

TiTaN TCS

Operation Manual



TiTaN TCS(Telescope Control System) is the most compact and powerful telescope control system which adopted the latest technologies in a small size.

In addition, the powerful CPU, memory, wireless module and various connectors are readily available for continuous updates of functions and upgrades, so that the device will meet your needs.

Contents	2
1. Main Functions of TiTaN Telescope Control System	3
2. How to Use Navigation Button & Wheel	6
3. Parking & Speed Volume knob	7
4. System Configuration Diagram	8
5. Operation Sequence of TiTaN TCS	11
6. Menu List	13
7. Explanation of Menu	21
8. Bluetooth	48
9. Technical Specifications	54
10.LX200 Commands supported	56
11.Replacing the battery	57
12.Pin Map	57
13.FAQ	58

1. Main Functions of TiTaN Telescope Control System

1. Titan has separate control CPU (120MHz / 32bit) and UI CPU for future expansion of required functions.
2. Internal GOTO databases including Messier, NGC, IC, Caldwell, and SH-2, so users can slew to the desired object using TCS without PC.
3. Supports Bluetooth Serial Protocol (SPP) to be connected with various devices.
4. Variable microstep (1/4 ~ 1/128)
By automatically selecting 1/128 microstep in tracking mode and 1/4 ~ 1/64 microstep in Slewing mode, precise tracking performance and high speed slewing could be simultaneously achieved within minimum power consumption. The TCS also dynamically controls the voltage and current according to the motor speed.
5. Internal DC voltage step-up regulator and current control enables powerful operation of the stepper motor.
6. Supports the widely used Meade LX200 compatible protocol; can be connected with various astronomical software.
Can be connected with the PC using the ASCOM driver for LX200.
7. If you correctly follow the parking steps, the parking position of the telescope will be automatically recovered, which enables more convenient observation.
8. Various functions in the compact size (86 x 115 x 35 mm)
9. High-resolution color graphic OLED display: allows to monitor various information including current status of the telescope, current consumption of motor. The OLED display always responsive immediately even below freezing, compared to LCD, which slow downs at low temperature.
(1.69" Diagonal Size, 160 x 128 Pixels, 16Bit Color)
10. The maximum motor current for slewing and tracking can be set separately, which is optimized for outdoor observations with limited power supply situations.
11. In tracking mode, the current consumption is about 0.25 ~ 0.6A depending on the setting, suitable for outdoor observations.
12. Power output through USB connector planned: 5V 0.6A will be available for external devices.

*The software upgrade is scheduled to support this feature
13. Two RS-232 connection ports: Two of PC or other devices can be connected by two ports at the same time. This allows simultaneous connection to multiple astronomical software.

14. USB Virtual COM Port Supported: can connect TCS to your PC via USB. Two Virtual COM Ports are supported, reducing the number of cables needed.
15. 4 LED equipped in the guide port input: The guide status for each axis can be checked in real time during auto-guiding.
16. The built-in beeper informs the status and problem situation of the controller.
17. Guide port is isolated from internal circuit with optocoupler, electrical noise and surge is blocked.

