OnStep GOTO Quick Start Guide
for Hubble Optics
UP12G/UL14G/UL16G/UL18G/UL20G/UL24G
(06/14/2024)

1 Introduction

The state-of-the-art OnStep GoTo controller, designed by Howard Dutton, is extremely powerful and feature-rich. However, this document will only explain the basic configuration and operation applicable to Hubble ULXXG scopes. For advanced users who want to explore the full potential of the OnStep controller, please refer to the OnStep Instruction Wiki.[OnStep instruction WiKi](#)

The Hubble OnStep controller supports:
- INDI (WiFi) and ASCOM (WiFi, Bluetooth, and USB) under the LX200 protocol.
- WiFi 802.11n/g/n connection with a built-in website accessible from any browser on any platform, and direct WiFi support for Sky Safari and Stellarium.
- Bluetooth classic 4.2 support for host computer ASCOM connection and direct wireless support to Sky Safari & Stellarium.
- iOS App and Android Virtual Handpad Apps for controlling the scope, including initialization, configuration, alignment, and movement (slewing and GoTo). You are strongly recommended to use the Android-based OnStep Controller2 for the initial setup!
- Smart Hand Controller with approximately 30,000 objects. Although the scope can be fully controlled — including initialization, configuration, alignment, and movement (slewing and GoTo) — without any other device needed, the use of the Android-based OnStep Controller2 is strongly recommended for the initial setup!
- Telescope Encoders for extra accuracy in pointing and tracking.
- Real-Time Clock (RTC): The RTC module maintains seconds, minutes, hours, day, date, month, and year information.

Please refrain from flashing the OnStep firmware on the controller and handpad independently without prior consultation with Hubble Optics. Failing to adhere to this directive may result in damage to the controller and/or handpad and will consequently void the warranty.

MPORTANT: Safety Warning Regarding Stepper Motors and Electrical Equipment

Stepper motors are powerful and, if misused, can cause extreme damage to equipment and pose significant risks to human life. Exercise utmost caution to ensure that your telescope does not move to a mechanical limit, such as the ground, to prevent damage to motors or gears and avoid injury to yourself and others. This product is NOT a toy and should not be operated by children.

Adhere to the following safety precautions rigorously:

- Avoid utilizing the equipment in adverse conditions.
- Be mindful of electrical safety: shocks and bodily injuries can occur if devices using electricity are mishandled, particularly outdoors. Proper setup and operation are vital to prevent electronic components from shocking, overheating, melting, or exploding.

Specifically:

1. **Avoid Wet Conditions**: Never operate the equipment or handle cabling if it is wet or moist, or if there's even a slight chance that parts of the equipment may be damp.

2. **Ensure Proper Grounding**: Connect all grounding points to the battery (-) terminal before powering on any equipment. Never disconnect the grounds while the unit is powered on.

3. **Avoid Reversing Power Leads**: Ensure power leads are not reversed. Misconnection will certainly cause component failure. Components may overheat and explode with violent force.

4. **Mechanical Limits**: Be mindful to prevent your telescope from moving to a mechanical limit (like the ground) to avert damage and injury.

5. **Voltage Caution**: Utilize 12VDC – Even though the controller can operate between 12V-24VDC. We recommend 12VDC only, for many reasons. WARNING: DC voltages higher than 12 volts can be lethal upon shock!

6. **Avoiding Cable Wrapping:** Ensuring that cables do not wrap around ALT pulleys is vital for safety and maintaining equipment integrity. The ALT pulley can easily break the cable, resulting in a short circuit, a potential electric shock, and significant damage. It is strongly advised to attach a battery to the telescope rocker, ensuring that all cables stay stationary relative to the OTA as the telescope moves. It's essential to select the battery that can deliver a constant 12VDC output, as not all products guarantee this.

It's imperative to observe these safety guidelines strictly. Your wellbeing and the integrity of your equipment depend on cautious and correct operation. If uncertain about any procedure, please consult the product manual or contact customer support.

2 Hardware Setup
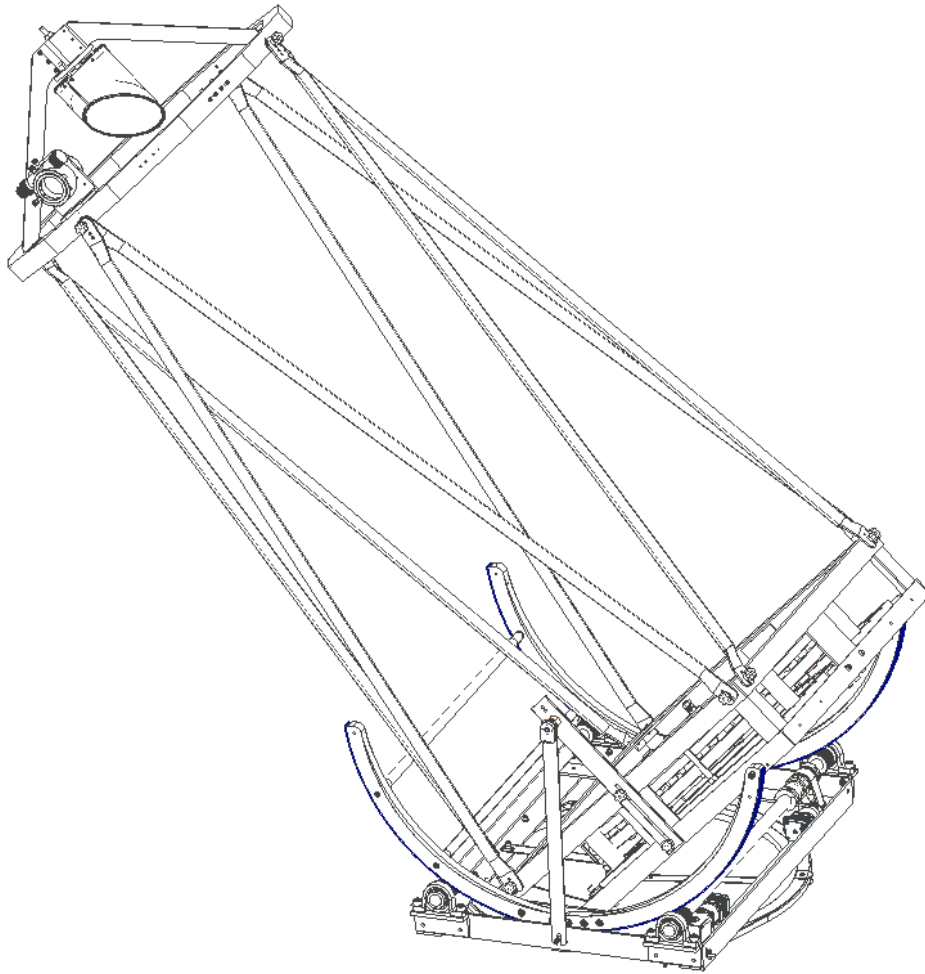
UL24G

The sketch below illustrates the vital components of the OnStep control system. Note that the following features and functions are optional and not provided by default:

Rotator and Focuser Control: These functionalities are not enabled and not included.

Home Switches: The necessary wiring for home switches is not provided.

Limit Switches: While the features for limit switches are enabled, the actual limit switches and necessary wiring are not included.
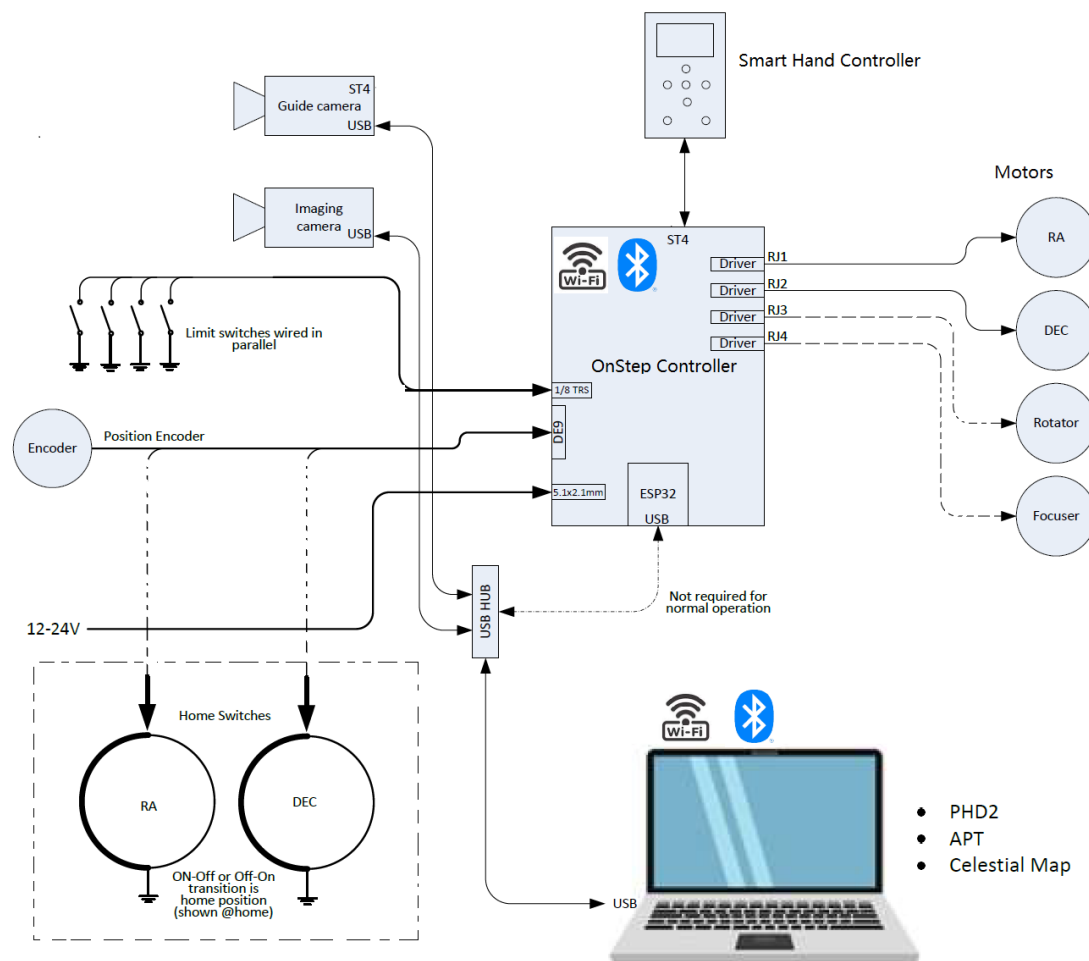
3 OnStep drivers Installation

To install the OnStep ASCOM driver, you will need to use a PC based on the MS Windows operating system. For utilizing the OnStep INDI driver, a Raspberry Pi system is required. Notably, the OnStep INDI driver is included in the standard Astroberry releases.

Please proceed as follows:

For the ASCOM Driver:
- Download and install the latest ASCOM platform.
- Subsequently, install the OnStep ASCOM driver, which can be obtained from: http://www.stellarjourney.com/index.php?r=site/software_telescope

4 OnStep GoTo Controller
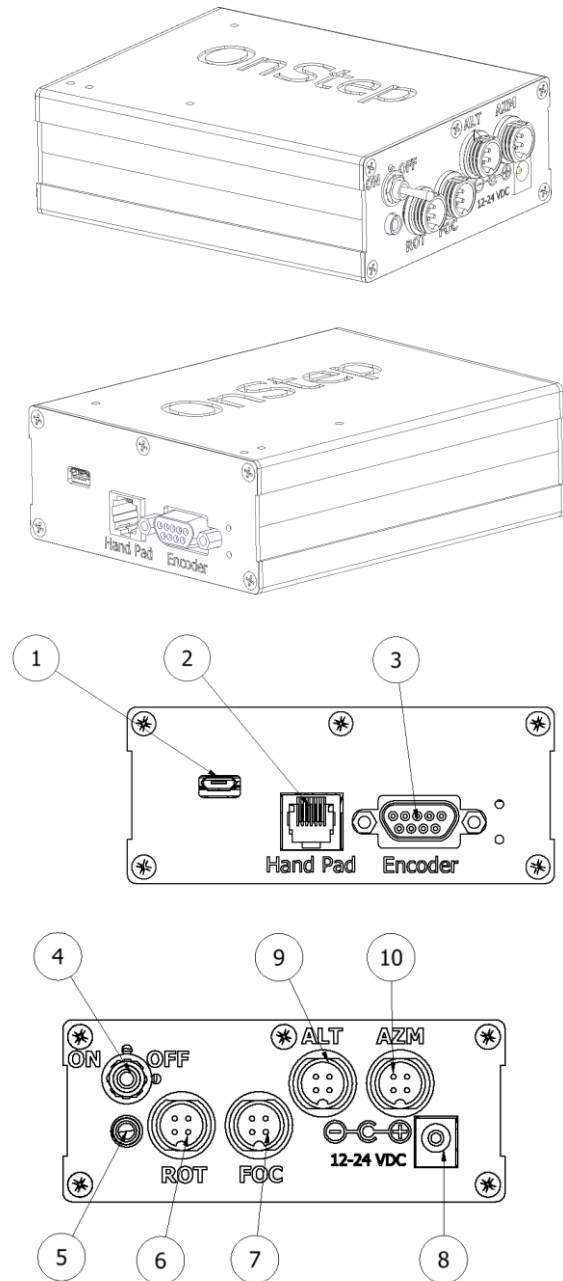

OnStep Controller

1. **USB Port**
2. **ST-4/Smart Hand Controller Port**
3. **DB9 Encoder Port**
4. **Locking Toggle Power Switch:** This switch features a safety mechanism to prevent accidental toggling. To change the switch positions, the toggle actuator

