



# Scope Dome Arduino Driver

Ver. 5.5.5.19

## SUMMARY

We invite you to read the manual of the ScopeDome Arduino card driver. You will learn how the driver works, what are its most important functions, how to use it and how to configure it for optimal and stable operation.

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# What is the ScopeDome Arduino Driver for

**ScopeDome Arduino Driver** is a Windows program that allows you to control and automate the operation of astronomical observatories controlled by ScopeDome Arduino cards.

Its main functions are: controlling the rotation of the dome, opening and closing the shutter, synchronizing the position of the dome and the telescope. In addition, it enables the automatic closing of the dome shutter in the event of various emergency situations, e.g. power failure, rainfall or loss of Internet connection.

The driver with the ScopeDome Arduino card allows you to control the operation of various types of observatories, from RollOffRoof, through typical domes with one or two shutters, to Clamshell domes. This is done by appropriate programming of the control card and selecting the appropriate settings in the program. One control card is enough to control the Clamshell dome and RollOffRoof observatory. Two cards are needed to control the rotation motorized astronomical domes and the shutter. The first one controls the rotation of the dome, the second controls the movement of the shutter via a radio link.

The driver also allows you to control the heating of the dome motors, enclosures containing the control electronics of the observatory, two telescope mirrors (or other elements requiring heating) and a rain and cloud sensor.

The driver can connect to popular weather stations, the AllSky camera, a cloud and rain sensor, the SQM sky quality meter and read data from them.

## Notation used in the user's manual

The program has many configuration options. To recall a specific option or item in the manual, we use the notation: **Window>Tab>GroupBox>Element Name**

For example: **Main>Dome State> Dome Radar** recalls **Dome Radar** in the main program window.



## Principle of operation of the dome driver

After starting the program, it connects to the card and starts reading its status periodically. From the level of the user interface in the program, the ASCOM platform, or the driver's internal procedures, commands are sent to the card, e.g. to turn to a given position, open a shutter or switch on a relay. All commands are asynchronously queued and then sent one by one for execution to the card. Pressing the "STOP" button stops the execution of the last command and clears the entire queue.

It should be remembered that the card and driver work independently and asynchronously - which may lead to incomprehensible at first glance software or dome behavior.

The driver can also execute commands that operate periodically, for example: if the options "Sync with Scope" or "Sync with Wind" are enabled, they constantly set (synchronize) the position of the dome depending on the current position of the telescope or the wind direction. Turning on "Sync With Sky" will cause the dome to make one turn every 24 hours.

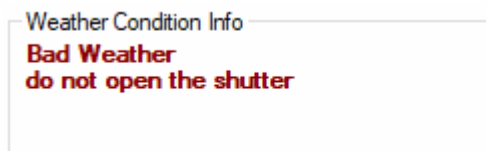
The card and the driver can independently of each other and automatically close the shutter in emergency situations. We can configure the card so that if the input "Cloud Sensor", "Rain Sensor", "No Power" or "Low UPS Battery" is activated, the shutter of the observatory will close automatically. Please note that this will happen even when the observatory control computer is turned off. Additionally, when the driver is running on the control computer, the shutter can be closed automatically: after losing Internet connection, in bad weather conditions, at a given time

or when the shutter is open for too long.

**Note: Due to the fact that the card closes the shutter without the computer assistance, the command to close it will not be displayed in the driver's window. The shutter will just close.**

You can also specify conditions necessary to open or close the shutter such as: parking the telescope from the ASCOM level, active "Park telescope" input on the card, no rain, clouds or good weather condition. This can be useful when controlling the observatory with programs such as CCD Commander or ACP.

The logic condition „**Weather>Weather Condition Info>Good Weather**“ is calculated as follows: Not (Cloud OR Cloudy OR Rain OR (Wind Speed> Hi Wind Speed)). Therefore, if any of these conditions are present, the Good Weather condition will not be met, which will prevent the dome from opening.



Regardless of the functions being processed, the driver or the card supports thermostats that allow to maintain a constant temperature of motors, electronics housings, or heating of the cloud and rain sensor. It also stores the necessary information in files, cloud sensor statistics, and photos from the AllSky camera, if configured on the system.

If you change anything in the program configuration, remember to save these changes and restart the driver. If the changes may alter the card configuration, remember to send them to the card by pressing the button „**Card>Send config to Card**“.



**Note: Never change more than one parameter at a time. This usually leads to software problems. Change one parameter and test what results are. If everything works as expected, save them. If you are not sure about the new settings, go back to the old ones loading the last saved configuration of the card. If you are completely lost, start with the default card settings and press the "Restore Default" button.**

## Security built into the driver

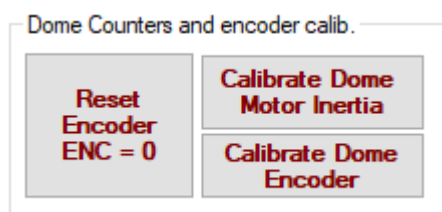
The driver has built-in protection against incorrect operation of the dome position encoder and limit switches that limit the shutter movements.

The driver does not allow to exceed the encoder counter value of the dome position defined in „**Config>Card>Card Configuration>Encoder Max Value/ Encoder Min Value**“. If the next operation of the dome rotation causes the maximum or minimum value of the encoder counter to be exceeded, it will not be executed or the dome will start to rotate in the opposite direction - it will perform a movement analogous to the so called Telescope Pier Flip.

If the counter is exceeded due to the inertia of the dome mass, the driver will only allow the movement in the opposite direction (decreasing the value of the encoder counter).

Manual control of the dome (from the buttons on the card's panel) in CW or CCW directions will work all the time. Rotating the dome out of the encoder counter range will be disabled.

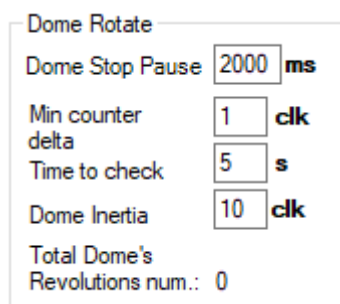
If the encoder range is exceeded - the easiest and fastest solution is to manually guide the dome to the Home sensor and reset the dome encoder counter using the button **Config>Card>Dome Counters and encoder calib.> Reset Encoder ENC = 0**.



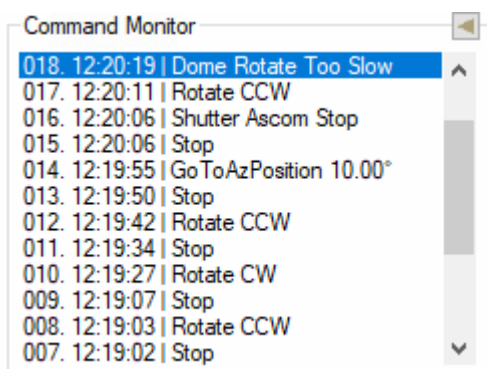
You can also reset the encoder counter „**Main>Dome commands>GoTo**“ by selecting an **Derotate** option from the drop-down list, which will start turning the dome towards the encoder value of 0.

The driver always checks if the dome position encoder is working properly. For this purpose, it measures whether the counter value has changed by the selected number of pulses in a given time. This is determined by the parameters:

- a) **Config>Dome>Dome Rotate>Min counter delta**
- b) **Config>Dome>Dome Rotate>Time to check**



For standard settings, during the rotation of the dome, the encoder counter must change the value by 1 within 5 seconds. If it does not do it, the dome motor will be stopped and a program error will be reported with the message "Dome Rotate Too Slow".

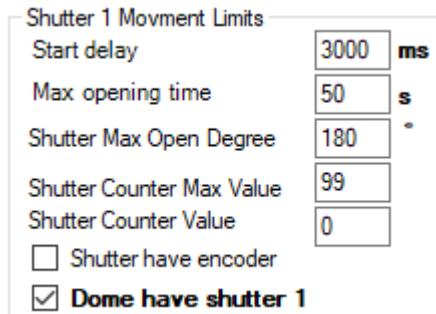


The driver checks the movement of the shutter on two levels:

- 1) after the opening or closing command has been issued, it is checked whether the state of the appropriate limit switch of the shutter has changed in a given time.
- 2) the total time of opening or closing the shutter is checked.

This is determined by the parameters:

- a) **Config>Shutter>Shutter Movment Limits>Start delay** (waiting for a status change of the shutter limit switch)
- b) **Config>Shutter>Shutter Movment Limits>Max opening time** (waiting for the shutter to open completely)

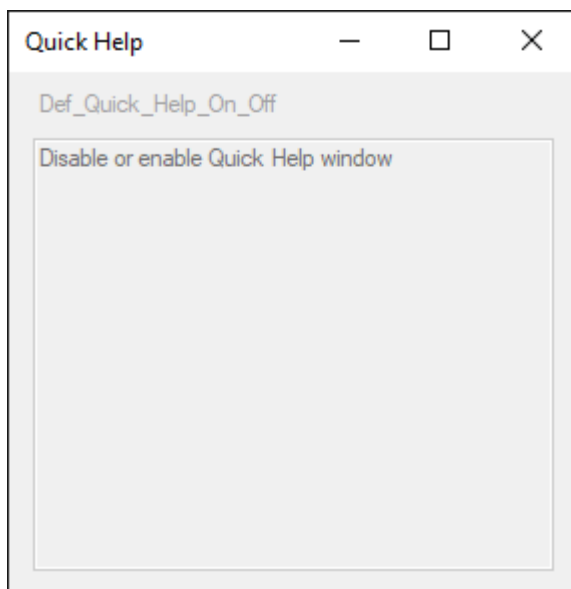


Shutter 1 Movment Limits	
Start delay	3000 ms
Max opening time	50 s
Shutter Max Open Degree	180 °
Shutter Counter Max Value	99
Shutter Counter Value	0
<input type="checkbox"/> Shutter have encoder	
<input checked="" type="checkbox"/> <b>Dome have shutter 1</b>	

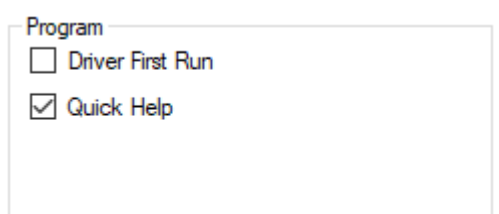
If the event expected by the driver does not occur within the set time, the shutter motor will be stopped.

## Quick Help

This is an automatically appearing window with hints and short description of driver's functions. When you hover the mouse cursor over any element, short hints and explanations of the program functions will be displayed.



To enable it, check the box: **Config>Program>Program>Quick Help**.



Program	
<input type="checkbox"/> Driver First Run	
<input checked="" type="checkbox"/> Quick Help	

# Installation of the driver

The description of the installation procedure can be found in the file:  
c:\ScopeDome\Doc\Software\_installation\_instructions\_EN - 5.5.5.18.pdf.