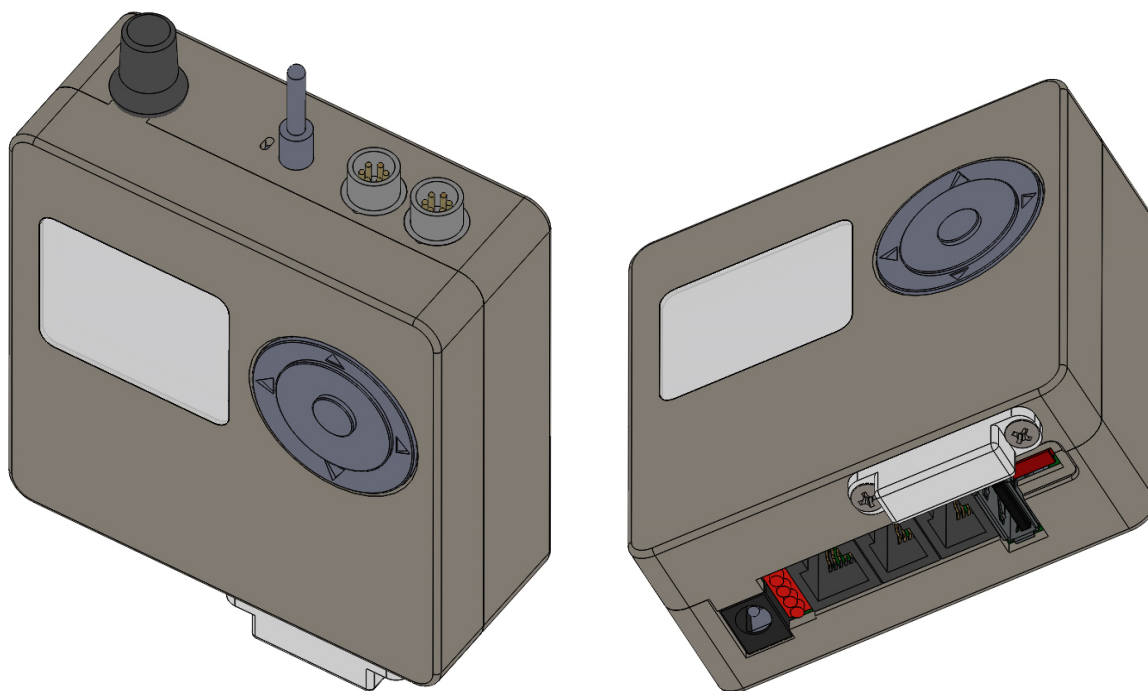
Notice

TitanTCS Hardware has two versions, V1 and V2.

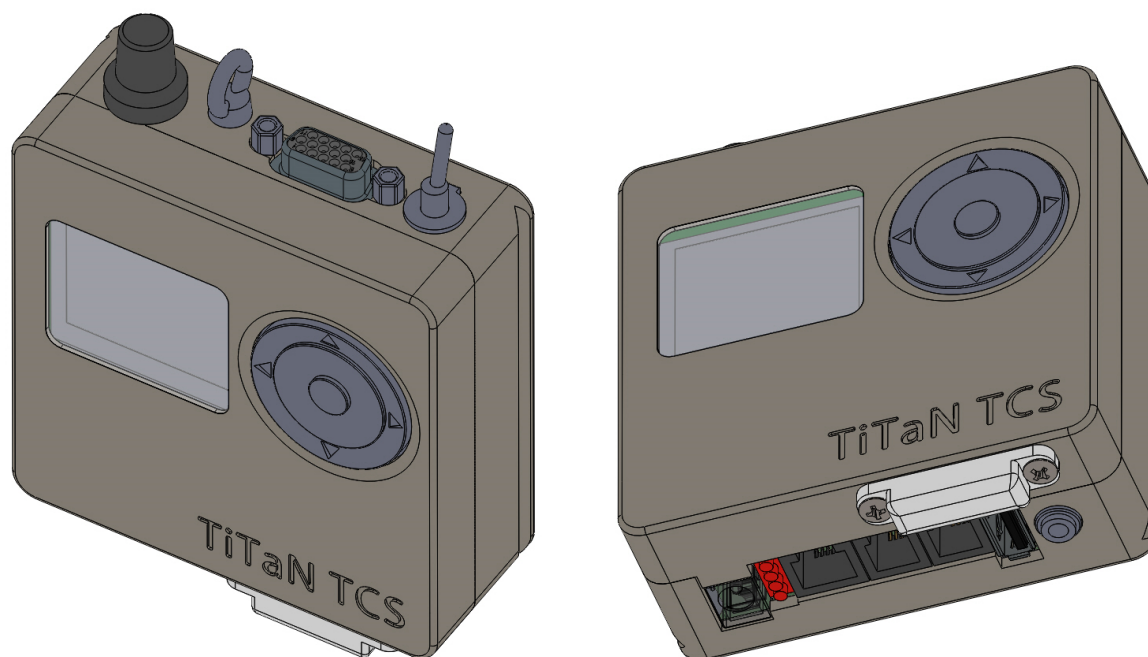
V1 is connected to the motor by a circular connector.

V2 is connected to the motor via D-Sub connector,
and camera shutter control function is added.