must first be pulled upward (or outward) in a "pull-to-unlock" motion. Only then can the switch's position be altered.
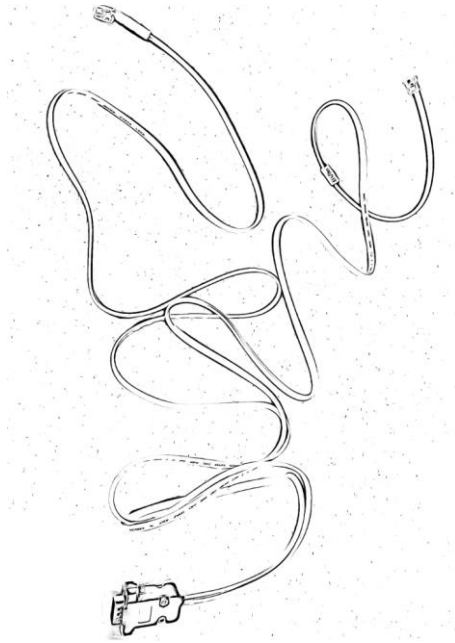
5. **Auxiliary Port (For limit switches)**
6. **Optional Rotator Motor Port**
7. **Optional Focuser Motor Port**
8. **Power Supply Socket (5.5-2.1mm, center positive)**
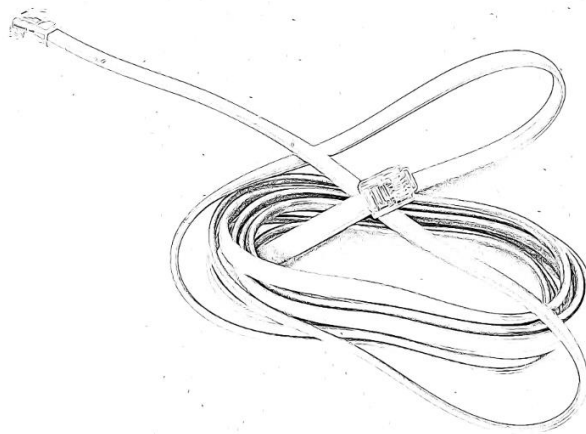9. **ALT Axis Motor Port**
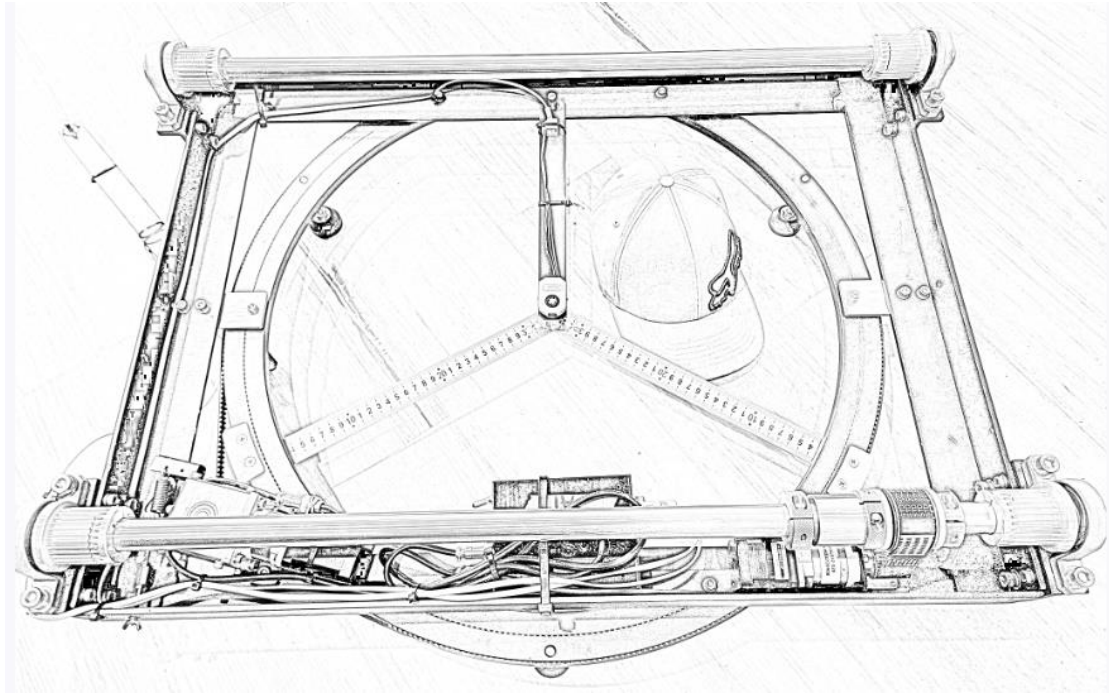10. **AZM Axis Motor Port**

Power Cable
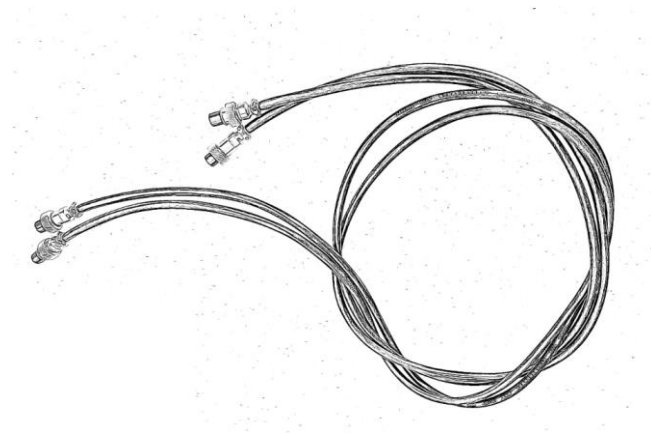
Motor Cables

Encoder Cable

Smart Hand Pad Cable

UL24G Cable Management

4.1 Power Supply

The controller features a 5.5mm-2.1mm power connector (center positive). Ensure to utilize a regulated supply or battery; a 12VDC supply with a 3-amp capacity is recommended. If employing a 12VDC battery, ensure it can maintain a constant 12VDC output.

WARNING:

- Power Supply Polarity: Pay keen attention to the power supply polarity for the OnStep controller! The wire with the white stripe is positive. Reversing the power connections will likely blow the fuse and potentially damage other components.
- Voltage Caution: DC voltages exceeding 12 volts can be lethal upon contact!
- Motor Cable Management: Do not disconnect the motor cable while the unit is powered on.
- USB Connection Protocol: Preferably, power on the unit before connecting the USB cable to the USB port. Always disconnect the USB cable before powering off the unit.

4.2 LED Operation
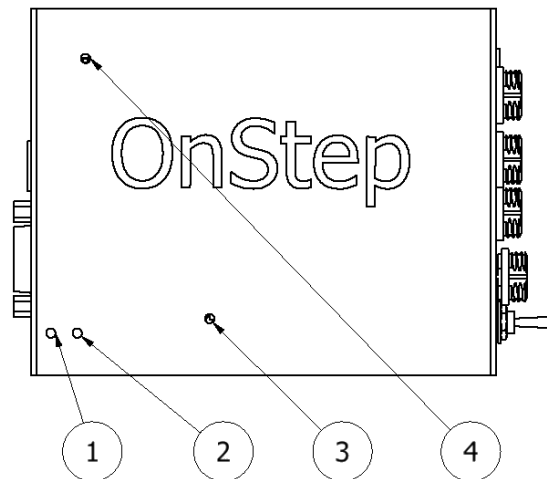
1. Power Supply LED
2. Scope Tracking LED
3. WiFi Status LED
4. CPU Status LED

The controller is equipped with four LEDs, labeled as LED 1, LED 2, LED 3, and LED 4. These LEDs serve to keep you informed about the controller's status and activity.

- LED 1 indicates the Power Supply status: It should remain illuminated while the controller is powered on.

- LED 2 reflects the scope's tracking status: It flashes while tracking and remains steadily illuminated otherwise.

- LED 3 indicates the status of the WiFi service: A flashing LED signifies that the WiFi service is being established, while a steadily illuminated LED indicates that the WiFi service is ready.

4.3 DB9 Encoder Port Connection

The RS232 serial port is a 9 pin modular jack which is mainly used for the telescope encoders. But it can also be used by other purpose.

Pin 1: Ground
Pin 2: Vsel (5V)
Pin 3: Encoder 1B, encoder 1 input B
Pin 4: Encoder 2B, encoder 2 input B
Pin 5:
Pin 6: Aux3, typically used for a Home SW on RA or Azm but can be used any purpose (dew heater for instance, on/off switch, etc.). Not wired and not enabled.
Pin 7: Aux4, typically used for a Home SW on Dec or Alt but can be used any

purpose (dew heater for instance, on/off switch, etc.). Not wired and not enabled.
Pin 8: Encoder 1A, encoder 1 input A
Pin 9: Encoder 2A, encoder 2 input A

5 Smart Hand Pad

The user can Configure, Initialize & Align the mount, Park, and find/goto celestial objects using the Smart Hand Pad. The objects include Moon, the Planets, and several catalogs: NGC/IC, Herschel 400, Messier, the named bright stars, and variable stars etc, about 30,000 objects in total.

The main display is the Alt, Azm, or RA and Dec that the telescope is currently pointing at; you can toggle between the Alt/Azm and RA/Dec by single clicking the center button. A small telescope icon with an H under it, means the telescope is in the Home position When the telescope is slewing, a double triangle will show. When it is tracking, a single triangle will show, as well as the pier side, and the tracking rate ('s' for sidereal).

- Press any of the N, S, W, E buttons to move the telescope

- Press the center (+) button to wake up the screen

- Press it again to cycle through status displays (RA/Dec coordinates, Alt/Az, Local/Sideral Time)

- Quickly press the center button twice to get to the Speed menu

- Long press the center button for the menu

    o Goto
    o Sync
    o Align
    o Parking
    o PEC
    o Settings

- Select a menu by the Up or Down button, then Right to enter that menu
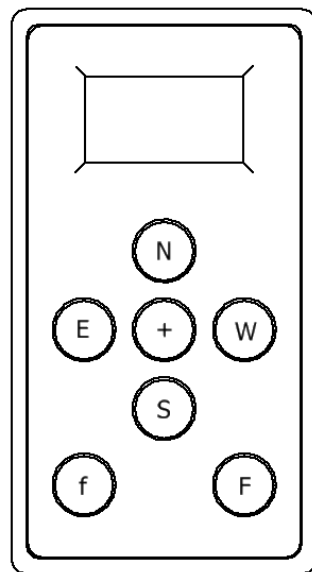
Smart Hand Controller (SHC)

5.1 Initialization Sequence
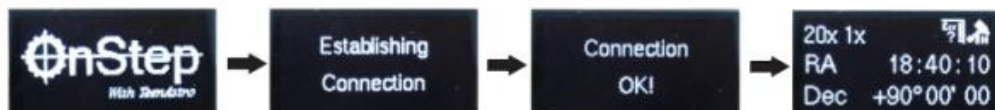
5.2 Starting Up

When the SHC is powered up an "OnStep" splash screen will appear for a few seconds then it'll tell you it's trying to connect. At this point the SHC presents a signal to OnStep on it's ST4 port to indicate that a SHC is present. After a couple of seconds OnStep re-configures the ST4 port lines for synchronous serial comms and the SHC will start displaying the status information across the top line (guide rate, pulse-guide rate, and a series of icons as described below) and the RA and Dec below that.

5.3 Button Functions

N： North when slewing or Scroll Up while in Menu's

E: East when slewing or Back while in Menu's

+: Short Press = Scroll Information screen, Long Press = Main Menu, Double Click = Feature Menu

W: West when slewing or select current option while in Menu's

S: South when slewing or Scroll Down while in Menu's

f: Decrease currently selected Feature

F: Increase currently selected Feature

5.4 Use Key functions:

- When at the main info display page, pressing [N],[S],[E],[W] guides in that direction at the rate selected (see below).
- When at the main info display page, a click on [+] cycles through the display of RA/Dec, Alt/Az, Time, and (optionally) ambient conditions.
    - When doing an align, a click of the [+] key instead accepts the align star once you've centered it using [N],[S],[E],[W]
- When at the main info display page, a double click on [+] brings up the **Feature key** selection menu where you can scroll to among guide rate, reticle light, utility light, focuser, or rotator for the [f] and [F] key action. Pressing the [W] key at this point makes the selected menu item the **Active Feature**.

    - Pressing the [f] (decrease) or [F] (increase) keys then adjusts the selected feature

    - When doing an align, a double click of the [+] key instead allows selecting a different align star (after the goto to the prior align star completes). Also, during an align, the [f] and [F] keys work only for guide rate selection.
- A long press on [+] brings up the menus
    - The [N],[S] keys then move up/down the menu selections.
    - The [W] key selects a menu item.
    - The [E] key navigates back to the prior level.