The program can be installed on a PC with the Windows operating system, version XP or newer. To work properly, the program requires the installation of the ASCOM platform in version 6.4 or 6.5 and the .Net environment in version 3.51 or newer.

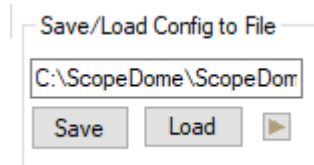
**Note: Before installing the new version, it is necessary to uninstall the older version of the driver.**

Before uninstalling the driver, you can save its configuration to a file using the button:

**Config>Program>Save/Load Config to File>Save**

After installing the new version, you can load saved configuration using the button:

**Config>Program>Save/Load Config to File>Load**



The settings are saved by default in a file C:\ScopeDome\ScopeDome\_Config.ini

**Note: ASCOM 6.5 installer does not install POTH and HUB by default. If you intend to use them to connect to a telescope, select this components when installing the ASCOM 6.5 platform.**

## Basic tests of the operation of the driver and the dome's driving mechanisms

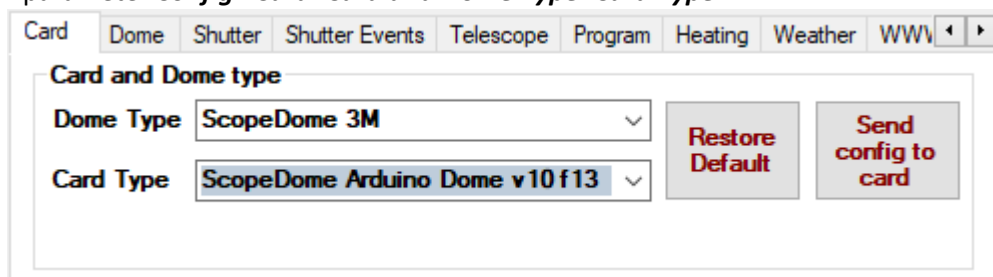
**Note: The driver requires that all dome components (control card, dome motors, limit switches, home sensor, encoder, telescope) work properly. After assembling the dome and installing the software, check their operation.**

If, after reading this manual, you still do not know what to do or the card does not work properly, please contact us by email with a description of the problems. We will try to verify the problem as soon as possible. In order to enable remote diagnostics, please install or run the current TeamViewer version and connect a webcam, which will allow us to see what your dome, telescope, power supply, etc. looks like. A typical service session takes about 2 hours.

## First steps of driver configuration

**After installation, the driver starts in the 3M dome simulator mode.** To complete configuration of driver and connect it physically to the card, follow the steps below:

1. Select the type of the dome:  
- parameter **Config> Card>Card and Dome Type>Dome Type**
2. Select the type of the card:  
- parameter **Config> Card>Card and Dome Type>Card Type**



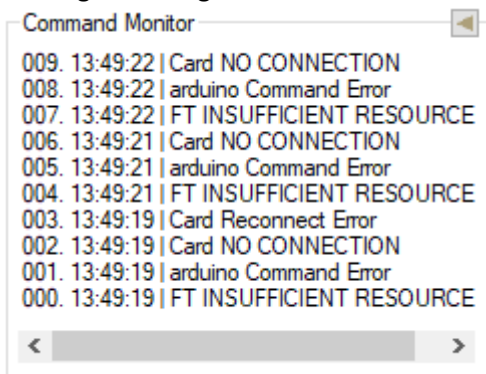
3. Save the settings (this is very important - thanks to this the driver knows how to restore the default settings):  
- button **Config> Card>Save Settings**
4. **Restore default settings:**  
- button **Config> Card>Card and Dome Type>Restore Default**



5. Choose how to connect to the card (by Ethernet or USB):
  - parameter **Config> Card>ScopeDome Arduino Card>Connect by**
6. Enter IP or COM port number:
  - parameter **Config> Card>ScopeDome Arduino Card>Ip Address:**
  - or parameter **Config> Card>ScopeDome Arduino Card>Com Port**

7. Save the settings again (from now on the driver knows how to connect to your card):
  - button **Config>Save Settings**
8. Send settings to card:
  - button **Config>Card and Dome Type>Send config to card**
9. Close **Config** window and main program window by clicking **Exit**.
10. Wait a few seconds and restart the driver.

After restarting, the driver should connect to the observatory control card. Connection errors are displayed in the window: **ScopeDome LS>Main>Command Monitor**. If connection has been made successfully, the command monitor window will remain blank. Otherwise, you will get messages about connection error:



The driver will use the standard configuration typical for the selected dome type. Standard configuration files for all types of domes are stored in the directory: **c:\ScopeDome\\_Def\_Config\_Files** and should not be changed.

## Test of computer connection with the card

The easiest way is to check the proper operation of connection between the card and computer is to test the function of "Telescope" or "CCD" relays. After pressing the relay control button on the card, the appropriate icon should change its state in the driver window and the relay should switch on.

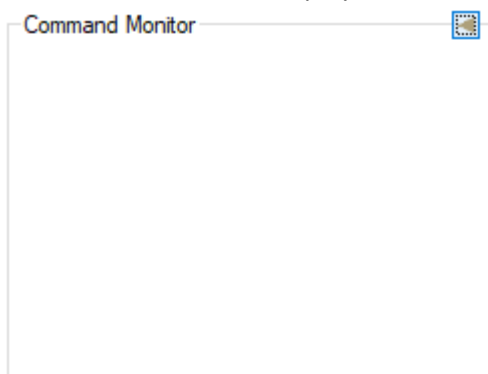
Before pressing the Telescope button:



After pressing the Telescope button:



Connection errors are displayed in the **Command Monitor** window:



**Note:** If the window is empty after starting the driver, it means that the driver has correctly connected to the card or is working in the dome simulator mode.

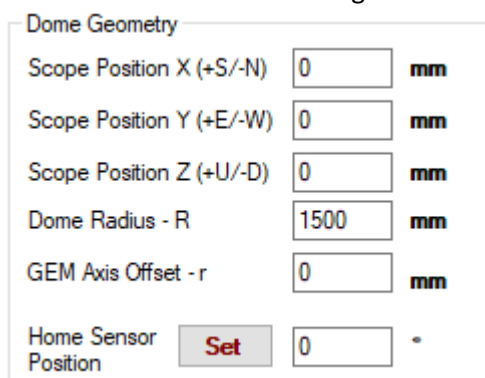
## Determining the position of the Home Sensor and how it works

The proper operation of the Dome Home Sensor is crucial for the functioning of the driver. It sets the initial (zero) position of the dome and on this basis the position of the dome during its rotation is determined.

When Home Sensor is active, the dome position encoder counter **must be zero**. It is a good idea to verify the encoder counter value from time to time and reset it if necessary. The current counter value is presented on the status line (bottom bar) of the main program panel (Enc: 0):



If the Home Sensor is not positioned to the south (the shutter points then to the north), then its position should be entered as parameter in filed **Config>Dome>Dome Geometry> Home Sensor Position** You can enter this angle manually or calculate it using the **Set** button:

The image shows a window titled "Dome Geometry" with several input fields and a "Set" button. The fields are: "Scope Position X (+S/-N)" with value 0, "Scope Position Y (+E/-W)" with value 0, "Scope Position Z (+U/-D)" with value 0, "Dome Radius - R" with value 1500, "GEM Axis Offset - r" with value 0, and "Home Sensor Position" with value 0. Each field has a unit "mm" next to it. The "Set" button is located next to the "Home Sensor Position" field.

### Using the Set button

- a) turn the dome to AtHome position (e.g. by **ScopeDome LS>Main>Goto> Find Home**)
- b) reset the dome position counter (button **Config>Card>Dome Counters and encoder calib.> Reset Encoder ENC = 0**)
- c) rotate the dome - so that the center of the shutter points exactly to the North direction
- d) press button **Config>Dome>Dome Geometry> Home Sensor Position>Set**

### Home Sensor operation can also be checked manually.

To do this, just insert a sheet of paper into the sensor gap and observe the main driver window. After covering the sensor, the driver should display a red text **AtHome**:



Various sensors of the dome's "home" position can be connected to the card. They can return one or zero logic signal when the sensor is active (e.g. old ScopeDome Home Sensors, or reed switches). The driver allows you to negate the value returned by the sensor. The marker is used for this:

**Config>Card>Card Configuration> Negative Home Sensor** . Selecting it will invert the signal from the Home Sensor.

Be sure to save the settings after changing this parameter (button **Config>Card>Save Settings**), then send them to the card (using button **Config>Card>Send config to card**) and restart the driver.

**AtHome** label in the driver window should be displayed only when the Home Sensor is obscured (active).

If the **Negative Home Sensor** parameter is incorrectly set - this inscription always appears and disappears when the Home sensor is active (covered).

**Note: The Home Sensor is sensitive to sunlight. A sensor illuminated by direct sunlight may not function properly. Cobwebs or dust are equally dangerous - from time to time you should clean the Home Sensor and the photodiode with compressed air or a clean, lint-free cloth.**

The operation of the Home Sensor depends on the position of the diaphragm (a metal, flexible plate screwed to the rear panel of the dome), it is necessary to ensure that the diaphragm has the appropriate length and position. It must stable and effectively cover the photodiode inside the sensor during the rotation of the dome. The pictures below show the correct setting of the diaphragm when AtHome position:



Examples of Home Sensor and diaphragm settings can be found in the file:

**Doc/Home Sensor Adjustment.pdf**

## Dome position encoder operation check

This is a very important component that determines the operation of the driver and the accuracy of the dome positioning. While the dome is moving, the "Encoder" diode on the card panel should blink (go on and off).

Incorrect alignment of the optical sensor with the encoder wheel mounted on the motor axis can cause unstable or erroneous dome position readings. In such a situation, the encoder pulses may not even be counted at all and the driver reports the error "Dome rotate too slow", even though the dome is rotating.

The easiest way to check the operation of the encoder is in the AtHome position of the dome.

To do this:

- a) set the dome in the AtHome position (AtHome sensor must be active)
- b) reset dome position counter (ENC=0) (button **Config>Card>Dome Counters and encoder calib.>Reset Encoder ENC = 0**)
- c) using function ScopeDome LS>**Main>Dome commands>ENC. GoTo** turn the dome to position 200
- d) using function ScopeDome LS>**Main>Dome commands>ENC. GoTo** turn the dome back to position 0 (zero)

After these operations the dome should return to position Enc = 0 and the AtHome sensor should be active. If the dome returns to the AtHome position every time, the encoder is working properly.

It is worth repeating these steps for different values **ScopeDome LS>Main>ENC. GoTo** (e.g. 300, 500, -200, -300, -500).