- Titan TCS V1



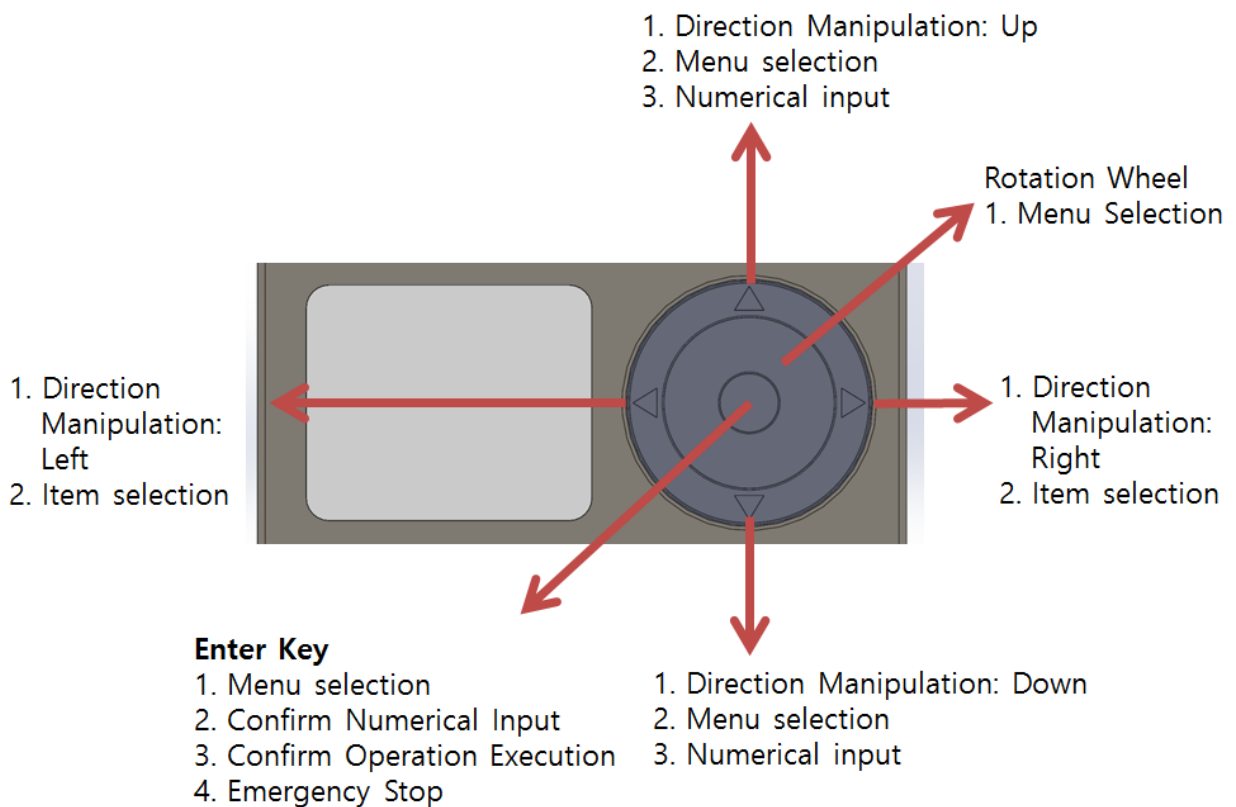
- Titan TCS V2



2. How to Use Navigation Button & Wheel

Option input can be done by rotating the navigation wheel, clicking arrow keys and the enter key at the center.

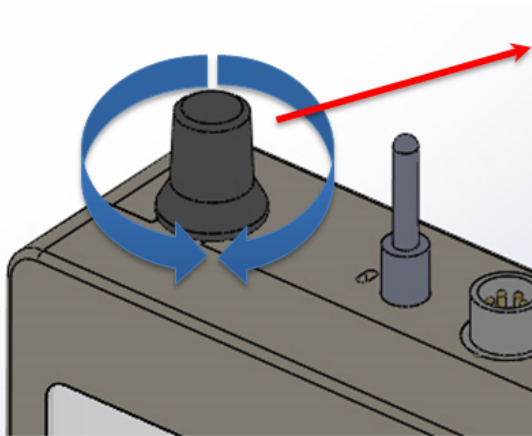
- Navigation button & wheel moves the telescope, searches for objects, and performs menu operations.
- Navigation button & wheel can be operated by rotating rotation wheel or pressing up/down/right/left arrow keys and the enter key at the center.
- Press Enter Key for 2 seconds to enter menu.



3. Parking & Speed Volume knob

Speed Selection: The slewing speed can be adjusted by rotating the volume knob. When you make adjustments, the OLED screen shows current slewing speed, which can be used for observation, astrophotography or fine adjustment.

Parking: When fully turned counterclockwise, the volume knob will tick and the telescope will be parked. The park/unpark function automatically saves and restore previous position, which ease the operation at the next observation.