5.5 Icons

Alignment Star #1

Alignment Star #2 (#3 thru #8 not shown)

Alignment Star #9 (last possible)

Telescope is at home position. Tracking is OFF

Unknown error. Tracking has stopped

Telescope position exceeds user defined Meridian limit. Tracking has stopped

Err Up! Telescope position exceeds user defined RA limits "Under Pole". Tracking has stopped

Err Az! Telescope position exceeds user defined Azimuth limits. Tracking has stopped

Err De! Telescope position exceeds user defined Declination limit. Tracking has stopped

Err →| Telescope limit sensed. Tracking has stopped

Err ↗↙ Telescope position exceeds user defined Horizon or Overhead limit. Tracking has stopped

Err MF! Motor fault. Tracking has stopped

(E) East side of pier. Declination is between 90 and -90

(W) West side of pier. Declination is between 180 and 90 or -90 and -180

P PEC, paused

P PEC, recording

P PEC, playing

▶▶ Telescope is slewing

▶C Lunar Tracking rate is selected

▶⊙ Solar Tracking rate is selected

▶K King Tracking rate is selected

▶★ Sidereal Tracking rate is selected

 Sidereal Tracking, refraction compensated (RA-axis only)

 Sidereal Tracking, refraction compensated (Dual-axis)

 Sidereal Tracking, refraction and pointing model compensated (Full)

 Sidereal Tracking, refraction and pointing model compensated (Full, Dual-axis)

 Tracking is OFF

 Telescope is guiding

 Park failure

 Telescope is slewing to park position

 Telescope is parked

5.6 Menu structure 3.x

The following is a map of the menu structure of the SHC as of version 3.x.

- Words that are in a normal font appear on the screen exactly that way (in the English-localized configuration).
- Anything in square brackets provides information that does not appear on the screen and is an interpretation of what the function means.
- The indentation level is intended to reflect the submenu nesting.

5.6.1 Main Menu [center button long press]
5.6.1.1 Goto
5.6.1.1.1 Stars
- Bright Stars [408 stars brighter than 4th magnitude]

- STF** [Struve The Father (Friedrich) double stars]

- STT** [the other Struve (Otto) double stars]

- GCVS~* [General Catalog of Variable Stars]

5.6.1.1.2 Deep Sky

Messier, Caldwell, Herschel400, Collinder, NGC, IC

5.6.1.1.3 Solar System

Sun, Mercury, Venus, Mars, Jupiter, Saturn, Uranus, Neptune, Moon

5.6.1.1.4 User

[Select from up to 16 user catalogs uploaded through SmartWebServer or Sky Planetarium interface]

5.6.1.1.5 Filter

[Define filters for catalog objects displayed on 'Stars' and 'Deep Sky' menus. If the selection as displayed is prefixed and suffixed by a small dot it means a filter has been set for that property. Initially, the 'Above Horizon' property is the only one set]

Reset Filter

Above Horizon

Constellation

[A list of the standard 88 IAU constellation names]

Type

All, Galaxy, Open Cluster, Star, Double Star, Other, Galaxy Pair, Galaxy Triplet, Galaxy Group, Globular Cluster, Planetary Nbla, Nebula, Hii Region, Cluster+Nebula, Asterism, Reflectn Nbla, SuperNov Rmnt, Emission Nbla, Non Existant, Nova, Duplicate, Dark Nebula

Magnitude

[for selections other than All, the magnitude is followed by an estimate of the minimum telescope aperture required to see the object]

All, 10th, 12th, 13th, 14th, 15th, 16th, 17th

Nearby

[angular distance from current position, does not mean distance from Earth]

OFF/Within 1, Within 5, Within 10, Within 15 [degrees]

Var* Max Per.

[maximum period for variable star filter]

Off, <=0.5, <=1.0, <=2.0, <=5, <=10, <=20, <=50, <=100 [days]

Dbl* Min Sep.

[minimum separation for double star filter]

Off, >=0.2", >= 0.5", >=1.0", >=1.5", >=2.0", >=3.0", >=5.0", >=10", >=20", >=50" [arc-seconds]

Dbl* Max Sep.

[maximum separation for double star filter]

Off, <=0.5", <=1.0", <=1.5", <=2.0", <=3.0", <=5.0", <=10", <=20", <=50", <=100" [arc-seconds]

5.6.1.1.6 Coordinates
[You can enter arbitrary RA/Dec coordinates here (e.g. comet or asteroid coordinates obtained from sources like a planetarium program)]

5.6.1.1.7 Spiral Search
[New as of version 3.02a. If your alignment is poor and a 'Goto' did not put the object in the field of view or you want to browse around an extended object like M42 in a spiral pattern, this function initiates a spiral search at the current guide rate around the current position. Press any button to stop.]

5.6.1.1.8 Last
[New as of version 3.02d. If you didn't locate the object using the Spiral Search function, perhaps because it was moving too slowly or too quickly, this option will return to the last used 'Goto' coordinates where you could change the guide rate and try again.]

5.6.1.1.9 Home
[Will prompt for confirmation of model clearance. Use N/S to toggle Yes and No ('Yes' clears the model and returns to the home position, 'No' aborts the Goto Home command). If you do not want to lose the model because the telescope will not be moved since the last alignment you should use the 'Park' function.]

5.6.1.2 Sync
['Stars', 'Deep Sky' and 'Solar System' will sync the telescope to the coordinates of the object selected without moving the telescope. You are expected to have centered the object already]

Stars

[Same selections as Goto, Stars]

Deep Sky

[Same selection as Goto, Deep Sky]

Solar System

[Same selection as Goto, Solar System]

Here

[syncs to the last Goto coordinates]

5.6.1.3 Align
1..9-Star Align

[e.g. '1-Star Align', '2-Star Align', '3-Star Align', etc.]

Show Model

[shows pointing model coefficients derived from the alignment points]

Clear Model

[clears the model]

Reset Home

[sets OnStep position to home after physical telescope movement to home]

5.6.1.4 Parking

Park

[move telescope to park position (default is home position) and save the alignment model in preparation for power down]

Un-Park

[when powered up at park position following use of Park command in previous session, restores the alignment model and starts tracking]

Set-Park

[used to define a custom park position at the current axis locations]

5.6.1.5 Tracking
Start / Stop

[The following 3 selections set the tracking rate to the standard for stellar objects, the sun or the moon]

- Sidereal

- Solar

- Lunar

Rate Reset

[Reset tracking rate to a standard rate]

[use the following to adjust tiny tracking rate errors due to gearing parameter inaccuracies]

Rate +0.02Hz

Rate -0.02Hz

5.6.1.7 Settings
Date/Time

[Set local date and time. Questions are asked about whether the time was AM or PM (if the SHC was configured with DISPLAY_24HR_TIME OFF) and whether the time was a DST-adjusted time]

Site

Select Site

[Select one of 4 user-defined sites. If the controller gets site data from a GPS, when received it is always stored in 'Site 1' with the name of 'GPS']

Latitude

Longitude

UTC Offset

[this is the inverse of your timezone offset, e.g. +5 for North American Eastern which is defined as -5 as a time zone. Do not adjust this for Daylight/summer time... the stars don't care about that]

Display

Turn off

[Press any key to turn on. That first key press is ignored so there's no worry it will cause a telescope motion]

Contrast [also known as brightness]

Min, Low, High, MAX

Dim Timeout

[dims display after key inactivity interval]

Disable, 30 or 60 seconds

Blank Timeout

[blanks display after key inactivity interval. On the wireless SHC it is advisable to use '1 minute' so that the unit spends the maximum amount of time in low-power mode.]

Disable, 1, 2, 3, 4 or 5 minutes

Buzzer [On or Off]

5.6.1.8 Configuration

Goto Speed

[Sets the Goto speed to 2x, 1.5x, 1x, .75x or .5x of the configured SLEW_RATE_BASE_DESIRED, respectively]

Fastest, Faster, Default Speed, Slower, Slowest

Backlash

[sets gear backlash for axis 1 and 2]

Axis1 RA/Az, Axis2 Dec/Alt

Limits

Horizon Limit

[Sets number of degrees telescope is allowed to point below the horizon while tracking or slewing]

Overhead Limit

[Sets number of degrees above the horizon that the telescope is allowed to point while tracking or slewing. This is important for Alt/Az telescopes especially because of the 'Dobson hole'. For others it prevents crashing the bottom of an OTA into a pier or tripod.]

Meridn Limit E/Meridn Limit W

[For GEM or FORK mounts, sets how close the telescope is allowed to track to the meridian before a meridian flip is required (tracking stops if meridian flip is not automatic)]

Pier Side

[Sets the 'preferred pier side']

Best, East, West

Firmware Ver

5.6.2 Feature Key menu

[Center button double tap. Select desired Feature [N] [S] to scroll, [W] to accept then press f or F button to alter selected feature. Depending on configurations not all of these selections may be present]

Guide Rate

[Select guide rate between 2x and Max slew speed]

Pulse Guide Rate

[Select pulse guide rate between 1/4x and 1x]

Utility Light

[Off or one of 5 levels]

Reticle

[Increase or decrease brightness]

6 Telescope Encoder Wiring and Setup

Once your encoders are properly wired, you can connect any device to the controller via WiFi and navigate to http://192.168.0.1 using a web browser to verify the connection and direction of the encoders. On the webpage's main screen, observe the encoder values as the telescope moves; these should alter concurrently and should closely align with the motor's values. Specifically:

- The altitude numbers should increase when elevating the telescope.
- The azimuth values should ascend as the telescope rotates clockwise.

Should the encoder values deviate in reverse, you have the option to invert the telescope encoder(s) under the "Encoder" tab. For detailed instructions, please refer to Section 7.

7 Using Browser to Configure and Control the Controller

After completing the mechanical configuration of the motors, ensuring the controller, power supply, handpad, and motors are all connected, and setting up the telescope encoders (if utilized) with proper cabling, it's time to update the controller with vital information about your mount via a web browser.

- Connect to the OnStep Ad-Hoc WiFi network.
- Navigate to http://192.168.0.1 in your browser.

Upon access, the first screen will present the status of the scope:
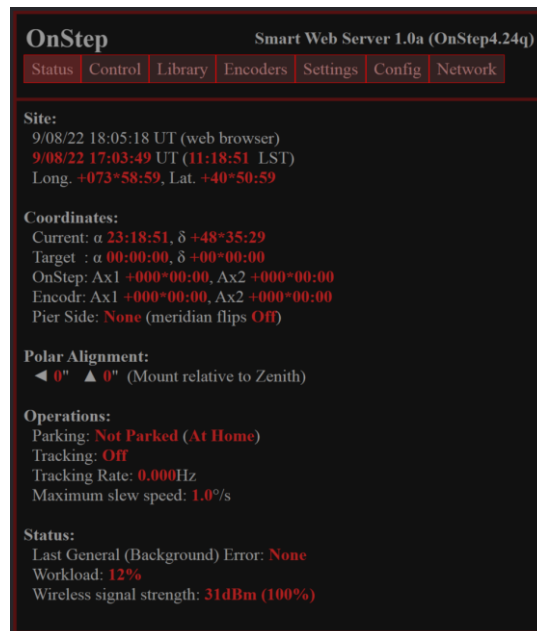
You can control the scope under the "Control" tab:
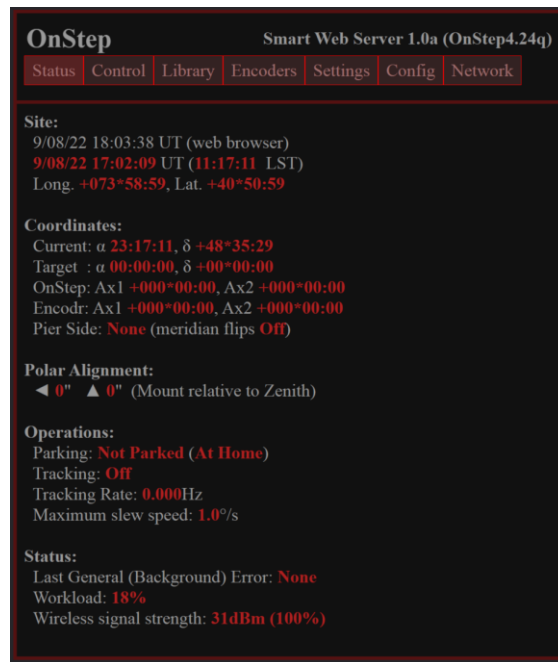
You can control the scope's movement under "Control" tab:
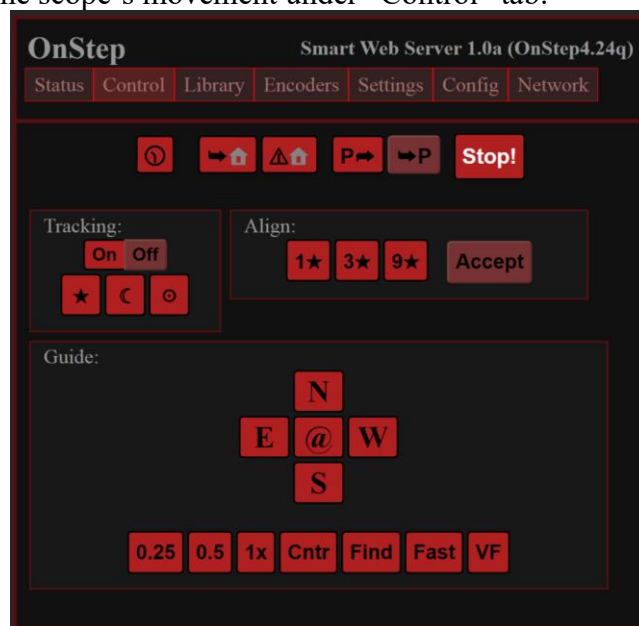
You can add/remove catalogs under the "Library" tab:

You can perform the telescope encoder operation under the "Encoder" tab:

To manage encoder synchronization, you can select from one of the two "Now" buttons:

- "Sync OnStep to Encoder"
- "Sync Encoder to OnStep"

Alternatively, click the "On" button to enable "Automatically sync. OnStep to Encoders" when a predefined difference between encoder ticks and motor steps is exceeded. Note that "On" is highlighted when Auto sync is Off!