If the encoder is not working properly, you should verify:

- a) if the dome drive gear wheel tightly coupled with the rack around the entire circumference of the dome. If necessary, adjust the position of the dome rotation motor, stopping the dome in this place.
- b) has the encoder wheel inside the housing come loose? For example: the bolt securing it to the axle has not loosened during transport or use and does the disc rotate with the axle of the gear.
- c) if the encoder wheel close to one of the edges of the optical sensor (normally it should be placed around 1/3 of the sensor aperture width)
- d) if the optical sensor of the encoder is dirty and needs cleaning
- e) if the encoder wires properly connected to the card

## Checking the operation of the shutter limit switches

The limit switches in ScopeDome have two functions:

- a) send the shutter status (open / close) to the driver,
- b) physically cut off the dome window motor control signal and stop it when activated.

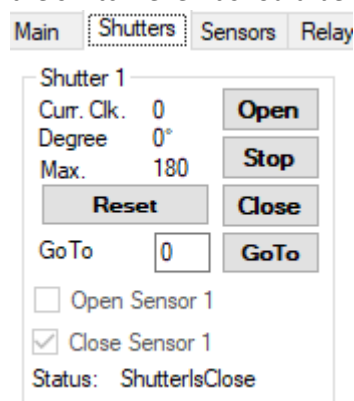
One pair of the limit switch contacts (NO - normal open) is used to transmit the signal of opening / closing the shutter, the second one (NC - normal close) is used to cut off the signal controlling the motor.

**Note: To check if the limit switches are working properly, first, using the buttons on the card, set the shutter so that it is half open.**

### Checking the operation of the shutter closure sensor

To do this, press the lever of the "Close" limit switch (simulating its activation by a pressure plate mounted on the shutter) and check the status of the shutter in the driver.

Marker **ScopeDome LS> Shutters>Shutter 1> Close Sensor 1** should be active and after releasing the switch lever it should be deactivated:



Proceed in the same way with the shutter opening sensor (located at the top of the dome).

The **Reset** button is used to reset the counter of the shutter position. If the program shows the wrong angle ("Degree" value) when opening or closing the shutter, reset the counter of the shutter position after the shutter is closed. The next time the shutter is opened, the software will measure the necessary parameters and the next time the shutter is opened it should show the correct values.

### Checking the operation of cutting off the signals controlling the shutter motor

Perform this test with the help of two people with the control software on the computer turned off. One of the people presses the Open or Close button on the card, and the other stops its operation activating the limit switch. After breaking the limit switch lever, the shutter should stop.

## Configuring the connection to the telescope

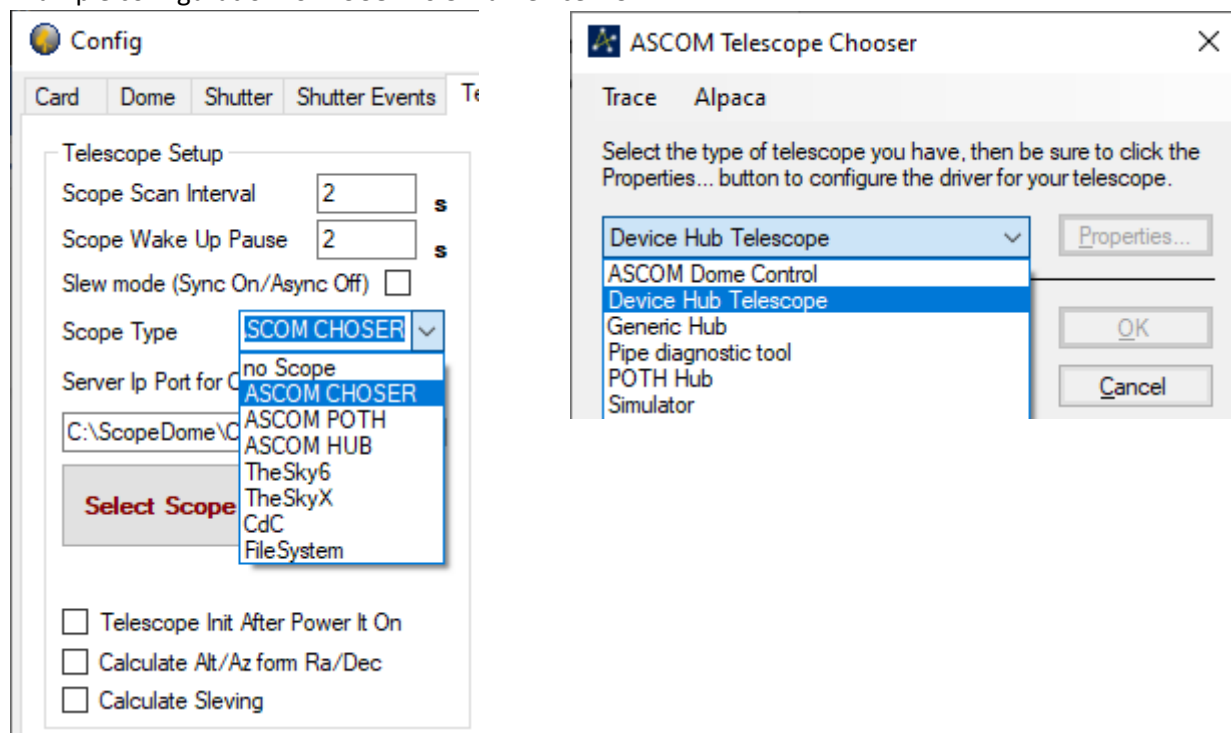
In order to automatically synchronize the position of the dome with the position of the telescope, it is necessary to send to the driver information about its position, the "PierSide" parameter (on which side of the pier the telescope is located) and the geographical coordinates of the observatory.

The driver works best with the telescope via the ASCOM platform. It is also possible to connect the telescope via TheSkyX, TheSky6, CartesDuCiel software or via an XML file.

From the ASCOM platform it is best to connect to the telescope via a Hub component working in Local Server mode. The most common mistake made by users is to connect the telescope's ASCOM driver to two programs at once, e.g. to MaximDL and some sky atlas software. This usually causes the telescope driver to hang, and then the entire ASCOM platform, including the dome driver. To avoid such a situation, first connect the telescope's controller, e.g. to POTH Hub, and then configure POTH Hub as the telescope's driver in other programs, i.e. in MaximDL, TheSkyX and ScopeDomeDriver.

**Note: ASCOM platform ver. 6.5 does not install the POTH component by default, you must manually select the necessary options during the installation or configure the connection with the telescope via ASCOM Chooser>Device Hub.**

Example configuration for ASCOM 6.5 via Device HUB:



It should be checked whether all the telescope control programs have the same geographical coordinates of the observatory. All programs communicating with the telescope must pass the same geographic coordinates of the telescope:

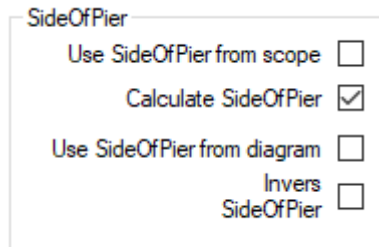
Site Info  
Latitude: N 37° 17' 43"  
Longitude: E 9° 40' 25"  
Elevation: 96,27 m  
Buttons: Get, Set from/in telescope

The **Get** and **Set** buttons allow you to upload and download the observatory coordinates from the telescope driver, provided that the selected ASCOM driver performs this function.

## „SideOfPier” parameter

PierSide (or SideOfPier) is, after geographic coordinates, the most important parameter determining the correct synchronization of the dome's position with the telescope. Its value depends only on the mode of operation of the telescope's driver and each manufacturer can use their own way for correctly passing this parameter. Due to the fact that there is no formal standard and thus there is no one universal method of configuring this parameter.

In the ScopeDome driver, several configuration options for this parameter are available at **Config>Telescope>SideOfPier**



SideOfPier

Use SideOfPier from scope ☐

Calculate SideOfPier ☒

Use SideOfPier from diagram ☐

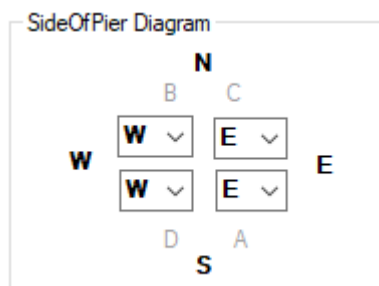
Invers SideOfPier ☐

Usually, the **Calculate SideOfPier** option works best, but for some telescopes, **Use SideOfPier from scope** is a good choice. Usually, the **Invers SideOfPier** option should also be selected.

The **Use SideOfPier from scope** option causes ScopeDome to read the SideOfPier parameter directly from the telescope controller.

The **Calculate SideOfPier** option uses the ScopeDome driver's built-in algorithm to calculate the value of this parameter based on the telescope coordinates. However, it is worth remembering that it all depends on the initial position of the telescope on the east or west side. In this case, the **Invers SideOfPier** option can be helpful, which allows you to quickly invert its value.

The **Use SideOfPier form diagram** option is the final choice if the options described above do not work. It allows you to define any SideOfPier value depending on which part of the sky the telescope is looking at. However, we do not recommend you to use this option. Its correct configuration could be very complicated.



To find the correct setting for your telescope, experiment with different settings or talk to other ScopeDome users who have a similar type of telescope to yours - they will certainly be able to suggest the best way of connection between the dome and the telescope. It should also be remembered that it is just as important as PierSide to correctly enter the X, Y, Z, GEM parameters and the coordinates of the observatory. If these parameters are entered incorrectly, the synchronization of the dome window with the telescope will not work properly. The key is the GEM parameter, which has the greatest impact on the synchronization of the dome with the telescope.

## Selecting the method of reading the AtPark Telescope sensor

Park Sensor

Telescope Driver AtPark Solution ▼

Telescope Driver AtPark Solution

Telescope Alt/Az Position

ScopeDome Card Telescope AtPark Se

telescope Park Alt/Az position

Altitude 44,24333!

Azimuth 180

Get Current Position

### - Option "Telescope Driver AtPark Solution"

The ScopeDome driver will use the AtPark function of the telescope driver to read the telescope's AtPark status.

### - Option "Telescope Alt/Az Position"

The ScopeDome driver will use the telescope's Alt/Az coordinates to read the AtPark state of the telescope.

### - Option "ScopeDome Card Telescope AtPark Sensor"

The ScopeDome driver will use the TelescopeAtPark input of the ScopeDome card to read the telescope's AtPark status.

## Selecting how to park the telescope

Park Sensor

Telescope Driver AtPark Solution ▼

Telescope Alt/Az Position ▼

Telescope Driver AtPark Solution

Telescope Alt/Az Position

Altitude 44,24333!

Azimuth 180

Get Current Position

### - Option "Telescope Driver AtPark Solution"

The ScopeDome driver for parking the telescope will use the Park function of the telescope driver.