Parking

Switch off : Parking Mode
on : Tracking Mode

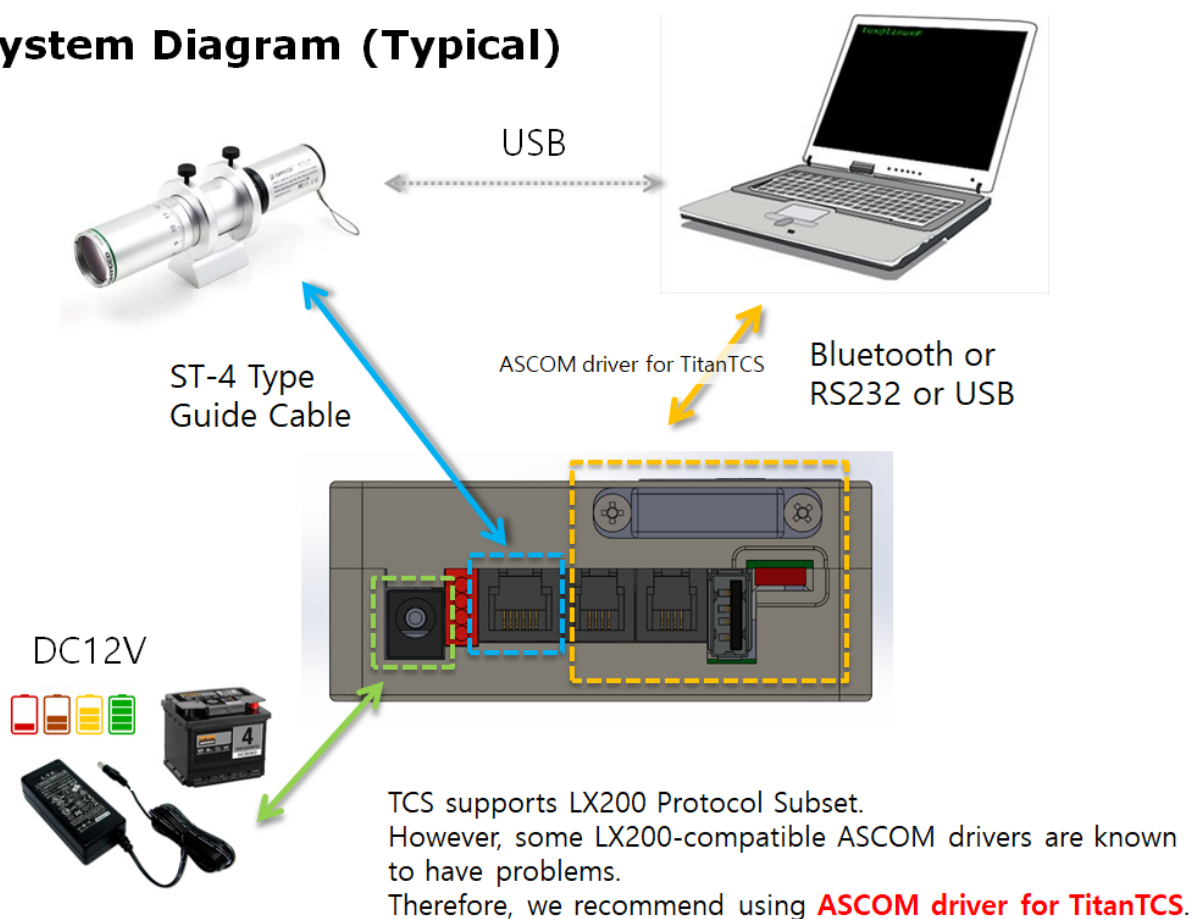
Slewing Speed

CCW : Decrease slewing speed
CW : Increase slewing speed

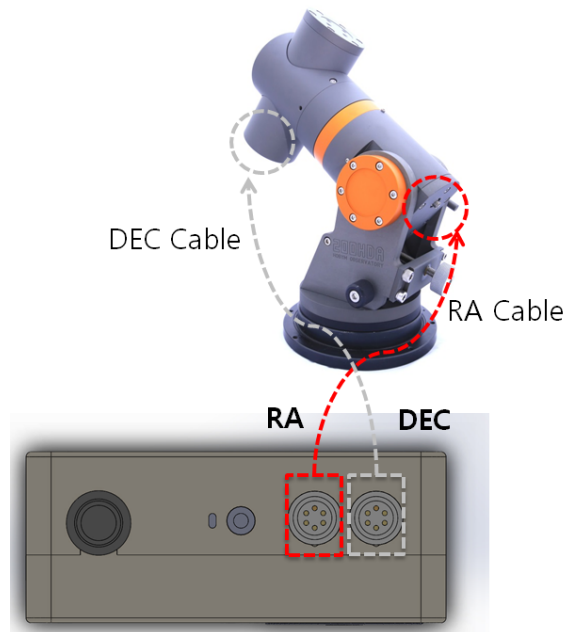
4. System Configuration Diagram

- When connected to a PC via Bluetooth, two connections may appear on the control panel, but only one connection can be used for Bluetooth.
- If you use older operation system such as Windows 7, you need to install USB driver manually.
- The driver program is provided separately.
When connected to a PC via USB, two virtual serial ports are created. Both virtual serial ports can be used simultaneously to communicate with various astronomical software.
- Caution) Even though TiTaN TCS has both Micro USB Type B connector and USB Type A connector, both are internally connected to same USB port. NEVER CONNECT TO BOTH CONNECTORS AT THE SAME TIME!
- Be sure to use a larger USB Type A if you are using USB connection. Micro USB Type B connectors have very small figure, which results in frequent contact failures depending on the cables used. Micro USB Type B is for emergency / spare use only.

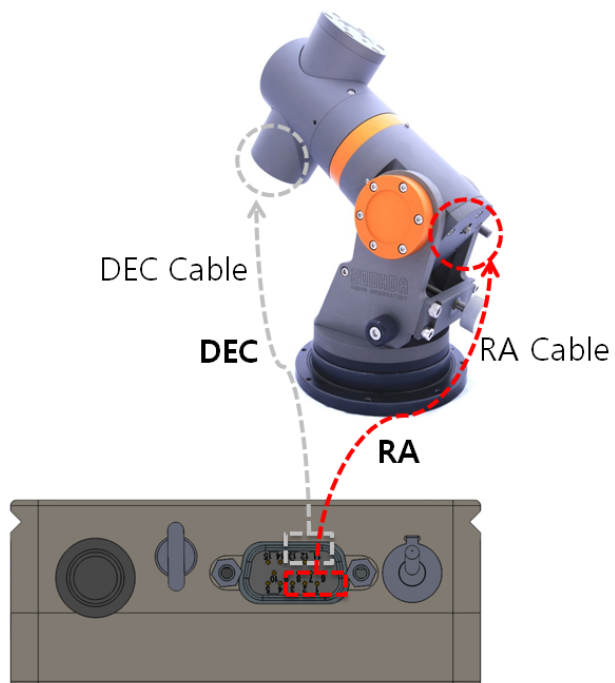
System Diagram (Typical)