To modify the encoder configuration, click on the "Axis1 RA/Az" and "Axis 2 Dec/Alt" buttons. Within this section, you can adjust the predefined encoders and motor difference thresholds mentioned previously. However, ensure not to alter the "Counts per degree," which is preset to 22.756 ticks/deg for the provided 8192 PPR encoders. You may need to toggle the "Reverse direction" option if you have mounted the encoders differently, as indicated in the installation manual.

You can set your Site information under the Config. There are some advanced configuration under the Config Tab too:

Changing WiFi Configuration

Navigate to the **Network** tab to adjust WiFi settings:

Default WiFi Password: The initial password is set to "password".
While you may wish to modify the SSID and/or password for security reasons, it's crucial to proceed with caution when altering these settings. It is imperative that you remember any new password set, as there is no straightforward method to retrieve or reset a forgotten password. In the event of a lost password, the unit must be returned to us for a password reset, which will necessitate covering all associated shipping costs and a service fee.

OnStep   Smart Web Server 1.0a (OnStep4.24q)

Status | Control | Library | Encoders | Settings | Config | Network

Performance and compatibility:
Command channel serial read time-out: 200 ms
Web channel serial read time-out: 200 ms
Upload

Station mode (connect to an Access-Point):
SSID: Home   Password: (8 char min.)
MAC: 58:bf:25:da:12:25
IP Address: 192 . 168 . 1 . 55
Gateway: 192 . 168 . 1 . 1
Subnet: 255 . 255 . 255 . 0
Enable DHCP: ☑ (Note: above addresses are ignored if DHCP is enabled)
Enable Station Mode: ■
Upload

Access-Point mode:
SSID: ONSTEP   Password: 8 char min.   Channel: 7
MAC: 5a:bf:25:da:12:25
IP Address: 192 . 168 . 0 . 1
Gateway: 192 . 168 . 0 . 1
Subnet: 255 . 255 . 255 . 0
Enable Access-Point Mode: ☑ (Note: auto-enabled if Station Mode fails to connect)
Upload

Network Configuration Security:
Password: Upload
Logout

Backlash Adjustment

Initially, you may utilize the Backlash Help Tool to fine-tune your backlash estimates at a later stage. For the time being, it might be advisable to leave it set to zero.

After making your desired changes, it's imperative to:

Save Your Changes: Navigate to the "Misc and Action" tab and select "Send Configuration to Controller". This ensures that all your modifications are transmitted and saved to the controller.

Return to Main Menu: Click the "OK" button. This action not only brings you back to the main menu but also ensures that the data you've edited is conveyed back to the main structure.

8 Quick Start Operations via OnStep Android App

Note: This guide is informed by the Quick Start Guide from Gemini Telescope Design and is tailored for WiFi setup with the Onstep Controller2 Android App.

Prerequisites:

- An Android device.
- OnStep App (available on the Google Play Store).
- You must enable the "Navigation Bar" of your phone/tablet to use this App. Do NOT use "Swipe" to navigate this App, you must use the Navigation Bar instead.
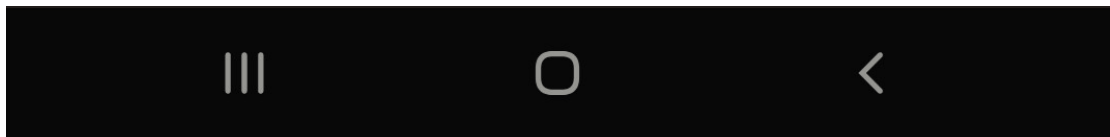
Guidance Steps:

1. **App Installation:**

- Install the OnStep App from the Google Play Store on your Android device.
2. **Connect to OnStep:**

- Power on your OnStep; WiFi becomes accessible after approximately 30 seconds.
- Activate your Android device's WiFi. Long press the WiFi icon and select "OnStep" from available networks.
- Upon receiving the "No internet connection" warning, select to connect regardless.
- Ensure your Android settings won't auto-disconnect from a network without internet to maintain the connection.

3. **Inputting Password:**

- If required, input "password" to establish a connection. Note that the password might be in the firmware or may not be protected.

4. **OnStep App Configuration:**

- Open the OnStep App. The connection should be automatic (likely IP address: 192.168.0.1).
- During the initial connection, configure certain parameters:
  - i. Observing Site: Input Latitude/Longitude and UTC offset (e.g., -1 if you're 1 hour East of Greenwich). Remember: UTC offset ≠ GMT time zone. For example, while New York City's Eastern Daylight Time is GMT -4, its UTC offset is +4.
  - ii. Horizon and Overhead Limits: Set the Horizon limit to 0° and the Overhead limit to 90° unless different limits are specified.
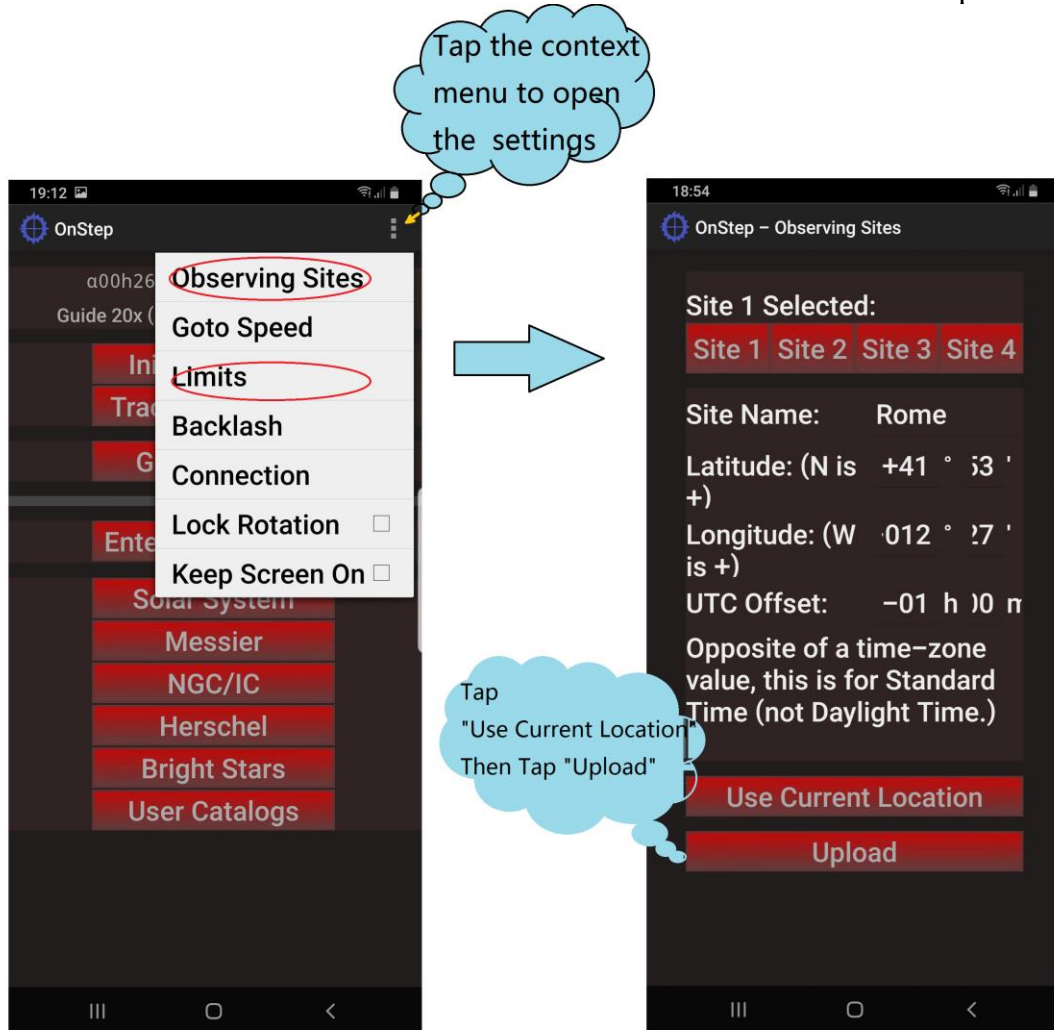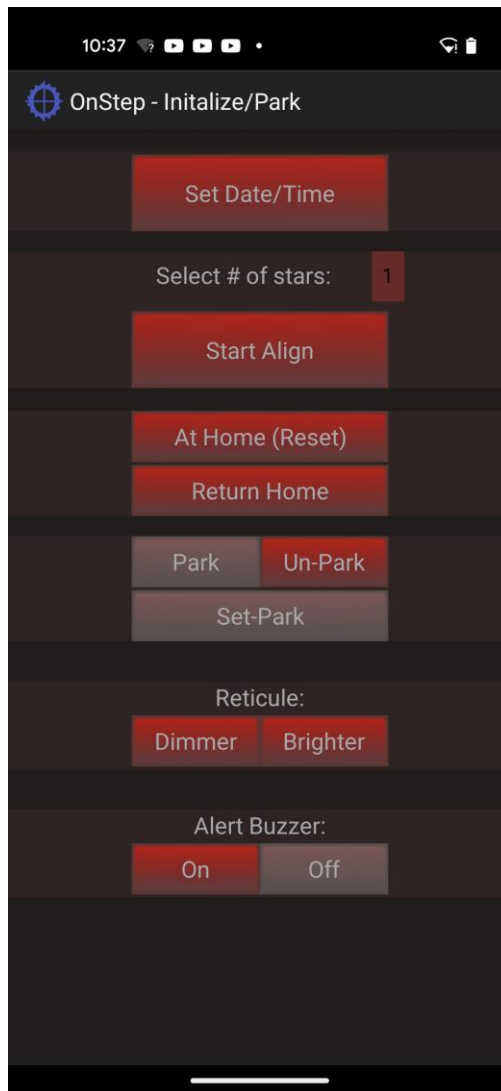

Next set the Horizon limit to 0 deg, and the overhead limit to 90 deg if they are different. (limits)
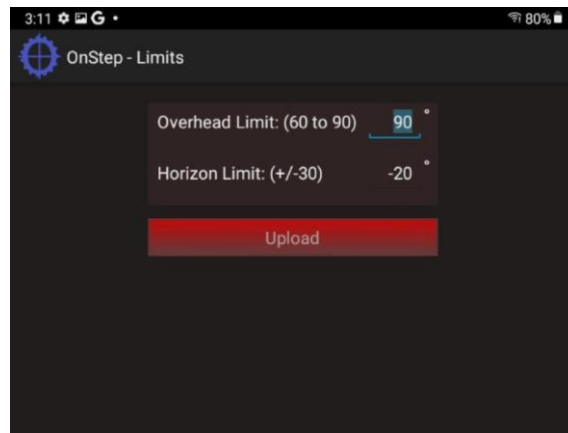
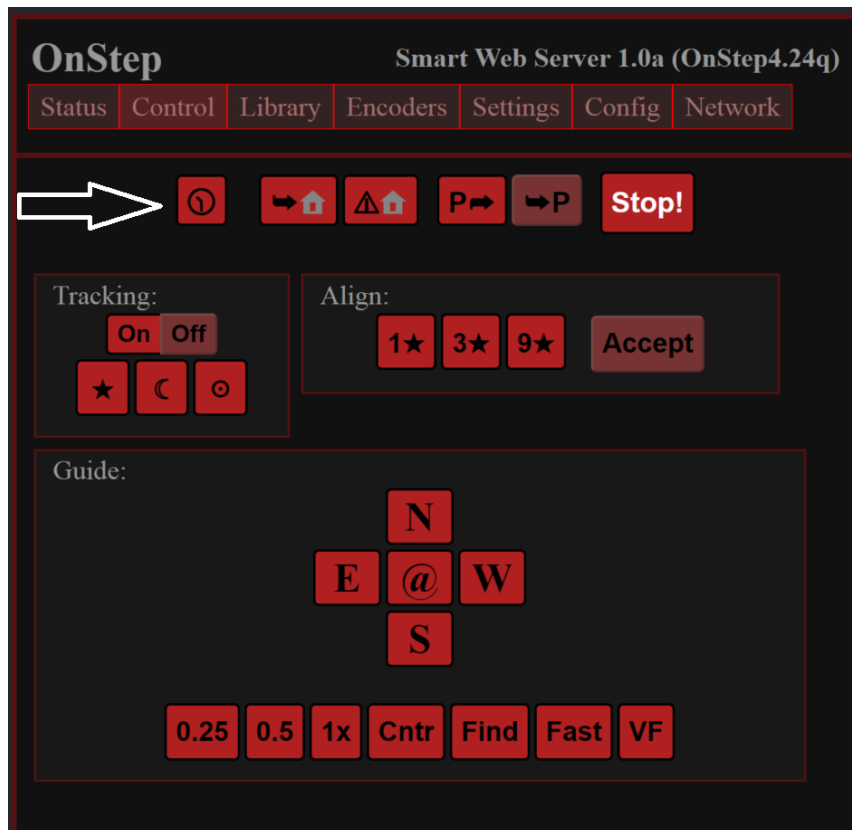Return to the main screen and tap "Initialize/park" and you will see these screens:
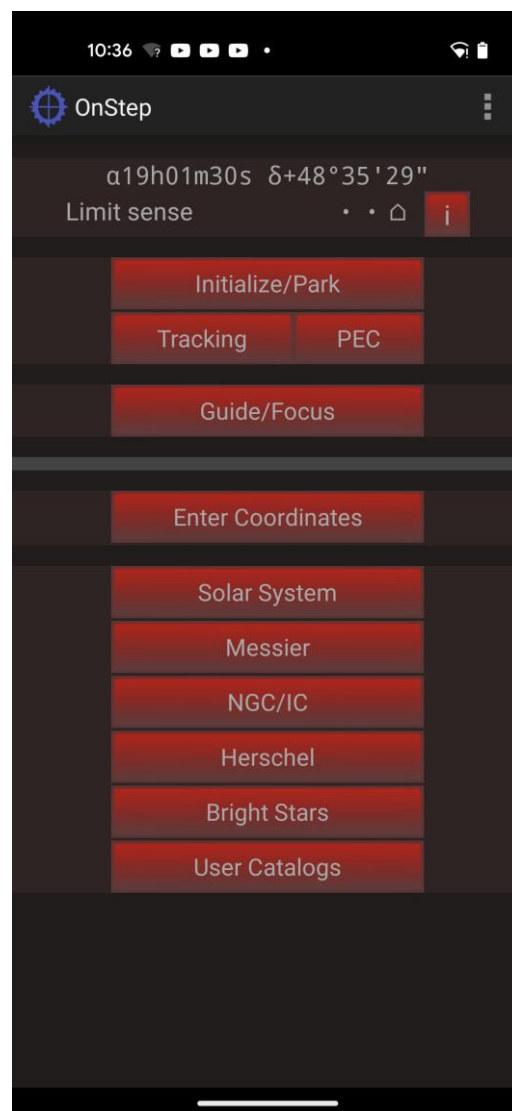
Now tap Set Date/Time button and the time will be set.