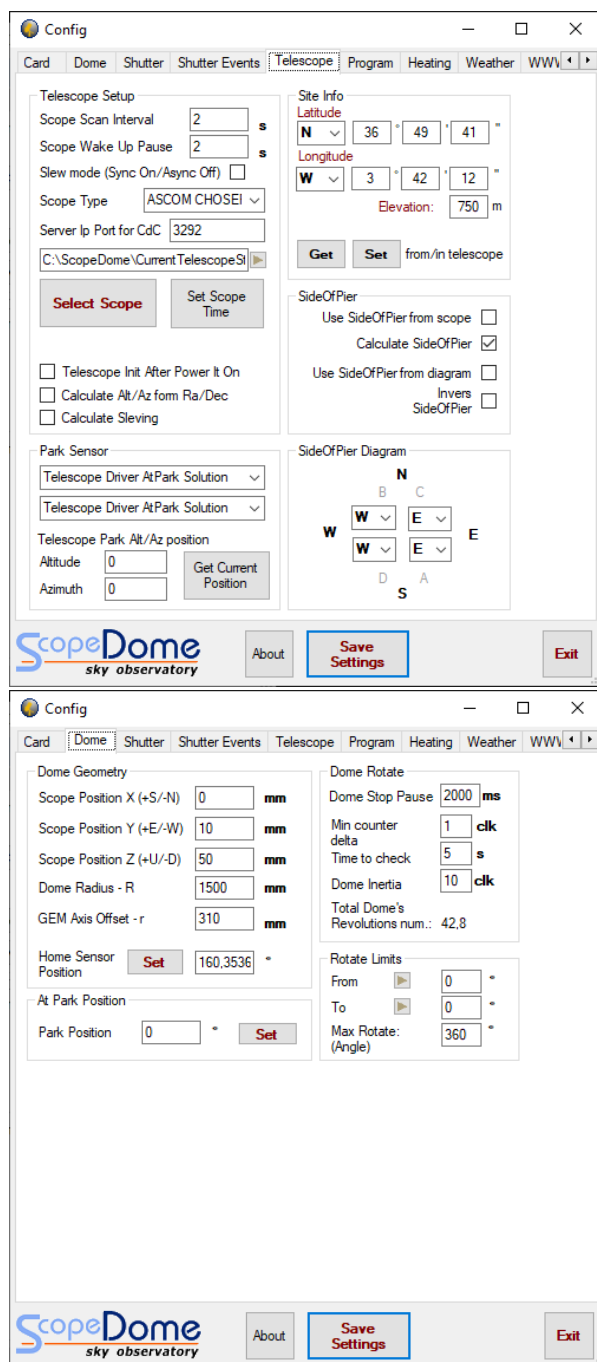
### - Option "Telescope Alt/Az Position"

The ScopeDome driver for parking the telescope will use the telescope's GoTo Alt/Az function.

The **"Get Current Position"** button fills the current telescope position with the Altitude and Azimuth parameters of the telescope coordinates - this allows you to quickly enter the telescope parking coordinates.



It is interesting that in such a configuration only connection via the ASCOM driver (and not directly via TheSkyX) allows the correct synchronization of the telescope with the dome. We have been using this configuration for several months and we have not noticed any problems with working of the dome with the telescope.



### Configuration of dome geometry (X, Y, Z, GEM) and observatory coordinates

The X, Y, Z Gem parameters determine the accuracy of the synchronization of the dome and telescope positions. The precisely measured parameters allow to achieve centimeter precision of the center of the dome's shutter in relation to the direction of the optical center of the telescope. Please note that the parameters X, Y, Z refer to the point of intersection of the telescope's RA and DEC axes, not the center of the pier. More information how to calculate these parameters can be found in the file:

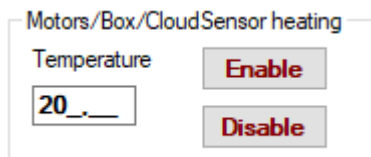
***Doc/Dome Geometry - Additional Information.pdf***

## Turning on the card and the dome motors heating system

The domes work in various weather conditions. Often, at night, when humidity is greater than 80% and temperatures drop below freezing. During humid nights, on electronics can deposit a moisture, causing short circuits, corrosion of paths on PCB and damage to electronic components. On the other hand, low temperatures thicken the lubricants in the engine gears, which makes it difficult to move the dome shutter.

**Note: To ensure trouble-free operation of electronics and motors, it is necessary to heat them 24 hours a day.**

Settings for heating inside the enslosures, motors and related settings can be found in the tab:  
**Config>Heating**



Motors/Box/CloudSensor heating

Temperature

20\_.\_

Enable

Disable

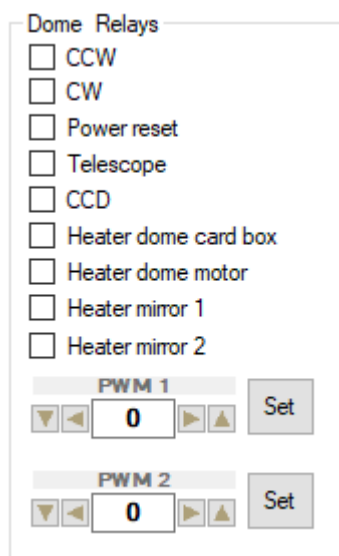
In the **Temperature** field, enter the desired temperature value of motors and electronics inside housings to be maintained, and then click the **Enable** button. Pressing the **Disable** button turns off the heating of motors and enclosures.

The driver assumes that the electronics and motor heaters are connected to the card's REL4 and REL5 relays, respectively. The temperature of the electronics is measured by the thermometer built into the card, the motor temperature is measured by the thermometer connected to the OW1 input. The motor thermometer should be screwed to the motor gear motor as far as possible from the motor heater.

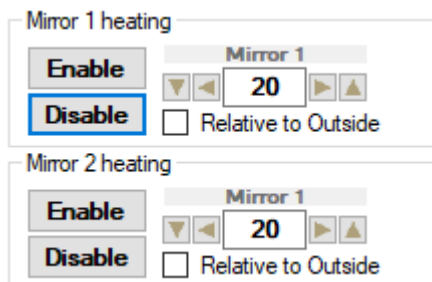
## Turning on the telescope mirror heating

The mirror heating can be controlled in three ways:

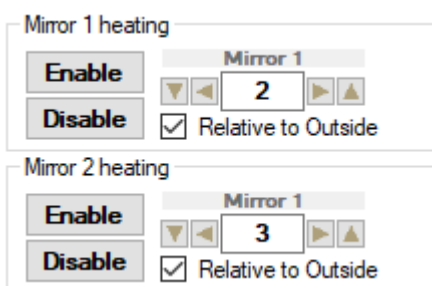
1. giving the fill (percentage of power) with which the selected heater is to work, and then press the button: **ScopeDome LS>Relays>Dome Relays>Set**



2. giving in **Config>Heating>Mirror 1/2 heating** window the desired mirror temperature, and then press the **Enable** button:



3. giving in **Config>Heating>Mirror 1/2 heating** window the difference between the mirror temperature and the ambient temperature, then press the **Enable** button:

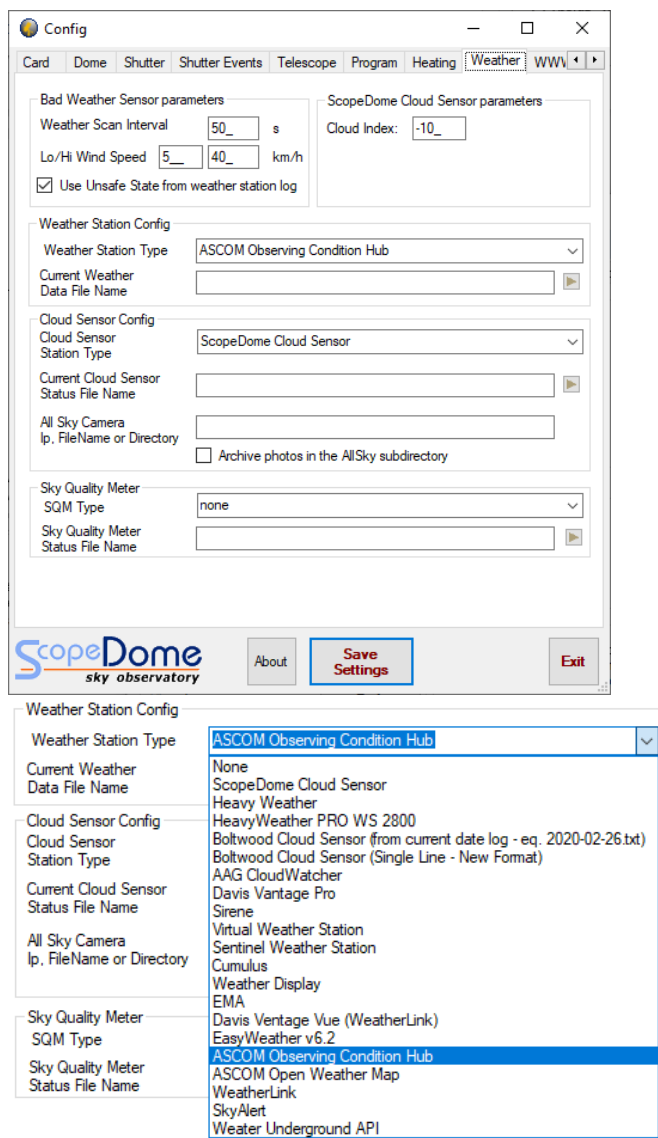


The driver assumes that the telescope's mirrors (or lenses) are heated through the card's PWM outputs. You will find a connection diagram of heaters and thermometers in the manual for the card, on pages 14 and 15 ([ScopeDome Arduino Card Manual](#)). The mirror heater number 1 should be connected to the PWM1 output, the mirror heater number 2 to the PWM2 output. The external temperature is measured by a thermometer connected to the OW2 input of the Shutter (Slave) card.

Please note that the maximum current flowing through the heater is 2A at 12VDC (24W). Turning on the mirror heating will require an additional power of approx. 50W and replacement of the card's power supply with one that will handle the greater demand for power.

**Note: We suggest using a power supply with a minimum power of 100W.**

## Configuration of connection with the weather station



The driver has built-in support for many popular weather stations. Settings regarding the selection of the weather station to work with the program can be found in the tab:

### **Config>Weather**

Data from the weather station are read from the log file saved by the weather station in CSV format in the computer's file system. The exceptions are **"ASCOM Observing Hub"**, **"ASCOM Open Weather Map"** and **"ScopeDome Cloud Sensor"**, which do not require a data exchange file (log).

For stations of the "Weather Underground API" type, it is required to provide the WWW address of the link to the data from the station and enter your own API key for this data, e.g.

<https://api.weather.com/v2/pws/observations/current?stationId=NAME&format=xml&units=m&apiKey=dcaca713088fa49c78a713088fa09c7a7>

where:

NAME – the name of your weather station

dcaca713088fa49c78a713088fa09c7a7 – your unique ApiKey

The connection to the "Weather Underground API" can be tested by entering this address into the browser - in response you should receive a typical xml file with current data. Weather.com counts the number of data readings per hour and blocks access to the data if the readings are too frequent. We suggest reading the data no more than once every 5 minutes (parameter **"Weather Scan Interval"**).