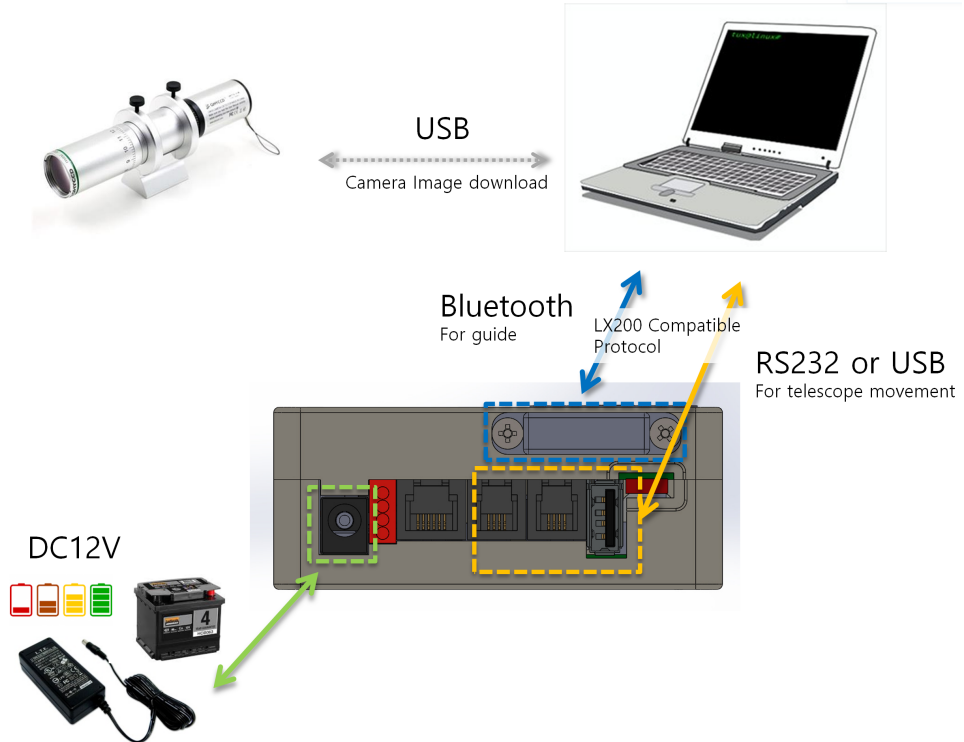
- **Motor Cable Connection (Circular Connector Type, V1)**



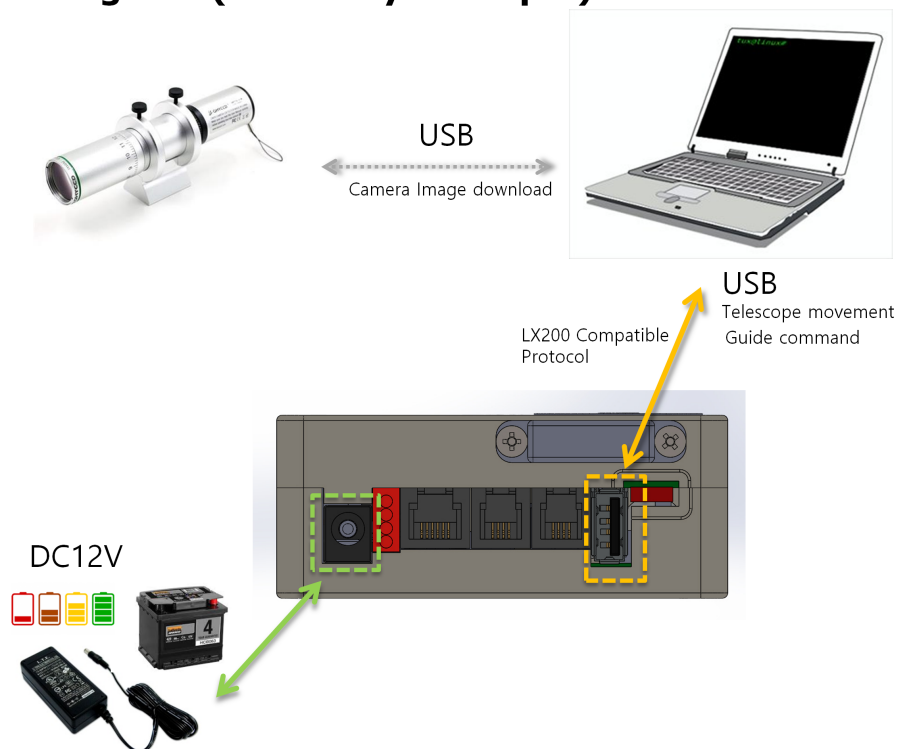
- **Motor Cable Connection (15 pin D-Sub type, V2)**