You can also use a browser from any device connected to the OnStep to set the date and time at http://192.168.0.1:

Just enter the "Control" tab, and then click the icon.

At this point it is recommended to check the LST (**Local sidereal time**) of the controller as this is fundamental for the correct functioning.

Use this link (or a planetarium program)
http://www.jgiesen.de/astro/astroJS/siderealClock/ to check your Local Sideral Time. If the difference is more than a few minutes you must investigate the reason. (incorrect Longitude most likely). Enter your local Longitude, and select either E or W based on your location.
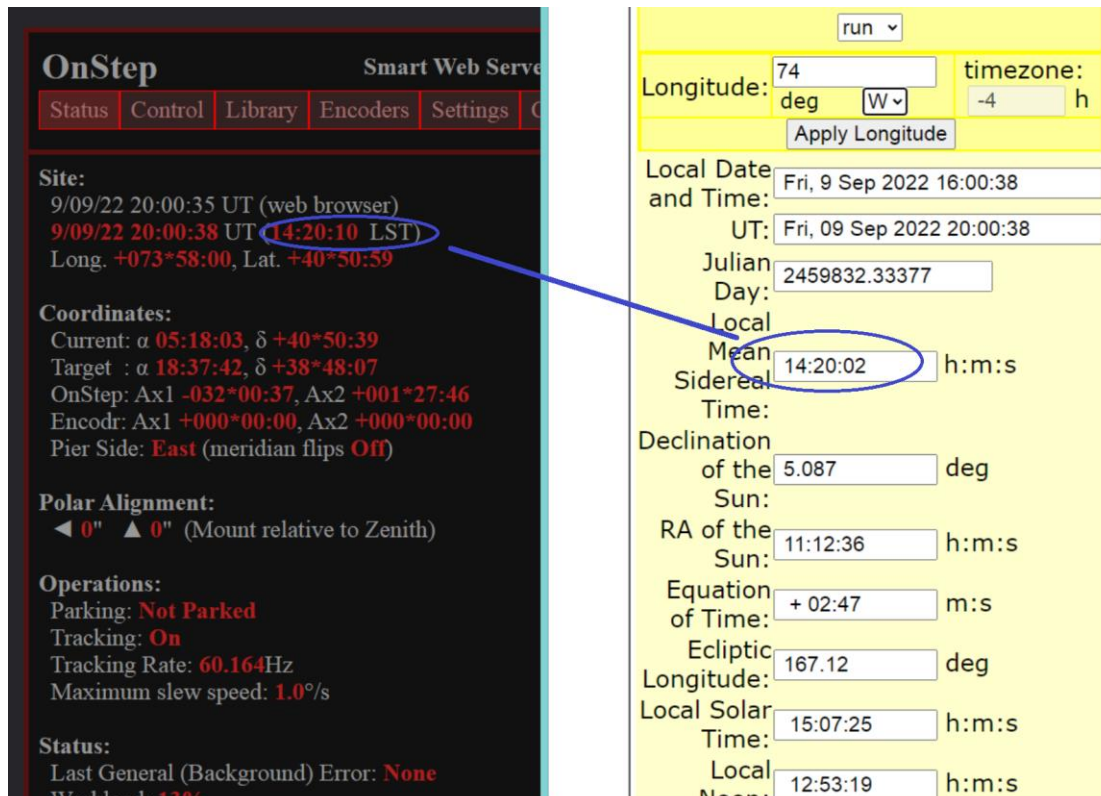
Initial Setup and Operation of OnStep
Initial Positioning

- **Assumed Starting Position:** OnStep assumes the telescope is initially pointed horizontally toward due north (Note: This refers to geographic north, not the celestial pole).
- **Manual Positioning:** Move the telescope to this position manually, ensuring it is in manual mode and the motor drive is unclutched.
- **Using the Smart Hand Controller:**
  - Enable tracking.
  - Utilize the HandPad buttons (E/W/N/S) to maneuver the scope to the desired position.
  - If the minimum altitude limit is reached before achieving a horizontal position, you may power off the controller, manually adjust the telescope further, and then power it back on.
- **Using "Park" and "Unpark" Features**

  - Parking: Always "Park" your telescope after use, especially if situated in an observatory, to preserve its position.
  - Unparking: On your next use, simply select "Unpark" to resume from the stored position without requiring realignment.
  -

Alignment and Further Instructions
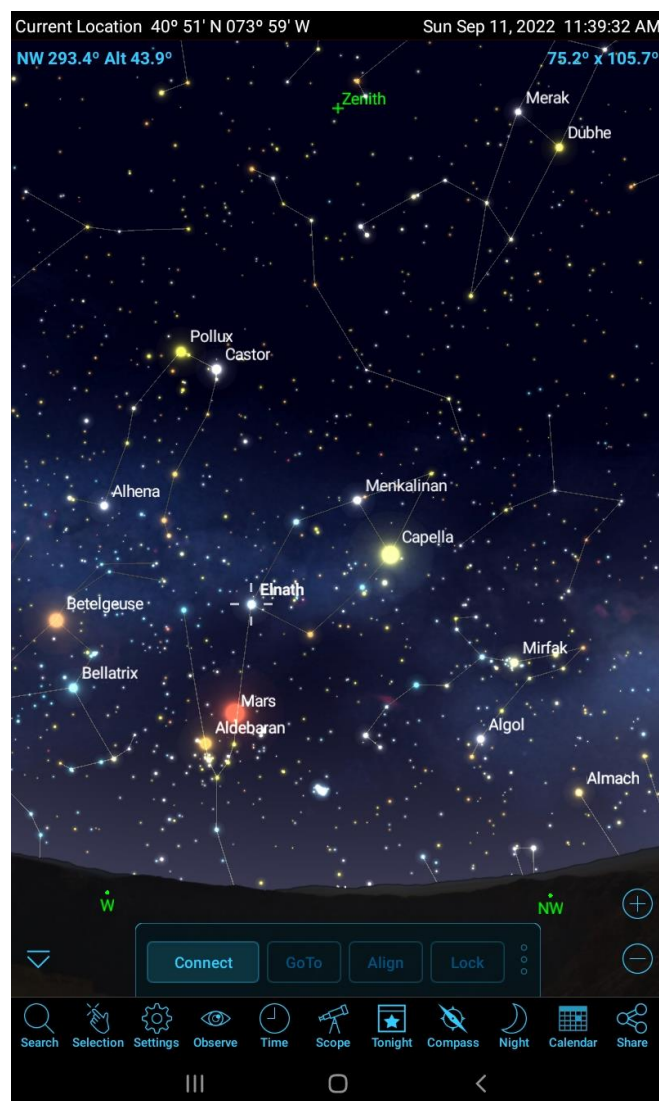Detailed instructions for alignment and other advanced features are available through the following resources:

- [OnStep Wiki Main Guide](#)
- [Additional OnStep Wiki](#)

9 Quick Operation Guide on Sky Safari
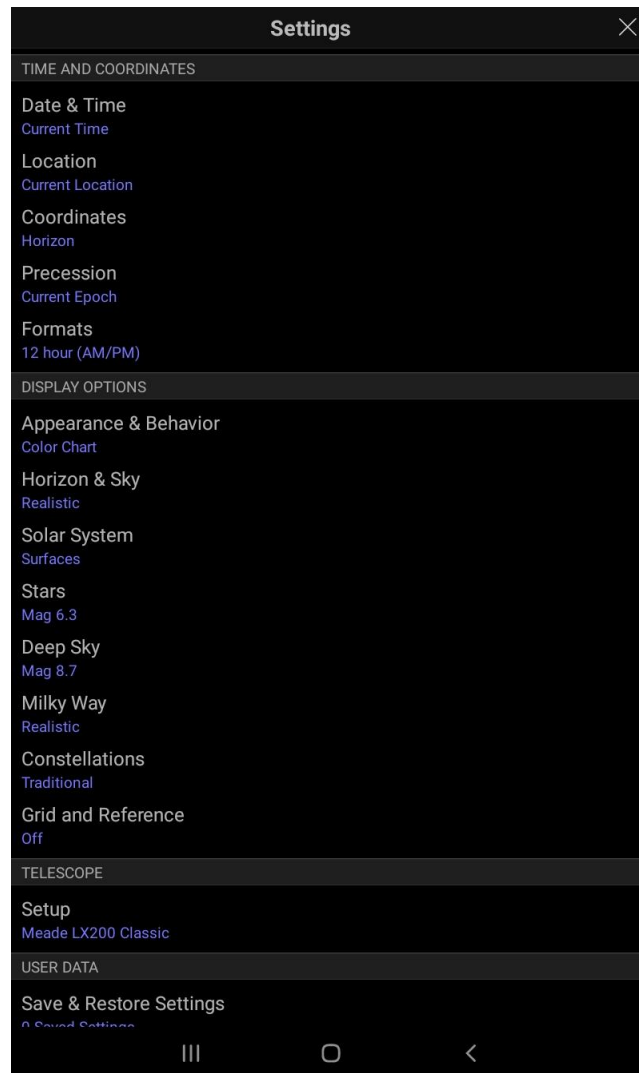
You should align the Scope using the Smart Handpad or the Handpad App first.

Connect the device to the OnStep controller via WiFi.

Click setting, and then choose the "Setup" under the TELESCOPE
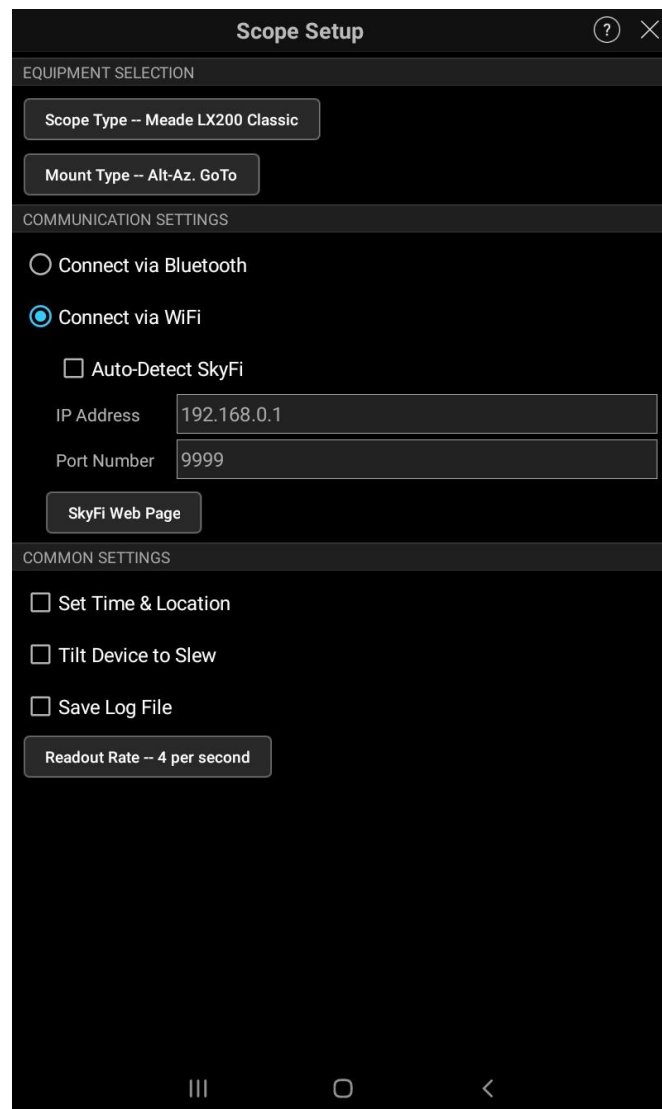
You should set:
Scope Type: Meade LX200 Classic
Mount Type: Alt-Az GoTo
You can choose either Bluetooth (on Android only) or WiFi.
For the WiFi:
IP address: 192.168.0.1
Port Number: 9999

Make sure to uncheck the "Auto-Detect Skyfi" and "Set Time & Location"

For the detailed instruction on Sky Safari Plus/Pro instruction, please refer to:
https://skysafariastronomy.com/support/manual/manual.shtml

10 Quick Operation Guide on Stellarium

Stellarium is available on all popular platforms (Linux, macOS, MS Windows, iOS, and Android). You will need to use Stellarium Mobile Plus (the paid version) on iOS and Android devices.