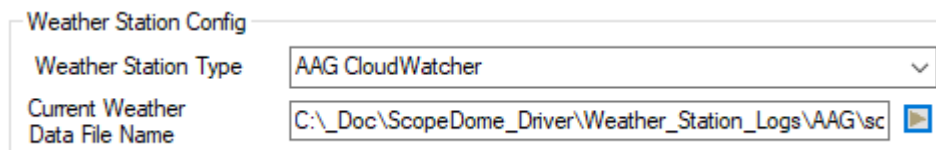
Sample file format for a popular weather station (and also a cloud sensor)

**„AAG CloudWatcher“:**

"Date","Time","Cloud Condition","Rain Condition","Brightness Condition","Cloud Value","Cloud Sensor Temperature","Rain Value","Brightness Value","Ambient Temperature","Rain Heating Percentage","Rain Sensor Temperature","Heating Status","Switch Status","Read Cycle","Timeout Errors","Safe Status","Wind Condition","Wind Value","Rel hum Condition","RH Value"

"2020-04-17","20:23:58","Cloudy","Dry","Dark",-  
15.6","10.3","4544","2868","10.3","20%","18.0","","Closed","5","0","Unsafe","Windy","7.0","Dry","50%"

To connect the weather station to the driver, select its type from the list in the field **Config>Weather>Weather Station Config>Weather Station Type**, then indicate the log file saved by the station in the field **Config>Weather>Weather Station Config>Current Weather Data File Name**, and then restart the driver.



The problem is that weather station manufacturers often change the format of the station data log file. Additionally, the file format may also depend on the regional settings of Windows (characters used to separate numbers). This causes errors in reading data from the weather station data file.

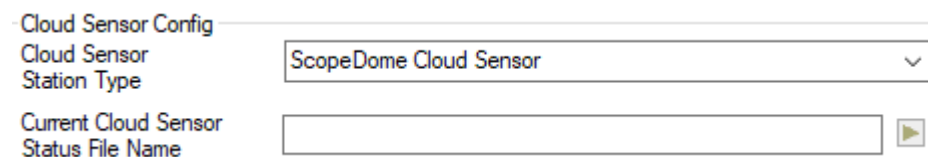
If you have difficulties connecting the weather station, please contact us. Usually we are able to help within a few days. Also, a remote service session may be necessary to solve the problem or you will need to send us your data log from the weather station and a link to its user manual.

**List of weather stations supported by the driver:**

1. ScopeDome Cloud Sensor
2. Heavy Weather
3. HeavyWeather PRO WS 2800
4. Boltwood Cloud Sensor (from current date log - eq. 2020-02-26.txt)
5. Boltwood Cloud Sensor (Single Line - New Format)
6. AAG CloudWatcher
7. Davis Vantage Pro
8. Sirene
9. Virtual Weather Station
10. Sentinel Weather Station
11. Cumulus
12. Weather Display
13. EMA
14. Davis Vantage Vue (WeatherLink)
15. EasyWeather v6.2
16. ASCOM Observing Condition Hub
17. ASCOM Open Weather Map
18. WeatherLink
19. SkyAlert
20. Weather Underground API


## Configuring the connection with the cloud sensor

The configuration of the cloud sensor is the same as for the weather station. To connect a cloud sensor to a driver, select its type from the list in the field **Config>Weather>Cloud Sensor Config>Cloud Sensor Station Type**, then indicate the log file saved by the sensor in the field **Config>Weather>Cloud Sensor Config>Current Cloud Sensor Status File Name**, and then restart the driver.



Cloud Sensor Config

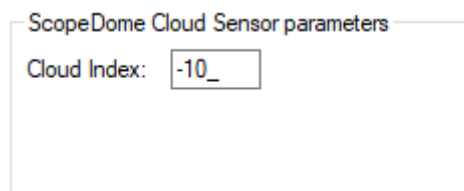
Cloud Sensor Station Type: ScopeDome Cloud Sensor

Current Cloud Sensor Status File Name:  

If the weather station has an integrated cloud sensor, it is enough to configure it only in the weather station section.

### Configuring the ScopeDome Cloud Sensor

ScopeDome Cloud Sensor to work properly requires entering the difference between the ambient temperature and the sky temperature read by the "Out Thermometer" and "Pirometer Sensor" respectively:



ScopeDome Cloud Sensor parameters

Cloud Index: -10\_

The value of this parameter depends on how the Cloud Sensor is installed. It should be aimed so that only the sky above the observatory is within its field of view, in particular it should not include surrounding trees or buildings.

For example, in Spain the optimal value seems to be -25 degrees. Entering an index equal to -27 degrees - will result in greater sensitivity to high clouds.

**Note:** After changing the "Cloud Index" parameter, it is necessary to save the settings ("Save Settings" button) and then send them to the card ("Send Config to Card" button).

### List of cloud sensors supported by the driver:

1. ScopeDome Cloud Sensor
2. Boltwood Cloud Sensor (from current date log - eq. 2020-02-26.txt)
3. Boltwood Cloud Sensor (Single Line - New Format)
4. AAG CloudWatcher
5. EMA
6. Tektite
7. Virtual Weather Station
8. ASCOM Observing Condition Hub
9. ASCOM Open Weather Map
10. SkyAlert

## Configuring the connection to the Sky Quality Meter

The way to configure the sky quality sensor (SQM) is the same as for the weather station or cloud sensor.

List of Sky Quality Meters supported by the driver:

1. SQM
2. SQM Reader 2
3. EMA
4. ASCOM Observing Condition Hub
5. ASCOM Open Weather Map

## Configuration of the shutter emergency closing conditions

Config

Card Dome Shutter **Shutter Events** Telescope Program Heating Weather WWW

Close shutter on input:

**Card inputs events**

☐ Cloud Sensor 5 s 3 clk

☐ Rain Sensor 5 s 3 clk

☐ Cloudy (Pirometer Sensor) 5 s 3 clk

☐ No Power 5 s 3 clk

☐ Low UPS Battery 5 s 3 clk

Battery threshold

Dome 11 V Shutter 12 V

**Software events**

☐ Lost internet connection 60 s 3 clk ☒ Enable Ip Watchdog

☐ Bad Weather 5 s 3 clk

☐ On time: 00:00:00 hh:mm:ss

☐ Shutter opened longer then 00:00:00 hh:mm:ss

IP address for internet connection test:

ScopeDome sky observatory About Save Settings Exit

This is one of the most difficult elements of the driver configuration. First of all, it is necessary to understand difference between **"Card inputs events"** and **"Software events"**.

**"Card inputs events"** are triggered by the corresponding card inputs and handled on the hardware level of the card. Which means that they will work always as long as the card has a power supply, regardless of whether the observatory's control computer is working at that time.

**"Software events"** are generated by the driver and operated from the level of the driver running on the observatory's control computer. For their correct operation, the computer in the observatory must be turned on, connected to the card and its driver must be running.

For example, the following entry means that the card will check the state of the "Cloud Sensor" input every 5 seconds and if this input is active three times in a row - the card will automatically start to close the shutter or the roof of the observatory.

Close shutter on input:

**Card inputs events**

☒ Cloud Sensor 5 s 3 clk

In other words, if the sensor is active three times in a row at 5-second intervals - the shutter will close. The time after which the shutter closes from the moment of activation of the "Cloud Sensor" input will be:  $5s \times 3clk = 15 \text{ seconds}$ .

**Note: Never enter a value of zero in the read frequency (s) and number of occurrences (clk) fields. This will cause the driver to hang.**

If during this time (15s) the sensor input stops being active for a while, the card will start counting the active state from the beginning and the shutter will not close. This avoids unnecessary dome closures in unstable weather conditions. The same applies to the other inputs of the card, both hardware and software.



## Description of the Card inputs events option

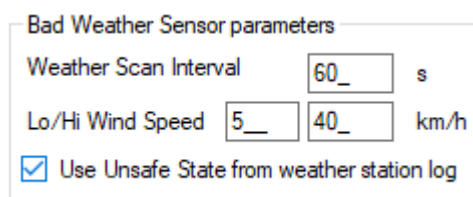
- **Cloud Sensor** – closes the shutter when the input of the "Cloud Sensor" card is active
- **Rain Sensor** – closes the shutter when the input of the "Rain Sensor" card is active
- **Cloudy (Pirometer Sensor)** – closes the shutter when **ScopeDome Cloud Sensor** will detect cloudiness - the operation of this option depends on the parameter value **Config>Weather>ScopeDome Cloud Sensor parameters>Cloud Index**
- **No Power** – closes the shutter when the card detects that 230V voltage is missing at the input of the "230V Sensor" card. This option is useful when the observatory is powered by UPS. The 230V sensor input should be connected before the UPS. If the UPS is not connected, this option will not work. The activation time of this sensor should be set in such a way that the UPS batteries allow the power supply to be maintained for the time necessary to close the observatory's shutter.
- **Low UPS Battery** – closes the shutter when the battery voltage in the UPS is too low. To use this option, connect the UPS's batteries to the "0-64 Voltage" input in accordance with the card manual (diagram on page 14) and enter the appropriate "Battery threshold" value.

## Description of the Software events option

- **Lost internet connection** – checks if the computer is connected to the indicated IP address. The checking consists in periodically sending PING to the indicated IP address (e.g. router address in the local network 192.168.1.1)
- **Bad Weather** – checks if Bad Weather input state is active
- **On Time** – closes the shutter at the specified time
- **Shutter opened longer then** – closes the shutter if it is open longer than the specified period of time
- **Enable IP Watchdog** – selecting this option and sending the settings to the card will make the card itself (without the computer's participation) ping the indicated address and, in the event of no answer, it will close the shutter
- **Ip address for internet connection test** – IP address used for Lost Internet Connection and IP Watchdog functions

The **Bad Weather** option integrates the status of all weather sensors from both card inputs, weather stations and the cloud sensor. It will be active when one of the sensors detects clouds, rain or too strong wind.

Set the maximum wind speed at which the dome can remain open, in the field **Config>Weather>Hi Wind**. The frequency of data readings from weather stations is set in the field **Config>Weather>Weather Scan Interval**:



Bad Weather Sensor parameters

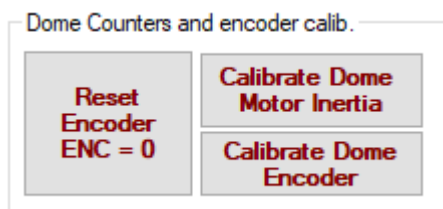
Weather Scan Interval  s

Lo/Hi Wind Speed   km/h

☒ Use Unsafe State from weather station log

- parameter „**Use Unsafe State from weather station log**” allows you to read the Unsafe status from the cloud sensor or weather station log. The option is especially useful for AAG Cloud Sensor users.

## Encoder counter reset



For the correct synchronization of the dome and telescope positions and for closing the shutters, the driver requires that the "Home Sensor" sensor is active while the encoder counter equals to zero (Enc = 0).