System Diagram (Bluetooth Guide Example)



System Diagram (USB Only Example)



5. Operation Sequence of TiTaN TCS

First Time Using or If you have not used Parking function:

- A. Mount the telescope on the equatorial mount: roughly balance the telescope when mounting.
- B. Connect the RA motor cable to the telescope controlling system: Connect red cable to the RA connector of the TiTaN TCS and yellow (or white) cable to the DEC connector of the TCS. Please check the indications on cable carefully as the color of cable may be different depending on the model or production date.
- C. Connect the power cable.
- D. Turn the power switch on.
- E. Select any bright star: it does not matter whether it is on the east or west. First, use the arrow keys of TCS to bring the star into the field of vision of the telescope.

Then, place it at the center of the eyepiece.

- F. Enter the controller's menu and navigate to [Object] - [Star Name] - (Pointed Star Name) - [Sync] to synchronize.
- G. Slew to the desired object and observe.

If Parking function was used in previous observation

- A. Mount the telescope in the same way as the previous observation: It will be easier to remember if you park the telescope pointing to the east horizon or to the west horizon.
- B. Connect the RA motor cable to the telescope controlling system: Connect red cable to the RA connector of the TiTaN TCS and yellow (or white) cable to the DEC connector of the TCS. Please check the indications on cable carefully as the color of cable may be different depending on the model or production date.
- C. Connect the power cable
- D. Turn the power switch on.
- E. Make sure that "SYNC" message appears at the top of the TCS screen.
If there is no "SYNC" message, you should follow instruction under "First Time Using or If you have not used Parking function" section.
- F. Select adequate bright star from [Object] menu and slew the telescope to it.
- G. Make fine adjustments at low speed to center the star exactly.
- H. In the controller menu, select [Object] - [Star Name] - (Pointed Star Name) - [Sync] to synchronize.
- I. Slew to desired object and observe.

6. Menu List

6.1. User Menu

Top Menu	Sub Menu	U/I Mode	Option	Functions
Telescope	TCS Main Operation Screen Display RA, DEC, time and TCS status			
Object	Star Name	B	Alphabet	240 items
	Solar System	B	Sun / Mercury / Venus / Mars / Jupiter / Saturn / Uranus / Neptune / Moon	Tracking rate will be changed to lunar tracking rate or solar tracking rate after sync or slew.
	Messier	B	Number	110 items
	NGC	B	Number	7840 items
	IC	B	Number	5386 items
	Caldwell	B	Alphabet	109 items
	SH-2	B	Number	341 items
	Lower Object	B	Show / Hide	Shows or hides objects below the horizon.
RA (RA Settings) / DEC (DEC Settings)	Max Speed	B	Input numerical values	Maximum slewing speed
	Acc. Rate	B	Input numerical values	Acceleration Rate
	Reverse	E	Normal / Reverse	The direction of rotation of the axis. Depending on electrical wiring or machine conditions.
	Slow Current	E	Current setting for slow speed (Tracking condition)	135mA ~ 955mA (for CRUX Mini 135mA ~ 1405mA)
	Fast Current	E	Current setting for high speed	135mA ~ 1150mA (for CRUX Mini 135mA ~

			(Slewing condition)	1405mA)
Time Lapse	Alt, Az Speed	B	Speed setting for moving speed	Speed: 0 ~ 99.0x Direction: +, - Minutes : HH:MM 00:01 min ~ 99:00 min 1 minute ~ 99 hours Start Cancel
	Interval Tmr *This menu is only supported on V2 models.		Interval Timer for camera shutter control	Delay (Seconds) : 3 sec ~ 120 min Exposure (Seconds) : 3 sec ~ 120 min Interval (Seconds) : 3 sec ~ 120 min Repeat (Seconds) : 3 sec ~ 120 min Stop Mount when exposure: Yes or No Cut Count: 1 ~ 999 Exposure Set Count: 1 ~ 999 Sets for Cuts group Wake up: Wakeup signal for Camera (double focus commands) Stop Time-lapse: Cancel [Az,Alt speed] action F/S Swap: Swap Focus and Shutter signal for different cable connection. Start: Start Interval timer Cancel: Cancel this menu
Observatory	Date/Time	B	Set Date & Time	YYYY-MM-DD HH:MM:SS
	Site	E	Select a site from the site list.	4 sites are supported.

