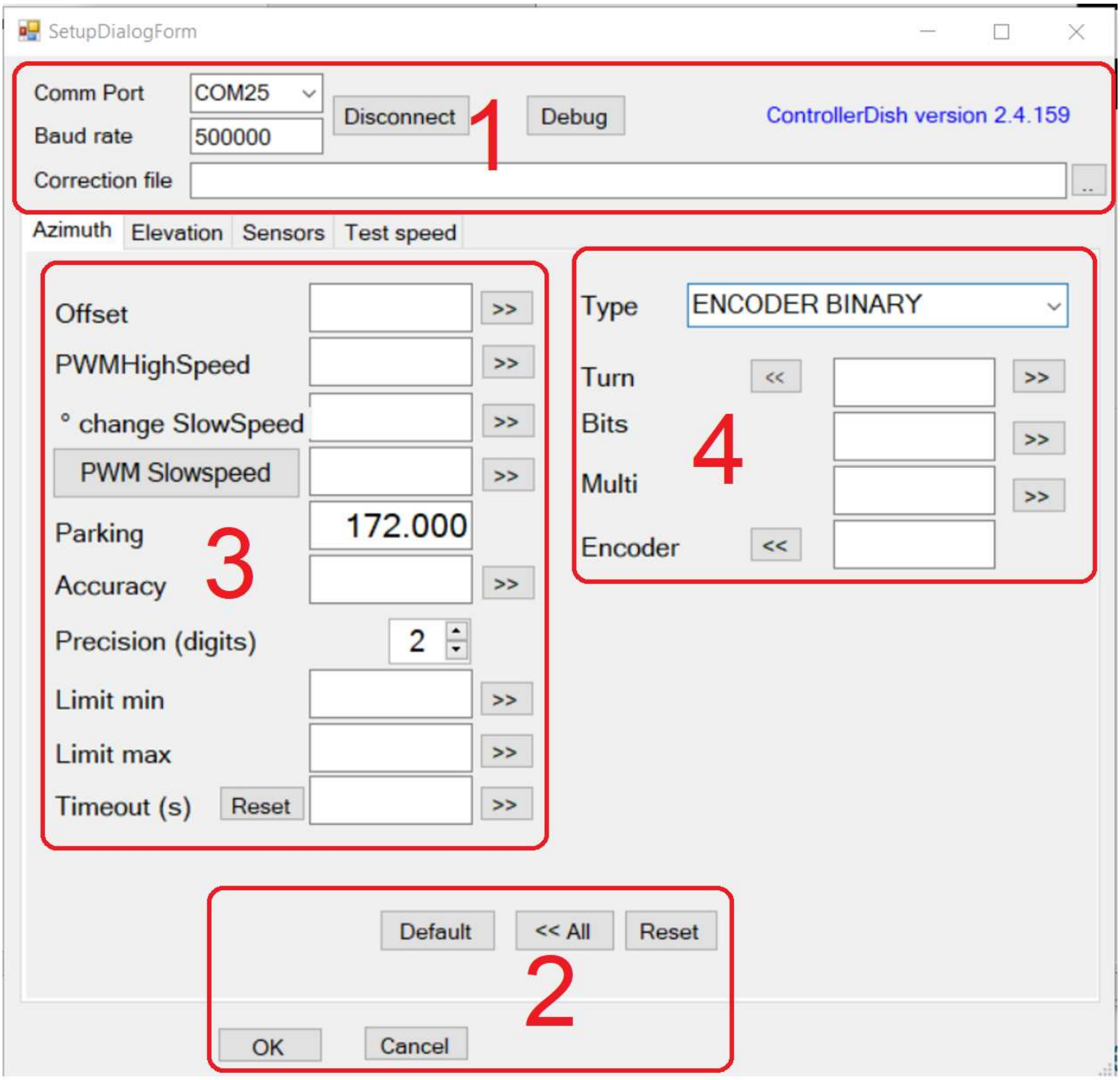
When we are in the correct position, we will press the button "**>>**", the values will be added to the ones we had previously, and the offset value will be reset to zero.