- On Linux, you will need to use INDI driver to connect to the OnStep controoler at IP address 192.168.0.1, and port 9998.
- On the Windows platform, you can simply connect the Stellarium via Bluetooth. You can also connect Stellarium via ASCOM driver over the Bluetooth or the USB port.

- On the Android platforms, you can connect Stellarium Mobile Plus to OnStep via WiFi (IP address 192.168.0.1, at port 9998) or via the Bluetooth
- On the iOS platforms, the Stellarium Mobile Plus can only connect to the OnStep via WiFi (IP address 192.168.0.1, port 9998)

10.1 Quick Operation Guide on Stellarium Mobile Plus

The Stellarium Mobile Plus is available on both the iOS and Android devices. You should align the Scope using the Smart Handpad or the Handpad App first. Connect your device to the OnStep controller via WiFi or Bluetooth.
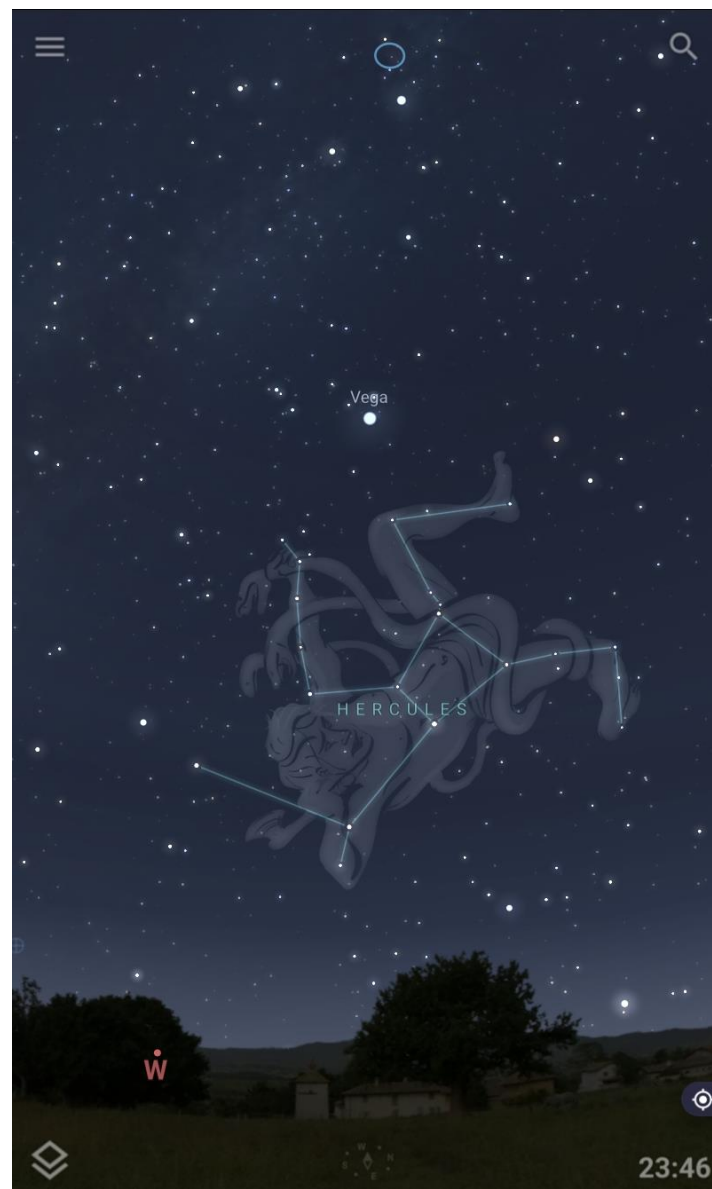
Open the menu by tapping the menu bar at the top left of the display
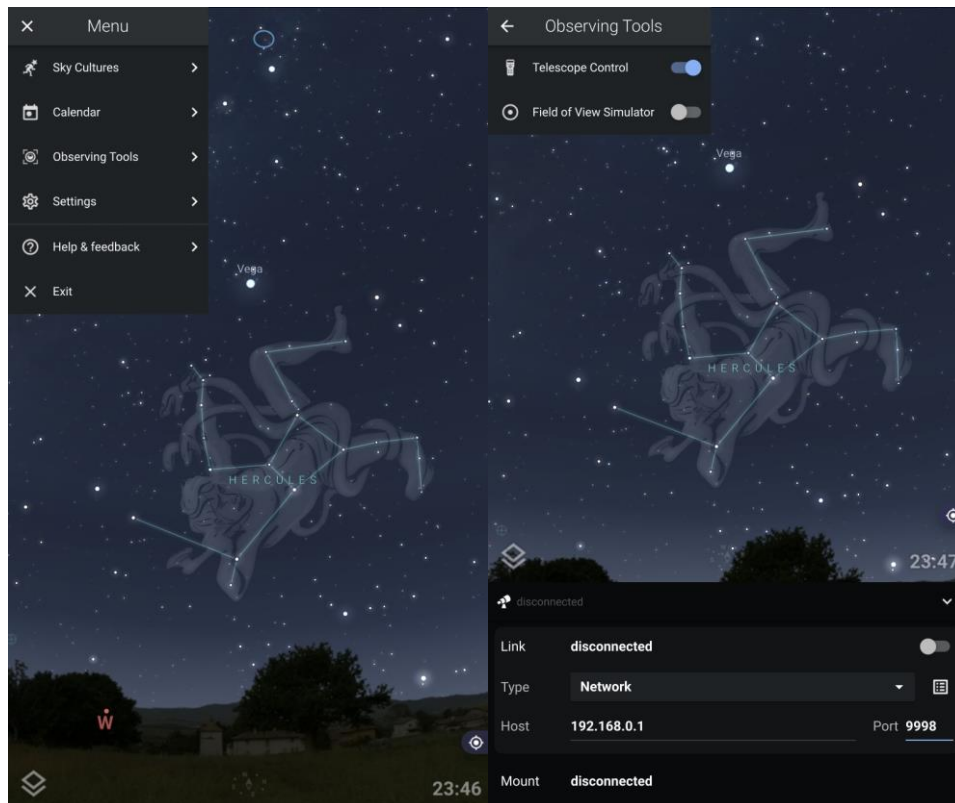
On the Type felid, you can choose either Network(i.e. WiFi) or Bluetooth. For the
WiFi, Enter Host to be: 191.168.0.1. and Port:9998; the tap the Link Button to
connect to the OnStep controller.
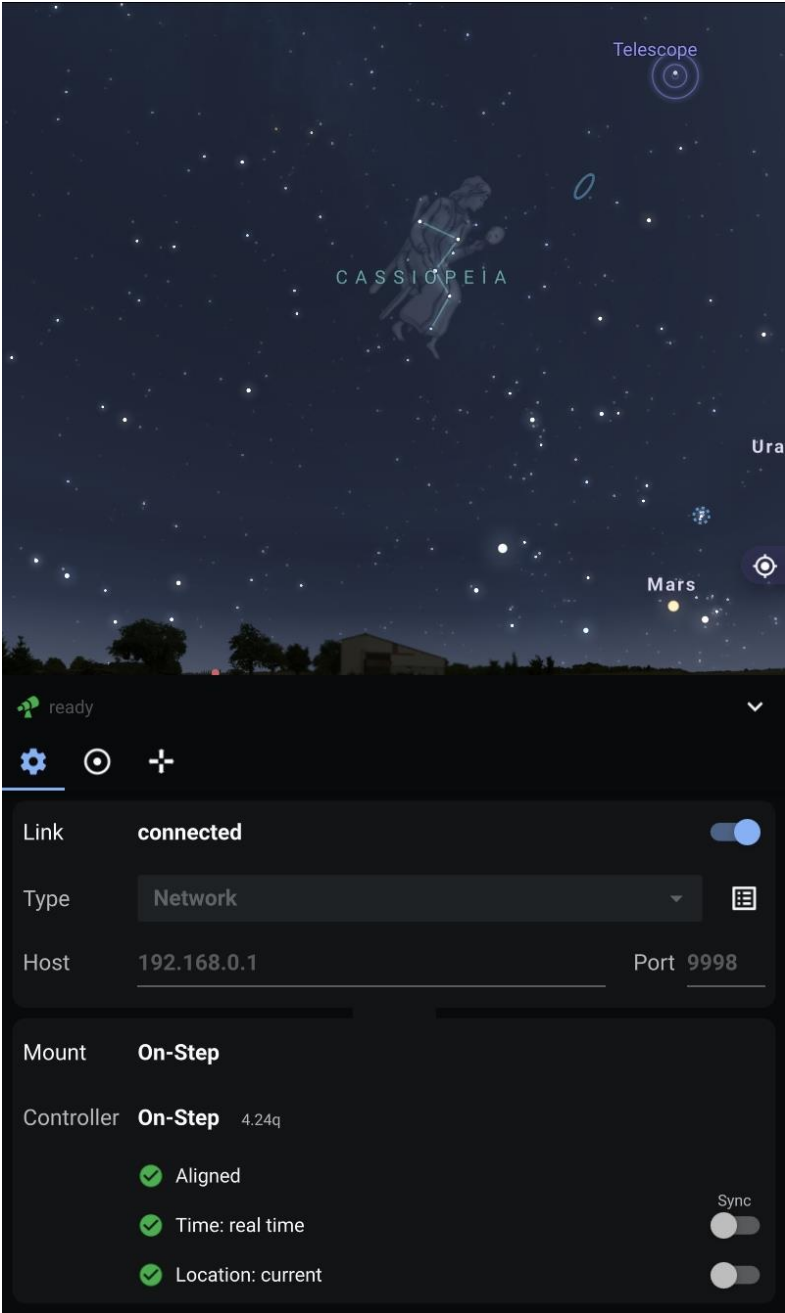
10.2 Quick Operation Guide on Stellarium on MS Windows platform

Stellarium on Windows offers a rich feature set and various ways to connect to the OnStep telescope controller. Here, we'll focus on establishing a connection via Bluetooth. Ensure you have the necessary drivers and software installed before starting the process.
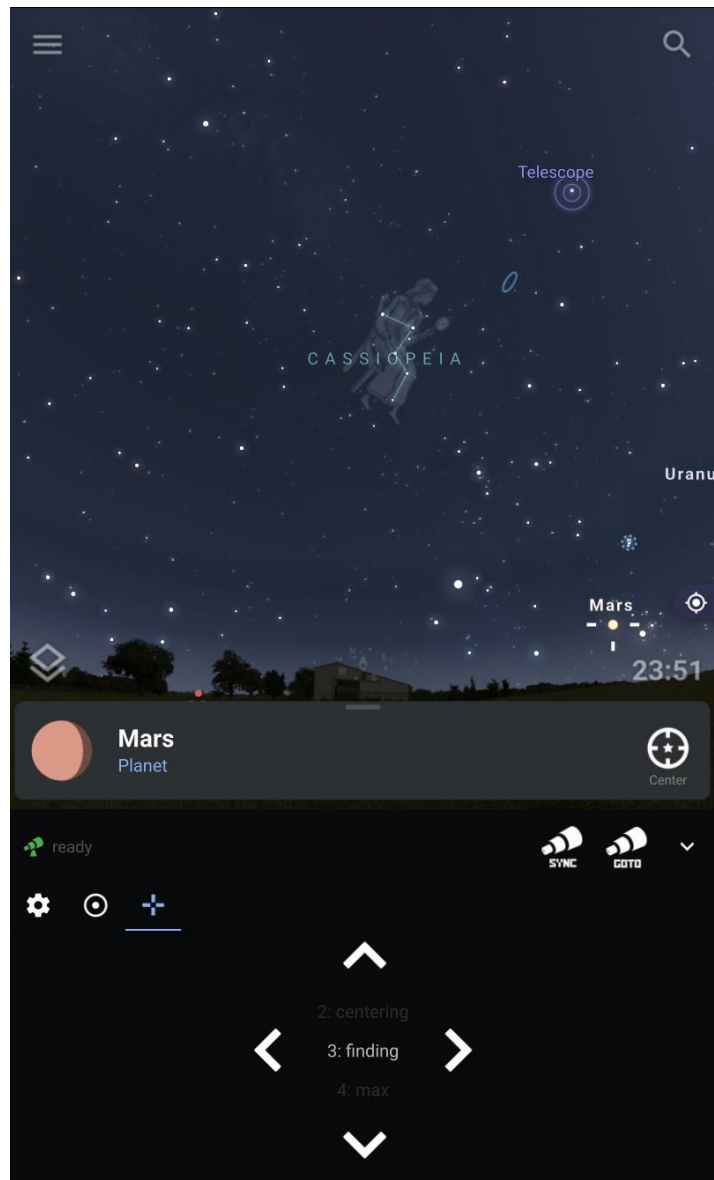
Step 1: Pairing with Bluetooth
Add Bluetooth Device: Ensure your OnStep controller's Bluetooth is turned on and discoverable. On your Windows machine, go to "Settings" > "Devices" and click on "Add Bluetooth or other device". Select the OnStep controller from the list and complete the pairing process.
Step 2: Identifying the COM Port

Navigate to Device Manager: Access the Control Panel and select "Device Manager". Expand the section labeled "Ports (COM & LPT)".