	Site Name	E	Enter the name of the selected site	Up to 12 characters
	Location	B	Enter the location of the selected site	Latitude, Longitude
	Time Zone	B	Enter the time zone of the selected site	-12 ~ + 12 hours
Parking	Select Bank		Select bank for parking configuration. Selected bank can set name & position. User 0 is for ASCOM. It cannot be renamed. It is parking information used by ASCOM.	Latest Position ASCOM (=User0) User 1 User 2 User 3 User 4
	Edit Name		Edit name of current selected bank	
	Save Position		Save the current position as the parking position of the selected bank. * This menu cannot be selected when not in sync.	
	Parking Knob		Select the location to park with the parking knob.	Select bank
Safety	Meridian Stop (RA Auto Stop)	B	Enable / Disable	Enable: In tracking mode, RA tracking automatically stops when the RA axis passes near the meridian. The auto stop position can be specified in the "Meridian Limit" menu. In case RA auto stopped, "RA Stop! Meridian" message is displayed at the bottom of the OLED.
	Meridian Limit	E	Input numerical values (Degree)	Adjust the "Meridian Stop" position in degrees. If it is negative, it will stop before passing the meridian. In case it is positive, it will stop after

				passing.
	Landscape	E	Sky view / Landscape	When Landscape mode is selected, RA tracking stops and " Stop! Landscape " message is displayed at the bottom of the OLED.
	Go below horizon	E	Enable / Disable	<p>Enable: When the TCS executes a command that slews to the target, the telescope can be directed down the horizon.</p> <p>But, if the "Meridian Flip" is disabled, the command to slew the telescope down the horizon is ignored.</p> <p>Disable :</p> <p>The TCS ignores commands that slew the telescope below the horizon.</p>
	Alt Lower Limit	E	<p>Altitude of the horizon limit (Degree).</p> <p>This limit is affect only slewing final target position.</p>	When [Go below horizon] option is enabled, you can adjust the altitude of the horizon.
	Alt Upper Limit		*Altitude limit for slewing target position. This limit is affect only slewing final target position.	0+ ~ +30 (*Value 0 is altitude 90, Value 30 is altitude 60)
	Idle Timer		Stop mount for long operation without any action.	Value 0 is disable idle timer. 1 ~ 999 minutes: Enable idle timer
	Sleep Timer		When the timer expires, the mount is stopped.	Value 0 is disable sleep timer.
Meridian (Meridian Flip)	Meridian Flip	B	Enable / Disable	

PEC	PEC	B	Enable / Disable	
	PEC Training	B	Start / Stop	
System	Max Bright	B	Input numerical values (%)	Maximum OLED Brightness (20~100 %)
	Min Bright	B	Input numerical values (%)	Minimum OLED Brightness (20~50%)
	Dimming Sec	E	Input numerical values (seconds)	OLED Auto dimming delay time (5 ~ 300 seconds) When the “Dimming Sec” elapses, the brightness of the OLED dims to the minimum brightness.
	Guide Speed	B	Input numerical values	0.1x ~ 0.9x
	Batt Low V	E	Input numerical values (voltage)	Set voltage for battery low voltage warning
	Batt Over V	E	Input numerical values (voltage)	Set voltage for battery over voltage warning
	DC/A Limit (DC Current Limit)	B	Input numerical values (current)	If the total current consumption exceeds the set value, the TCS temporarily reduce the motor acceleration rate. Note: The actual current consumption is not limited. It only reduces the acceleration of the motor.
	CPU Overheat	E	Input numerical values (Celsius degree)	Set Celsius degree for CPU Overheat warning.
	Tracking Rate	B	Select RA tracking rate	Sidereal / Solar / Lunar
	Beep Level		Select message beep level	Detail ~ Silent
Mount Type	E	Mount Type	Equatorial / Alt-Az *If you change the mount type, you must save and reboot.	

	Serial A	B	Communication Speed (BPS)	Default (115,200) 9600 ~ 115,200
	Serial B	B	Communication Speed (BPS)	Default (115,200) 9600 ~ 115,200
	U/I Mode	B	Select U/I menu level Beginner / Expert	This setting is not reflected until reboot.
	Power Monitor		Power monitor	Volt & Current for DC-in. Volt & Current for internal motor power source. The current sensor may have an offset error of about 0.2A. Users can optimize power consumption for low power system.
	Guide Port		Ignore guide port.	Guide port(RJ-12) can be ignored using this menus. TCS has pulse guide function using ASCOM or LX200 protocol.
Security	TCS Name	B	Enter name of TCS for Bluetooth connection.	Up to 12 characters
Save	Save, Exit	B	Save last settings	Yes / Cancel
	Backup	E	Save last settings to backup memory	
	Restore	E	Restore settings from backup memory	
	Reboot	B	Reboot TCS	
Help	Hardware	B	Illustrations of various connector locations on TCS	
	Serial BPS	B	Display the speed of serial port A/B (Display only)	RS-232 / BPS
	Version	B	Display firmware information & Serial	Model, version, date Serial Number

			number of TCS	
	Firmware Update		Enter firmware update mode	To terminate this function, turn the power off and on. However, never turn off the power after the firmware has been started.