This is a very important function for users of 4M and 55M domes as well as other domes where the shutter card and drive is powered by power contacts operating only in the "**At Home**" position.

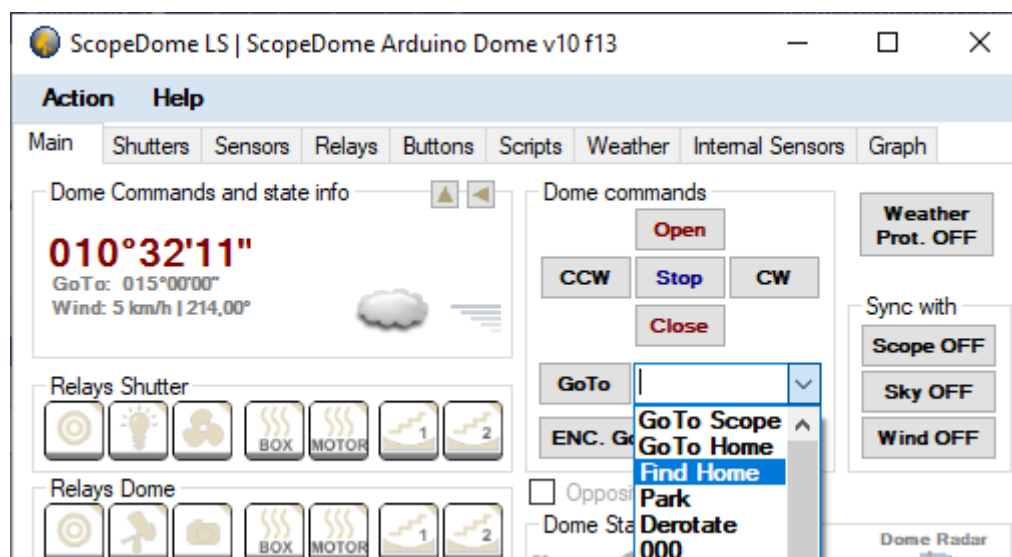
Due to the mechanical play (inaccuracies) on the gears and gears of the dome's rotation motor, periodically check that when encoder counter equal to **zero** (Enc = 0), the dome stops in the place of the "Home Sensor". It is worth doing such a test even once a month.

It also happens that the encoder counter in the "At Home" position has a value lower or higher than zero due to a hang of the card or computer controlling the dome. After this type of failure, always check the value of the encoder in the AtHome position.

### Manual encoder reset

If we are in a dome, it is usually the fastest to reset the encoder counter manually. First, rotate the dome using the CW or CCW buttons on the card - so that the **Home Sensor** is active, then press the button **Config>Card>Dome Counters and encoder calib.> Reset Encoder ENC = 0**. It is worth paying attention to the position of the diaphragm covering the Home Sensor. It should be positioned in the center of the black sensor inside the Home Sensor housing (approximately one third of the width of the Home Sensor housing).

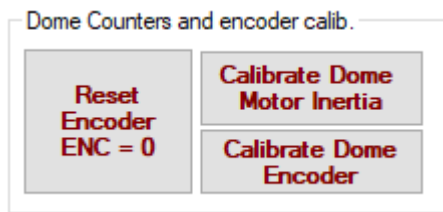
### Automatic finding of the encoder zero position



If the dome's rotary drive is working properly and the **Home Sensor** is working reliable, we can use the **Find Home** function from the main driver screen. The dome will start to rotate until it hits the Home Sensor.

## Encoder calibration

The **Calibrate Dome Encoder** function is available in the tab **Config>Card>Dome Counters and encoder calib.**



It allows you to check how many encoder pulses are counted per full turn of the dome. This feature will be especially useful for owners of domes from manufacturers other than ScopeDome. For ScopeDome, it is restored from the default values for the selected dome type.

**Note: The function will only work when the HomeSensor sensor is working - check its operation before starting.**

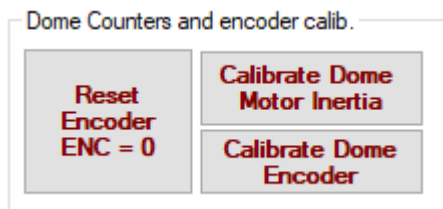
It is best to activate this function when the dome is in the **"At Home"** position - the At Home text on the driver's main panel must be shown in red color:



After pressing the **"Calibrate Dome Encoder"** button, the dome will move a few degrees in the CW direction, then it will start turning CCW, waiting for the next two Home Sensor activations. The number of pulses counted between successive Home Sensor activations will be saved in the field **Config>Card>Card configuration>Encoder value for 360°**. This value, together with the Home Sensor position, allows the dome shutter azimuth to be calculated in degrees.



## Dome motor inertia calibration



Function **Config>Card>Dome Counters and encoder calib.>Calibrate Dome Motor Inertia** is used to improve the accuracy of the function **Main>GoTo** i **Main>Enc GoTo**.

Thanks to it, the driver can take into account the inertia mass of the dome. The domes are quite heavy, e.g. a 3M dome weighs around 200 kg, and a 55M dome over 1000 kg. It is not easy to set them in motion, and even more so to stop them in a selected place with an accuracy of one encoder pulse, which corresponds to about 2mm of the dome circumference.

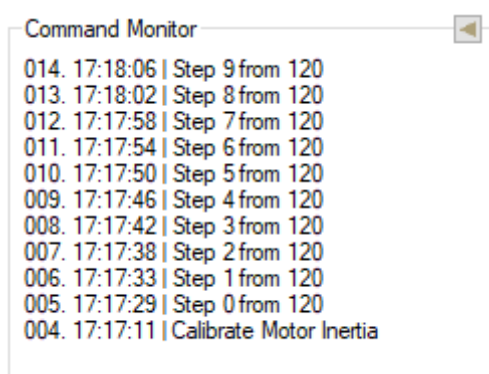
Thanks to this function, the dome will reach the given azimuth angle faster (without unnecessary position corrections). It is the similar to the backlash adjustment function known from telescope mounts.

For this function to work properly, it is necessary to check the operation of the Encoder and Home Sensor beforehand. The dome must rotate smoothly and without jamming around its circumference, and the encoder must return the correct values. Activating this function is also a great test of the dome's rotating mechanism.

After pressing the **"Calibrate Dome Motor Inertia"** button, the driver will perform 120 to 150 dome motion tests. This will take approximately 20 minutes. During the test, the driver will perform measurements as long as the number of encoder steps set by the EncGoTo function differs from the actual position reached by the dome, the measured results will be saved after the end of the test to the file *ScopeDome\_DomeInertia\_Table.txt*.

**Note: For ScopeDome 2M, 3M, 4M and 55M users, we have prepared typical files that are played back during driver configuration. So, as long as your domes are properly assembled, there is no need to follow this procedure.**

### Typical appearance of the program window during calibration



If an error message appears in any of the following steps, you should manually change the content in the file: *ScopeDome\_DomeInertia\_Table.txt* or repeat the entire calibration procedure. In case of problems, please contact us via email.

You can also just delete the wrong file: *ScopeDome\_DomeInertia\_Table.txt* and restart the driver. On the computer disk, in the c:\scopedome directory, a copy of the file from before the calibration procedure should be saved, it is enough to rename it to restore the previous values.

## Description of the contents of log files saved by the driver

### Arduino\_Commads\_Log.txt

- Logs all commands sent by the driver to the ScopeDome Arduino card except the GetStatus command.

### Arduino\_Error\_Log.txt

- Logs low-level errors reported by the card.

### ScopeDomeCard\_InternalSensors\_Log.txt

- Logs data on the values of all card inputs, saved every 30 seconds.

### Cloud\_Statistic.log

- Logs data from the sensor Cloud, records every 1 minute.

### ScopeDomeCard\_Log.txt

- Logs all operations from the user and from the ASCOM platform performed by the driver.

### ScopeDomeCard\_Error\_Log.txt

- Logs high-level errors reported by the card.

### ScopeDomeCard\_Log\_ASCOM.txt

- Logs the commands sent by the ASCOM platform to the driver.

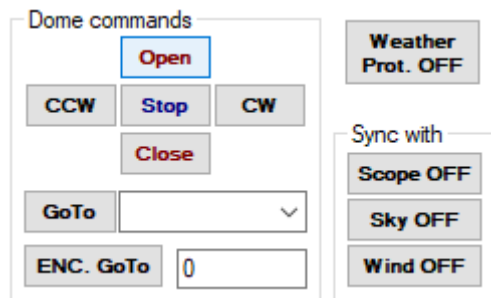
### Config\_Change\_Log.txt

- Logs configuration changes.

### Cloudy\_Sensor\_Status.txt

- Shows the current state of the Cloudy input (ScopeDome Cloud Sensor state).

# The most important functions of the driver



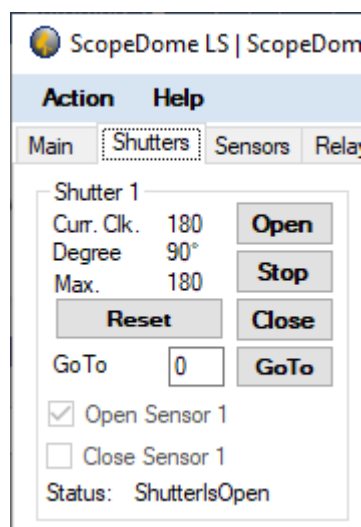
## Opening and closing the shutter

To open or close the dome's shutter, press the Open or Close button in the main program window. If the dome has more than one shutter, a sequence of commands will be automatically executed to open or close individual shutters in the order 3-2-1 for opening and 1-2-3 for closing. The active shutter of the dome can be defined in the window **Config>Shutter** selecting the option **Dome have shutter 1/2/3**.

☒ **Dome have shutter 1**

Additionally, in the **Shutters** tab, you can issue the shutter opening command only to specified angle selected in the **GoTo** field. If the dome has more shutters, you can open or close selected shutter individually in this tab.

The **Reset** button allows you to reset the counter or encoder of the shutter position. At the next sequence of opening/closing the shutter, the driver will automatically calculate the Max value (maximum value of the shutter position counter) - which will allow you to select the angle to which the shutter is to open.



## CW and CCW dome rotation

After pressing these buttons the dome starts to rotate in the selected direction as long as you hold down the left mouse button.

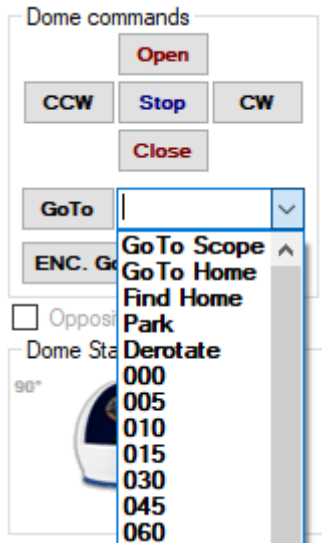
## Rotating to a selected angle - GoTo

Pressing **Main>GoTo** button causes the dome to rotate to the azimuth angle selected in the field next to the button. We can enter the angle manually or select it from the list. You can also enter a value, e.g. 5+ or 5, which will rotate the dome by 5 degrees from the current position.