Locate OnStep Ports: You should observe two entries titled "Standard Serial over Bluetooth link" followed by a COM number (e.g., COM3, COM4). This number is crucial as it indicates the communication port through which Windows and OnStep will converse. Unfortunately, it is not explicitly stated which port is master, so it may require testing both.

Step 3: Configuring Stellarium

Access Plugin Tab: Open Stellarium. On the lower-left side of the screen, find and click on the "wrench" icon to open the Configuration Window. Navigate to the "Plugins" tab.

Navigate to Telescope Control: Scroll until you find "Telescope Control" in the left pane and select it. Make sure the "Load at startup" box is ticked; if not, do so and restart Stellarium after saving the configuration.
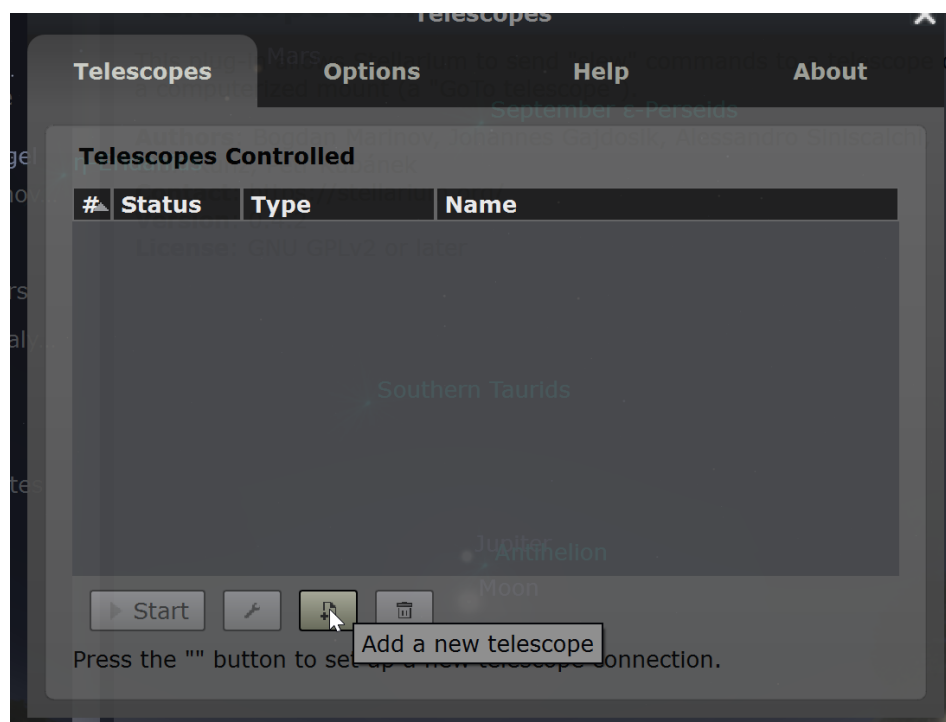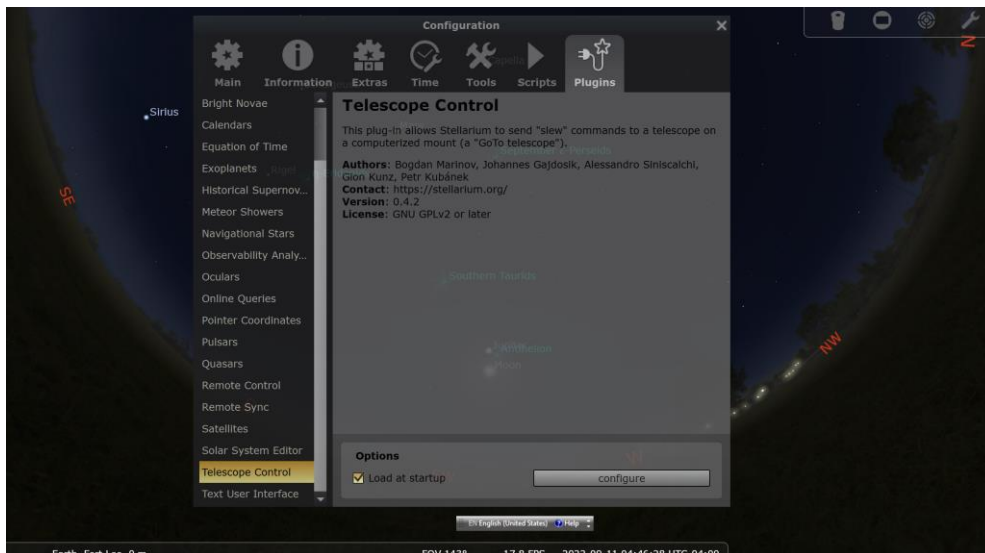
- Telescope Configuration:
    - Click on "Configure".
    - In the pop-up window, click "Add".
    - Select "Stellarium, directly through a serial port" and configure the additional settings below:
        - **Name**: Assign a recognizable name to your telescope setup.
        - **Device Model**: Choose "Meade LX200 (compatible)" as the protocol.
        - Serial Port: This is where you select one of the COM ports identified in Step 2. If you're uncertain which one is correct, you may need to try both options.

- **Baud Rate:** Choose the baud rate as per your OnStep configuration. If unsure, 9600 is a standard rate and a good starting point.
- **Time & Location:** Ensure the time and location are set correctly in Stellarium to provide accurate celestial tracking.

Add New Telescope

Telescope controlled by:

- ◉ Stellarium, directly through a serial port
- ◯ External software or a remote computer
- ◯ RTS2 telescope
- ◯ INDI/INDIGO
- ◯ ASCOM
- ◯ Nothing, just simulate one (a moving reticle)

Telescope properties

Name:

UL24G f/3.3

Connection delay: 0.50s

Coordinate system:
- ◯ J2000 (default)
- ◉ Equinox of the date (JNow)
- ☐ Start/connect at startup

Device settings

Serial port: COM5

Device model:

Meade LX200 (compatible)

Any telescope or telescope mount compatible with Meade LX200.

OK   Cancel
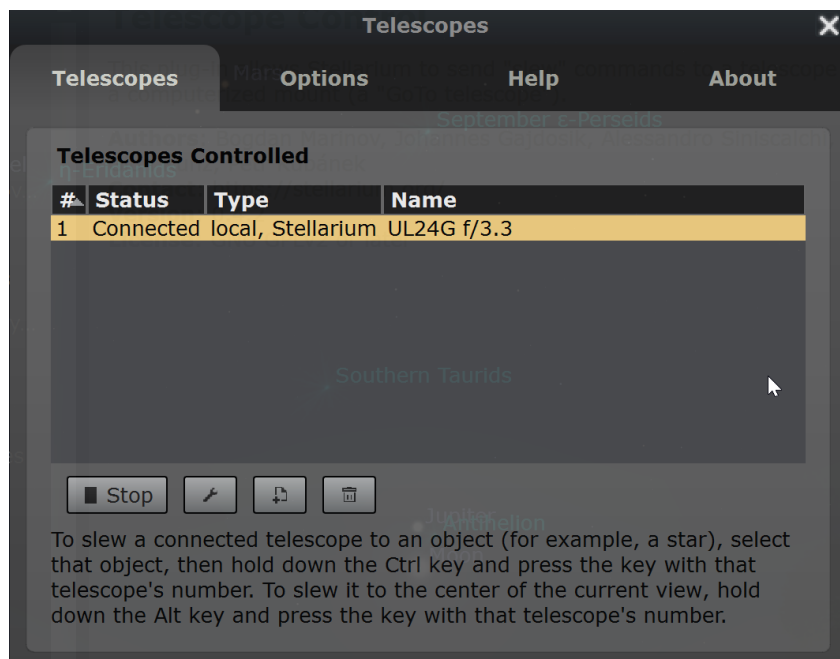
Slewing to a Selected Object in Stellarium

Once your OnStep telescope controller is successfully connected to Stellarium, navigating or "slewing" to specific celestial objects becomes an interactive and straightforward process. Here's a quick guide on how to slew to a selected object using the Stellarium software on a Windows platform:

Navigating to a Selected Object:

Select Object:

- Navigate through Stellarium and click on the celestial object you wish to observe. This could be a star, planet, galaxy, etc. Details of the selected object should appear on the top-left corner of your Stellarium window.

Telescope Control:

- Ensure that the "Telescope Control" plugin is activated and that your telescope (via the OnStep controller) is connected and configured properly in Stellarium.
- Ensure your telescope is properly aligned and that Stellarium has the correct location and time settings to ensure accurate slewing.

Slew to Object:

- Once you have selected an object, simply press CTRL+'n', where 'n' is the corresponding digit of your telescope in the telescope control plugin. Here's how:
    - Open the "Telescope Control" plugin window if it isn't open already.
    - Locate the telescope you're using (the one you've named and configured in the previous steps).
    - Note the digit at the left end of the telescope's line. This digit represents the telescope's identifier in Stellarium.
    - Now, with the object selected, press **CTRL** and the digit ('n') at the same time. For instance, if your telescope is listed as "1: [Your Telescope Name]", you would press **CTRL+1**.
- The telescope should now slew to the selected object, aligning itself to bring the object into view through the eyepiece.

Additional Tips:

- **Zooming:** Use the scroll wheel or page up/page down keys to zoom in and out on the Stellarium sky view. Zooming in might assist in centering the selected object more accurately in your telescope's view.
- **Tracking:** Ensure that tracking is enabled on your telescope controller (OnStep) if you wish for the telescope to continuously follow the object as it moves across the night sky.
- **Slew Speed:** Check the slew speed settings on your OnStep controller and ensure it's set to a speed that is both quick yet smooth enough to allow for accurate stopping on the desired object.

11 Telescope control via ASCOM Planetarium programs on MS Windows

One of the most powerful and useful Onstep capabilities is to interface with ASCOM Compliant Planetarium programs and telescope control routines inside CCD imaging programs. The following popular Planetarium programs are supported via the OnStep ASCOM driver:

- Earth Centered Universe (ECU)
- TheSky™
- Cartes du Ciel
- *MegaStar*
- [Sky Planetarium](#)

Noted, when setting up and using the OnStep driver with Cartes du Ciel (Sky Chart) and other ASCOM compliant software, it's important to avoid using the ASCOM Device Hub to control the telescope. The OnStep ASCOM driver may not be fully compatible with the ASCOM Device Hub, which could lead to issues or limitations in functionality.

Here are the procedure to install and use the OnStep ASCOM drive with Cartes du Ciel. To interface your telescope with Cartes du Ciel (Sky Chart) using the OnStep ASCOM driver, follow these steps for a smooth setup and operation. This guide assumes you're using the OnStep ASCOM driver version 1.0.37 as of March 2024.

Step 1: Install the Latest ASCOM Platform
Firstly, ensure that you have the latest ASCOM platform installed on your computer. The ASCOM platform is essential for providing a standard interface for computer control of telescopes and other astronomical devices.

Step 2: Install the OnStep ASCOM Driver
Next, download and install the latest OnStep ASCOM driver. As of March 2024, the latest version is 1.0.37. This driver allows your OnStep controlled telescope to interface with ASCOM compliant software.

Step 3: Align Your Telescope

Before proceeding with software connections, physically align your telescope using its standard alignment procedures using the smart hand pad. This might involve aligning it with 2-9 known stars. Successful alignment is essential for accurate tracking and control.

Step 4: Configure ASCOM with Cartes du Ciel

To use your telescope with Cartes du Ciel, follow these steps:
Download and Install Cartes du Ciel
Download the latest version of Cartes du Ciel (Sky Chart) and install it on your computer.
After installation, configure the time zone and location settings in the software to ensure accurate celestial tracking.