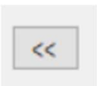
The controller stores these offset values, while the program stores the values we use to determine the position (in green).

DRIVER ESP32 SETUP TABS

There are four clusters in the Azimuth and Elevation setup tabs



Clusters 1, 2, and 3 are identical in both Azimuth and Elevation tabs.

The  buttons read the parameter value stored in the controller

The  buttons send the parameter value to the controller.

CLUSTER 1, COMMS AND CORRECTION FILE

Here, you can choose:

- Communication **port** selection
- Communication **speed**, which is a fixed value and shouldn't be changed
- **Correction file**. This file contains a sky map every 5 degrees with offsets for correction.
- **Connect-disconnect** button for communications with the controller
- **Debug** button to have the controller send process information through the debug port.
- Controller **firmware version** information.

CLUSTER 2

These buttons have the following functions:

- **Default** initializes the controller parameters with the initially defined ones.
- **<< All** reads all the parameters from the controller; initially, no parameters are displayed on the screen.
- **Reset** resets the controller if it became unresponsive.
- **Cancel**, exits without saving the main configuration.
- **OK** exits and update the main configuration.

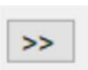
CLUSTER 3, AZIMUTH OR ELEVATION SETTINGS

In this section, the controller's characteristics for managing the entire process are defined.

These are the definitions for each parameter.

- **Offset:** the difference in degrees between the encoder readout and the antenna position.
- **PWMHighSpeed:** the 16-bit value that the controller uses to achieve maximum speed, range 0-65535. By default, the maximum (65535) is used.
- **° change SlowSpeed**: the degree change at which the controller switches to low speed before reaching the destination. This value is vital and will be elaborated in a separate chapter.
- **PWM SlowSpeed**: the 16-bit value that the controller uses to move at minimum speed, ranging between 0 and 65535. The controller can calculate this value by clicking the button.
- **Parking**: the axis position when we want to park the antenna.
- **Accuracy**: the number of degrees at which the controller will stop before reaching the requested destination. In other words, it represents the inertia of the system. This is a crucial parameter and will be specifically covered in a separate chapter.
- **Precision:** the number of decimal digits displayed on the screen and used by the controller for internal calculations.
- **Limits mi:** the minimum value that the controller will move the axis. Software endstop.
- **Limit max:** the maximum value that the controller will move the axis. Software endstop.
- **Timeout:** the time in seconds it takes to move one degree. Still work-in-progress! can be deactivated by setting it to 0.

Important: when changing a value don't forget to press the “**>>**” button to make it effective.

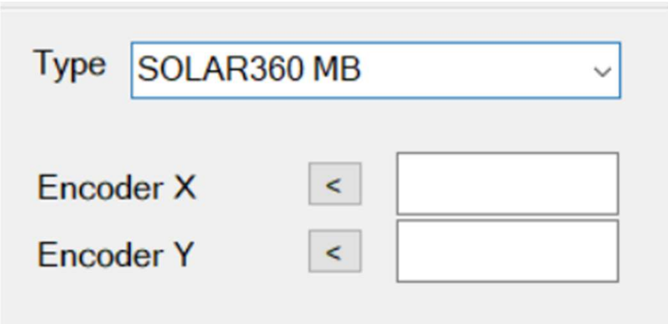


CLUSTER 4, AZIMUTH ENCODER SETTINGS

This cluster is specific to the AZ or EL axis and the Encoder being used.

- **Type**: The type of Encoder used. It does not need to be manually inputted; the software automatically sends it when changed.
- **Turn**: In a multi-turn rotary encoder system, this represents the current turn value.
- **Bits**: The number of bits in a binary encoder.
- **Multi**: In a multi-turn rotary encoder system, this indicates the relationship between one turn of the Encoder and 360°.
- **Encoder**: The binary position of the Encoder, this information is provided for reference purposes only.

CLUSTER 4, ELEVATION ENCODER SETTINGS



Within the elevation tab, the Encoder type and the binary reading of the Encoder are presented. If a dual-axis Encoder is in use, the values of both axes can be observed. This information is provided for reference purposes only.