Additionally, we can issue commands:

- GoTo Scope –rotation of the dome to the telescope position.
- GoTo Home –rotating the dome to the Home Sensor position.

- Find Home – the dome will start rotating until it finds the Home Sensor active.
- Park – rotation of the dome to the AtPark position defined in the window  
**Config>Dome.**
- Derotate – function intended for users of domes in which the shutter is wired. It allows the dome to be rotated in the opposite direction to the winding power supply cable of the shutter.

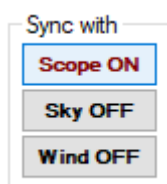


### Rotating to the selected encoder position - ENC. GoTo

In addition to rotating the dome to a given azimuth, we can rotate the dome to the selected encoder value. This function is useful when testing the operation of the Home Sensor, encoder and dome rotation motor. For example:

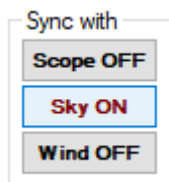
1. Set the dome manually on the Home Sensor (ENC: 0) - so that the Home Sensor is active.
2. Reset the encoder counter with the button **Config>Card>Dome Counters and encoder calib.>Reset Encoder ENC = 0.**
3. Rotate the dome several times to the ENC: 300 position and back to the ENC: 0 position.
4. Check if the dome still hits the Home Sensor - the AtHome marker must be displayed in red.

### Synchronization of the dome with the position of the telescope - Sync with Scope



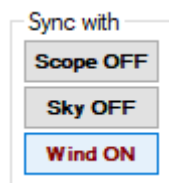
Pressing the **Scope OFF** button will cause the dome to synchronize its position with the position of the telescope. Once activated, the button will change its color and description to **Scope ON**. Of course, you must first configure the X, Y, Z, Gem, PierSide parameters and enter the coordinates of the observatory. It is also necessary to configure the connection to the telescope. The telescope must be synchronized with position on the sky.

## Sync with Sky



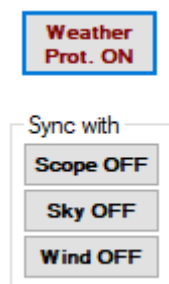
This is a function intended for visual observation - turning it on will cause the dome to make one rotation every 24 hours.

## Sync with Wind



Enabling this function will cause the dome to turn automatically with the shutter according to the direction of the wind. This is useful when strong winds are forecast that could damage the dome.

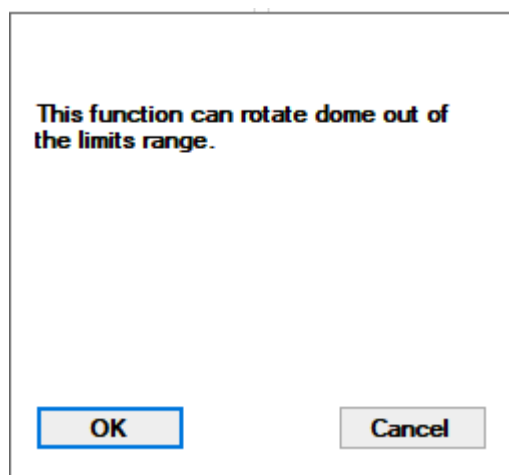
## Protection against bad weather - Weather Prot.



After enabling this function, the driver will automatically close the dome and force synchronization with the wind direction. The function is triggered by the **Bad Weather** marker. This allows you to be sure that in the event of rainfall or too strong wind, the dome will close by itself, without the user's intervention.

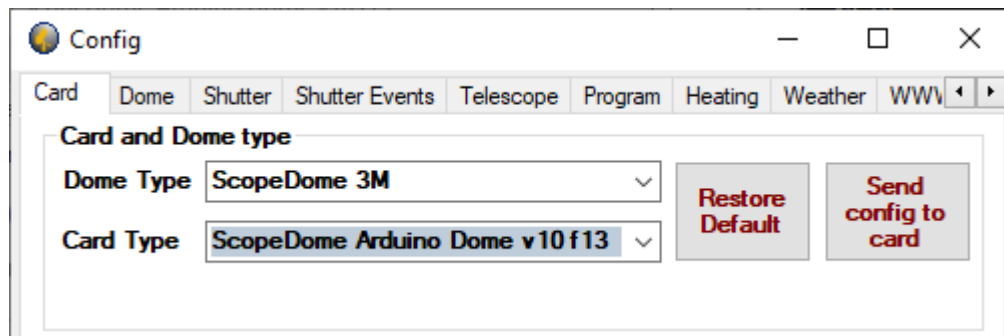
## Finding Home position

To find Home Sensor positions use the function **GoTo>Find Home**. When you select it from the list, a warning will be displayed that the dome may rotate outside the limits specified in **Config>Card>Card Configuration>Encoder Max Value/ Encoder Min Value**.





## Restoring the driver's factory settings and saving the configuration to a file



In order to restore the factory default settings of the driver:

1. Select the type of dome and card.
2. Press the **"Save Settings"** button at the bottom of the Config window.
3. Press **"Restore Default"** button.
4. Enter the method of connection with the card from the beginning.

## Upgrade firmware - the card's firmware

Firmware upgrade can only be done via USB connection. You should always upload the same software version to both cards: Dome and Shutter.

Please see the video on the website: [Facebook](#)

( <https://www.facebook.com/1338769339600016/videos/1483129165182748> )

# Typical card connection configurations

## ScopeDome 2M

Config

Card Dome Shutter Shutter Events Telescope Program Heating Weather WWV

**Card and Dome type**

Dome Type: ScopeDome 2M

Card Type: ScopeDome Arduino Dome v10 f13

Restore Default Send config to card

**Card Configuration**

USB Card Loop Time: 250 ms

Encoder DebounceTime: 2 ms

Sensors Debounce Time: 30 ms

Encoder Max Value: 15000 clk

Encoder Min Value: -15000 clk

Encoder value for 360°: 3240 clk

Dome inertia calibration steps: 120 step

Dome position compare precision: 10 clk

☒ Disable Derotate on Inertia Calibration ☐ Disable Calib. Request

☐ Negative Home Sensor

**ScopeDome Arduino Card**

Connect by: Ethernet

IP Address: 192.168.001.120

Password: default

COM port: COM11

Reset Master Reset Slave

**Dome Counters and encoder calib.**

Reset Encoder ENC = 0 Calibrate Dome Motor Inertia

Calibrate Dome Encoder

ScopeDome sky observatory

About Save Settings Exit

Config

Card Dome Shutter Shutter Events Telescope Program Heating Weather WWV

**Card and Dome type**

Dome Type: ScopeDome 3M

Card Type: ScopeDome Arduino Dome v10 f13

Restore Default Send config to card

**Card Configuration**

USB Card Loop Time: 250 ms

Encoder Debounce Time: 2 ms

Sensors Debounce Time: 2 ms

Encoder Max Value: 15000 clk

Encoder Min Value: -15000 clk

Encoder value for 360°: 3280 clk

Dome inertia calibration steps: 120 step

Dome position compare precision: 10 clk

☒ Disable Derotate on Inertia Calibration

☐ Disable Calib. Request

☐ Negative Home Sensor

**ScopeDome Arduino Card**

Connect by: Ethernet

IP Address: 192.168.001.120

Password: default

COM port: COM11

Reset Master Reset Slave

**Dome Counters and encoder calib.**

Reset Encoder ENC = 0

Calibrate Dome Motor Inertia

Calibrate Dome Encoder

ScopeDome sky observatory

About Save Settings Exit

**Config**

Card Dome Shutter Shutter Events Telescope Program Heating Weather WWW

**Card and Dome type**

Dome Type **ScopeDome 4M** Restore Default Send config to card

Card Type **ScopeDome Arduino Dome v10 f13**

**Card Configuration**

USB Card Loop Time 250 ms

Encoder Debounce Time 2 ms

Sensors Debounce Time 30 ms

Encoder Max Value 15000 clk

Encoder Min Value -15000 clk

Encoder value for 360° 4579 clk

Dome inertia calibration steps 150 step

Dome position compare precision 10 clk

☒ Disable Derotate on Inertia Calibration ☐ Disable Calib. Request

☐ Negative Home Sensor

**ScopeDome Arduino Card**

Connect by: **Ethernet**

IP Address: 192.168.001.120

Password: default

COM port: COM11

Reset Master Reset Slave

**Dome Counters and encoder calib.**

Reset Encoder ENC = 0 Calibrate Dome Motor Inertia

Calibrate Dome Encoder

**ScopeDome**  
sky observatory

About Save Settings Exit

Config

Card Dome Shutter Shutter Events Telescope Program Heating Weather WWW

**Card and Dome type**

Dome Type **ScopeDome 55M** Restore Default Send config to card

Card Type **ScopeDome Arduino Dome v10 f13**

**Card Configuration**

USB Card Loop Time 250 ms

Encoder Debounce Time 2 ms

Sensors Debounce Time 30 ms

Encoder Max Value 15000 clk

Encoder Min Value -15000 clk

Encoder value for 360° 5803 clk

Dome inertia calibration steps 160 step

Dome position compare precision 10 clk

☒ Disable Derotate on Inertia Calibration ☐ Disable Calib. Request

☐ Negative Home Sensor

**ScopeDome Arduino Card**

Connect by: **Ethernet**

IP Address: 192.168.001.120

Password: default

COM port: COM11

Reset Master Reset Slave

**Dome Counters and encoder calib.**

Reset Encoder ENC = 0 Calibrate Dome Motor Inertia

Calibrate Dome Encoder

**ScopeDome**  
sky observatory

About Save Settings Exit

**Config**

Card Dome Shutter Shutter Events Telescope Program Heating Weather WWW

**Card and Dome type**

Dome Type **ScopeDome Clamshell 3M**

Card Type **ScopeDome Arduino Clamshell v10 f**

**Restore Default** **Send config to card**

**Card Configuration**

USB Card Loop Time  **ms**

Encoder Debounce Time  **ms**

Sensors Debounce Time  **ms**

Encoder Max Value  **clk**

Encoder Min Value  **clk**

Encoder value for 360°  **clk**

Dome inertia calibration steps  **step**

Dome position compare precision  **clk**

☒ Disable Derotate on Inertia Calibration ☐ Disable Calib. Request

☐ Negative Home Sensor

**ScopeDome Arduino Card**

Connect by: **Ethernet**

IP Address:

Password:

COM port: **COM11**

**Reset Master** **Reset Slave**

**Dome Counters and encoder calib.**

**Reset Encoder ENC = 0** **Calibrate Dome Motor Inertia**

**Calibrate Dome Encoder**

**ScopeDome**  
sky observatory

**About** **Save Settings** **Exit**

**Config**

Card Dome Shutter Shutter Events Telescope Program Heating Weather WWW

**Card and Dome type**

Dome Type **ScopeDome RollOff Roof**

Card Type **ScopeDome Arduino RollOffRoof v1**

**Restore Default** **Send config to card**

**Card Configuration**

USB Card Loop Time  **ms**

Encoder Debounce Time  **ms**

Sensors Debounce Time  **ms**

Encoder Max Value  **clk**

Encoder Min Value  **clk**

Encoder value for 360°  **clk**

Dome inertia calibration steps  **step**

Dome position compare precision  **clk**

☒ Disable Derotate on Inertia Calibration ☐ Disable Calib. Request

☐ Negative Home Sensor

**ScopeDome Arduino Card**

Connect by: **Ethernet**

IP Address:

Password:

COM port: **COM11**

**Reset Master** **Reset Slave**

**Dome Counters and encoder calib.**

**Reset Encoder ENC = 0** **Calibrate Dome Motor Inertia**

**Calibrate Dome Encoder**

**ScopeDome**  
sky observatory

**About** **Save Settings** **Exit**

## Cloud Sensor Statistics

The driver, if it has a cloud sensor connected, saves data on the state of the sky and builds statistics based on it. This allows you to keep track of the quality of the sky above the observatory. For the statistics to be real, the computer controlling the card in the observatory must be running 24 hours a day.