Connect to the Telescope
- In Cartes du Ciel, navigate to **Telescope** > **Telescope settings...** and make sure "ASCOM" is selected as the telescope interface.
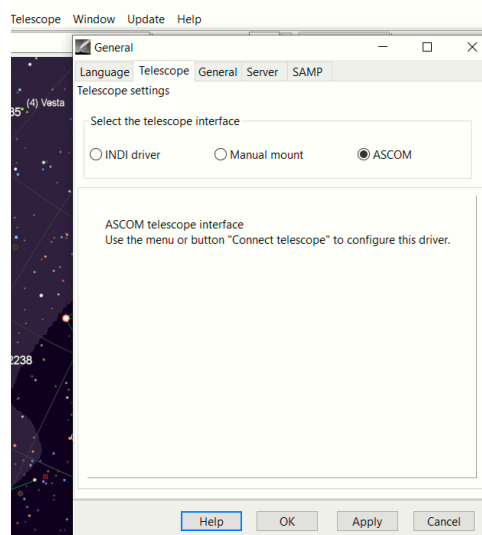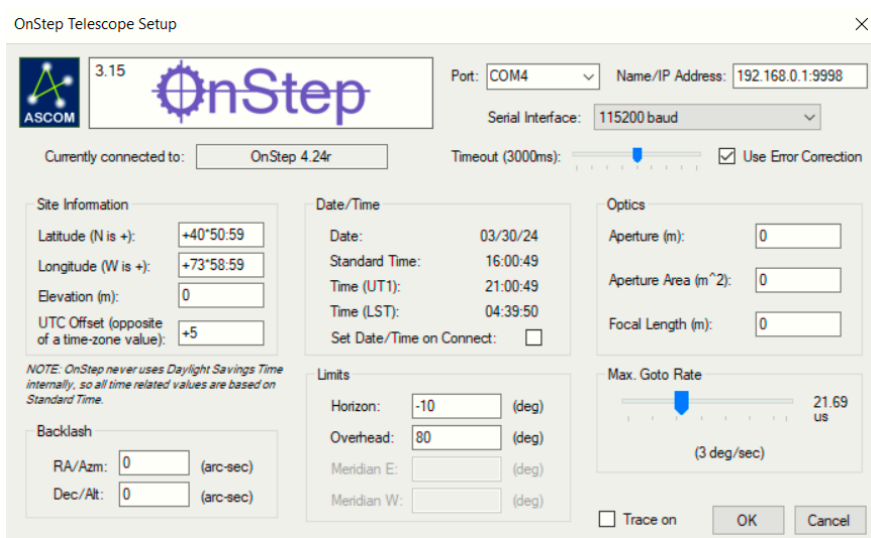

- Then go to **Telescope** > **Connect telescope**.
- Click on **Select**, and choose "OnStep Telescope" from the list of available telescopes.
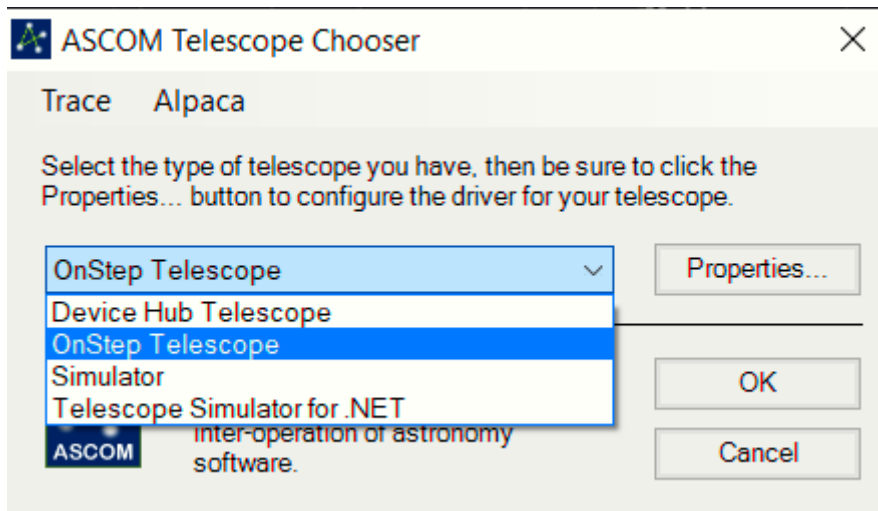
Configure Connection Settings:

- Click on **Properties** of the above windows to access the ASCOM configuration window. Here, you can choose between connecting over a USB/Serial port or via WiFi.
  - If using a USB/Serial port, check the Windows Device Manager to identify the serial port number assigned to OnStep's USB port. Note that this port number may change after rebooting your computer.
  - **Set the baud rate to 115200 (controller firmware 4.24r) or 9600(controller firmware 4.24s or later) for the connection to work properly. You can use the hand pad to find out the firmware version of your controller.**
  - Optionally, select "Set the Date/Time on connect" to synchronize your telescope's clock with your computer.

- After configuring these settings, click the red **CONNECT** button in the **Telescope** > **Connect telescope** window to establish a connection with your telescope.
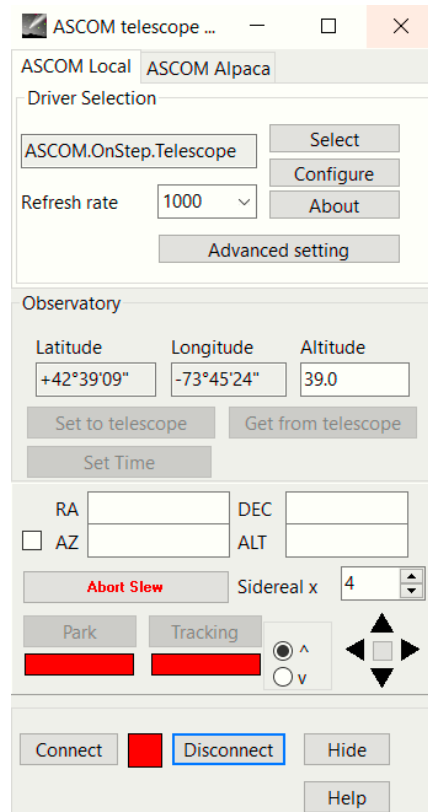
Once the connection is successfully established, the interface will indicate the connection status, and you will be able to use Cartes du Ciel to control your telescope, pointing it at various celestial objects with ease.
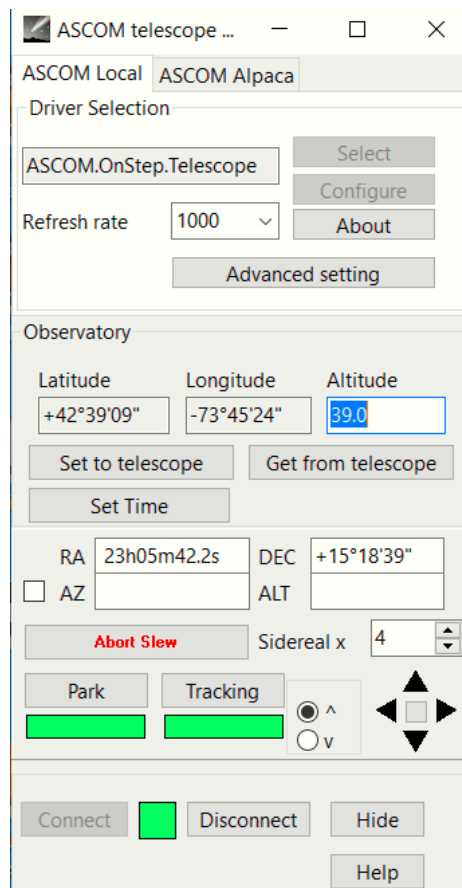
By following these steps, you'll have a powerful setup for astronomical observation, combining the precision of the OnStep telescope controller with the extensive celestial database and user-friendly interface of Cartes du Ciel.

To find out which serial port is allocated to your OnStep's USB port through the Windows Device Manager, follow these steps. This process is necessary because the port number might change after each reboot of Windows, affecting how your astronomy software connects to the telescope.

1. **Connect Your OnStep Device**: First, ensure that the OnStep controller is connected to your computer via USB.
2. **Open Device Manager**:
   - Right-click on the Start menu and select "Device Manager," or
   - Press **Windows + X** and then click "Device Manager," or
   - Type "Device Manager" in the search bar next to the Start menu and press Enter.
3. **Locate the COM & LPT Ports**:
   - In the Device Manager window, look for a section named "Ports (COM & LPT)." Click the arrow next to it to expand the section. You should see a list of all COM ports currently in use.
4. **Identify the OnStep USB Port**:
   - Look for a port labeled with the name of your OnStep controller or a generic term such as "USB Serial Port (COMX)" where "X" is the port number. The description might also include the manufacturer's name if it's a specific type of USB-to-serial adapter.
5. **Note the COM Port Number**:

- Take note of the COM port number assigned to your OnStep device. This is the port number you will select in your astronomy software when configuring it to communicate with your telescope.

6. **If the Port Changes**:
   - If you disconnect your device or reboot your computer, the COM port number may change. It's a good practice to check the Device Manager again to verify the COM port number before starting your astronomy software.

7. **Troubleshooting**:
   - If you don't see your device listed under "Ports (COM & LPT)," try disconnecting and reconnecting the USB cable, or use a different USB port on your computer. You may also need to install or update drivers for your USB-to-serial adapter, especially if it's the first time you're connecting the device to your computer.
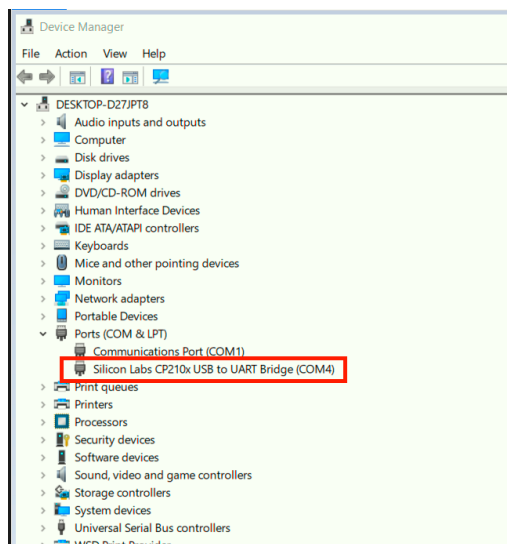
12 Smart Telescope Setup

TBD

13 Imaging with ULXXG

With the ability to add the focuser and rotator control on the Hubble OnStep controller, Astro imaging and EAA with ULXXG is certainly an exciting possibility; but you are on your own…at least for now.

14 Limited Warranty

Optel Engineering Group Inc., Seller, warrants to the original purchaser only, that goods sold will be free of material defects in design, materials and workmanship for a period of 6 months following the date of shipment by Seller to Buyer. Seller will repair or replace, or refund the purchase price as to, goods that do not conform to the foregoing warranty, provided the cause of the nonconformity does not arise from or relate to modification, misuse, or abuse by the customer, and provided a warranty claim. Repair or replacement of the product or refund of the purchase price, at Seller's sole option, shall be the Buyer's exclusive remedies. Seller shall not be responsible for any indirect, special or consequential damages arising from use of the products. Goods subject to this warranty must be shipped postage pre-paid by Buyer to the Seller.

If the controller has been damaged by modification, lightning, faulty wiring, moisture, or other misuse, the warranty is void.

Any modification on the controller and firmware update by yourself will void the warranty.

15 Technical Support

Hubble Optics (Optel Engineering Group Inc.) will provide the support for the basic operations by email. You will receive a response, generally within 24 hours. For the advanced features beyond this document, please refer to the OnStep WiKi instruction.

Appendix A: Motor and Motor Encoder Pin Out
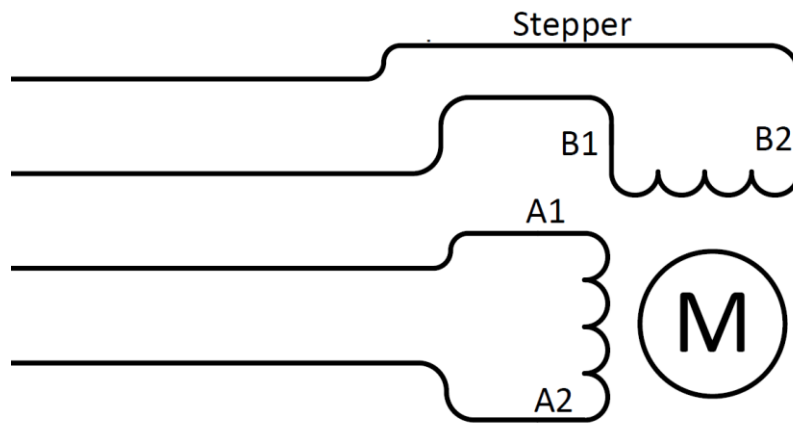
ALT connector:
4: Black (A+)： 1A
3: Green (A-)：   1B
2: Blue (B-)：2B
1: Red (B+)：   2A

AZM connector:
1: Black (A+)：   1A
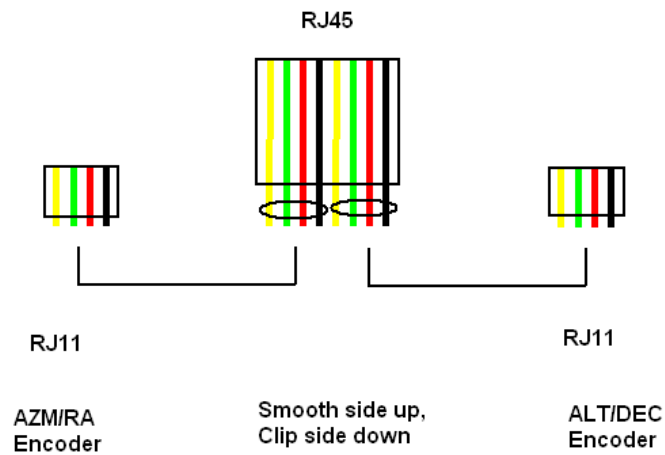2: Green (A-)：   1B
3: Blue (B-)：2B
4: Red (B+)：   2A

Figure 1: Mount and Motor Encoder Connections

G: Black, Ground
X: Not used
A: Red, A Channel
5V: Green, +5V
B:, Yellew: B Channel

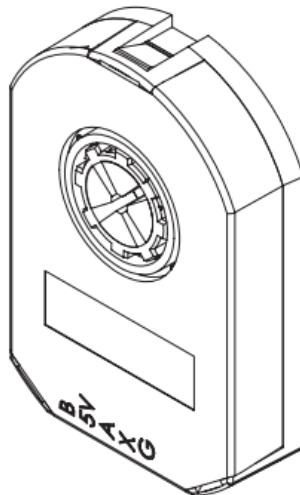*Note that the real color of the wire may be different from this document.*

Figure 2: Encoder (The pin "X", the index pin, is not used)