Additionally in C:\ScopeDome\_Driver\AllSky directory thumbnails of photos from the “All Sky” camera can be automatically saved. To do this, select the option **Config>Weather>Archive photos in the AllSky subdirectory** and of course, configure access to photos from the “All Sky” camera.

All Sky Camera   
Ip, FileName or Directory

☒ Archive photos in the AllSky subdirectory

To convert the values, press the button **Weather>Update Statistic**

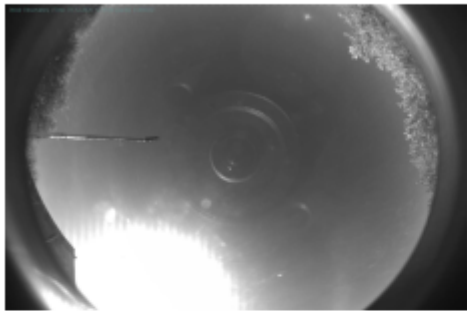
An example of statistics from the Otivar Observatory from October to the end of December 2020.

ScopeDome LS | ScopeDome Arduino Dome v10 f13


ActionHelp

MainShuttersSensorsRelaysButtonsScriptsWeatherInternal SensorsGraph

All Sky Cam View



Cloud Sensor



SQM

Cloud Sensor Status

2020.12.31 12:30:01

Day/NightDay

CloudsClear

RainNo Rain

WindNo wind

Safe SwitchOpened

Weather Condition Info

Good Weather

you can open shutter

WeatherStation

2020-12-31 12:29:31

Wind Speed4 km/h

Wind Gust4 km/h

Wind Direction140°

Indor Temp.0 °C

OutDor Temp.13,5 °C

Indor Hum.0 %

Outdoor Hum.44 %

Dew Point-2 °C

Pressure1001,32 hpa

Rain0 mm/h

Solar Radiation279,8 W/mkw

Cloud Sensor Statistic (% of clear sky) — Log data from: 2020-10-04 (10347)

	Global	Year	Month	Week	Day	Hour
Day	74 %	74 %	72 %	86 %	100 %	100 %
Night	72 %	72 %	69 %	89 %	100 %	NaN %
All	72 %	72 %	70 %	88 %	100 %	100 %

Update Statistic

Enc: -1094| C: 513| S: 534|



# Additional software

Additional utility software is installed with the driver in *the Driver\_LS* subdirectory. Necessary shortcuts to these programs are installed in the Windows menu.

## Arduino\_Test\_App.exe

With this program, you can fully configure all the parameters and operation of the Arduino ScopeDome card. It is a utility for advanced users to test and diagnose the card. It should not be used as a tool for operating the observatory. It will certainly be helpful for people who want to write their own card control software.

In the **Card** tab, configure the connection parameters with the card and then press **Save Settings**. After setting the connection parameters, press the **Connect** button. This is the only place in the program that allows you to change the IP address, MAC and password to access the card. If you use several ScopeDome cards in one network, each of them must have a different **IP** address and a different **MAC** address. The default IP address saved to the card configuration is 192.168.1.120. Pressing the **Get Status** button will cause the current status of the card to be read once. The **Start** button causes repeated (at intervals set in the **Card Status Reading Interval** field) sending of the command selected in the **Command** field to the card.

In the **Status** tab you can read the current card status.

The **Status Txt** tab displays the answer from the card in a clearer way, broken down into sections.

The **Thermometers** tab is used to configure the operation of the card's thermometers and thermostats.

The **Emergency Shutter Close** tab allows for advanced configuration of emergency shutdown conditions of the dome shutters.

## Changing the IP and MAC address of the card

The new IP or MAC address should be entered after the field **Card>Ip address**, then press the **Save Settings** button.

## Turning on selected thermometers

With these options, you can enable or disable all or only selected thermometers on the card. The **Board** option allows you to select the card you want to program (Dome or Shutter). **Master**

**Preset** and **Slave Preset** options are used to restore the typical ScopeDome driver settings of the card.

### Activating selected thermostats

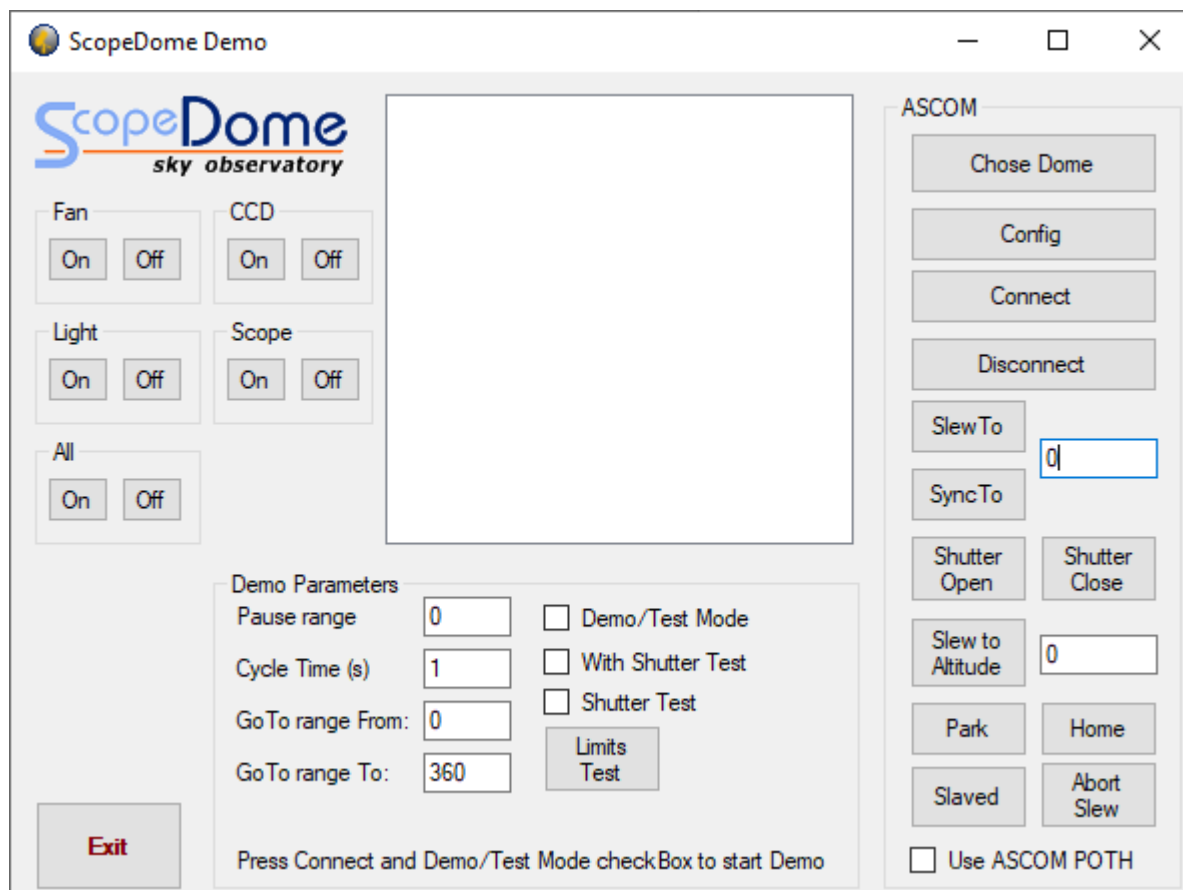
Board	Enable/Dis	Thermometer	Mode	Relay	Set On °C	Histeresis °C	Compare To	
master	Disabled	none	none	none	20	0.5	none	setThermostat
Master Preset		Slave Preset		Set All Preset		Clear All		

**Clear All** disables all thermostats on the selected tab.

The thermostat, based on the temperature, pressure or humidity read from the selected thermometer, can turn on or off the selected relay depending on whether the set temperature has been reached (**Set On °C** field). In other words, it enables, for example, the heating of a telescope's motor or mirror to a preset temperature, of course if a heater is connected to the selected relay. An interesting feature is the ability to turn on the heating depending on the value of a different thermometer - it allows, for example, to heat the telescope's mirrors by 2 degrees above the ambient temperature.

Board	Enable/Dis	Thermometer	Mode	Relay	Set On °C	Histeresis °C	Compare To	
master	Enabled	Ow1	Heater	PWM_1	2	0.1	Ow2	setThermostat
Master Preset		Slave Preset		Set All Preset		Clear All		

**Note:** Pushing the "Send Config to card" button in the ScopeDome driver will overwrite all changes made with this program, except the card's IP address.



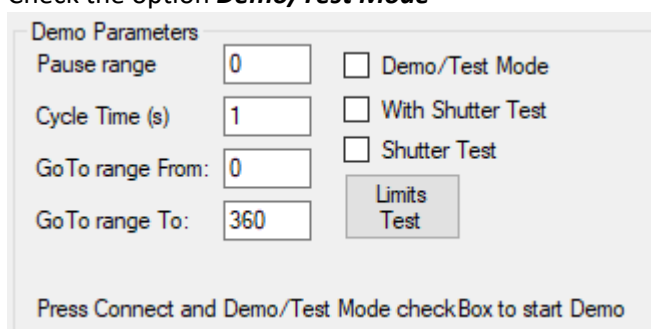
With this program you can:

- Perform a random rotation and dome opening test.
- Configure the card in a situation when the card driver freezes after the changes made by the user.

## Random test of dome operation

To run the test:

1. Press button **ASCOM>Connect**
2. Enter the range of rotation angles **Demo Parameters>GoTo Range From / To**
3. Check the option **Demo/Test Mode**



## Emergency launch of the Config window

After starting the program, press the button **ASCOM>Config**