U/I Mode

B : Beginner Mode

E : Expert Mode

"Observatory" / "Date / Time" does not need to be saved after changing the setting. Immediately after entering the Date & Time is reflected in the internal clock.

"Safety" / "Landscape" does not need to be saved after changing the setting. It is an execute command, and this value is not stored in memory. When you reboot, it will always be initialized to "Sky View" mode.

[System] / "Tracking rate" does not need to be saved after changing the setting. It is an execute command, and this value is not stored in memory. When you reboot, it will always be initialized to "Sidereal Tracking Rate" mode.

[System] / "U/I Mode" must be saved after changing the setting. This setting is reflected in the menu after rebooting.

"PEC" / "PEC Training" does not need to be saved after changing the setting. If training is started and training is successful by the "PEC" / "PEC Training" / "Stop" menu, it is auto-saved in separate memory for PEC.

"Security" / "TCS Name" does not need to be saved after changing the setting. Immediately after entering the TCS Name is reflected in the internal special memory.

You do not need to save the "Telescope", "Object" and "Help" menu groups. These menu groups are execution commands.

Menus not specifically mentioned above must be saved after setting values have been changed so that the changed values can be read after rebooting.

[RA] and [DEC] menus must be saved after setting value is changed to reflect the changed result. The TCS performs the calculations and initialization related to the motor again when setting values are saved.

Under normal operating conditions, if the temperature of the TCS exceeds 40 ° C, it may be overloaded.

To improve the overload condition, adjust the Slow / Fast Current properly in the [RA], [DEC] menu.

Operation for long time beyond 55 ° C may result in damage to internal components.

Power devices generate heat, so the temperature is higher than the CPU.

It is recommended that you save, reboot, and check the function again after you change important settings.

7. Explanation of Menu

1. How to enter menu mode

To enter the menu operation mode, press the enter key in the center of the navigation button for more than 2 seconds.

Press for more than 2 seconds at "Telescope" Mode.



When you enter menu mode, the top menu is displayed on the screen.

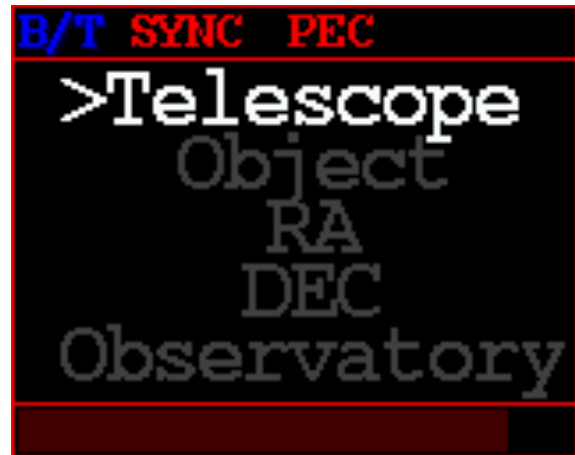
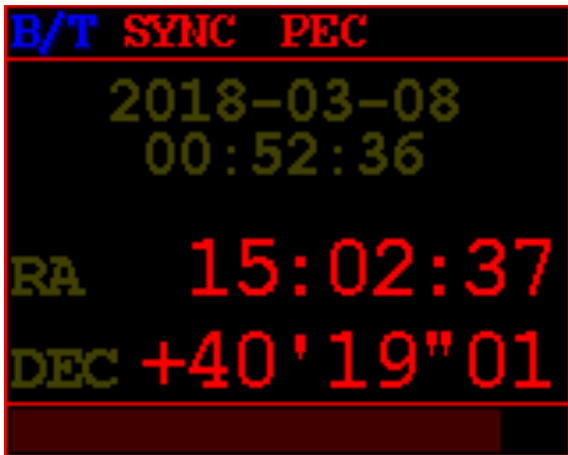
To return to telescope mode, select the telescope menu and press the enter key.

Use the rotation wheel for quick menu navigation.

2. Telescope

The first state after power up is Telescope mode.

Displays basic information, including current date and time, RA and DEC, current status.



- B/T : When Bluetooth is connected to the TCS, “**B/T**” is displayed at the top.
- SYNC : When TCS is synchronized, “**SYNC**” is displayed at the top.
- PEC :
If the PEC data is valid but the PEC has not been started, dimmed gray color “**PEC**” will be displayed at the top.
If the PEC has been started, red color “**PEC**” will be displayed at the top.

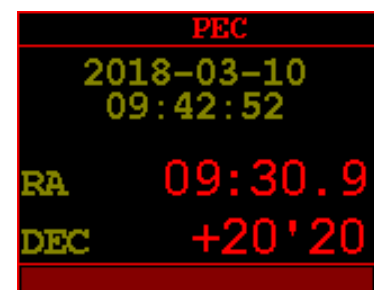
● PEC Status Examples



No PEC information



PEC data is valid.



During PEC operation

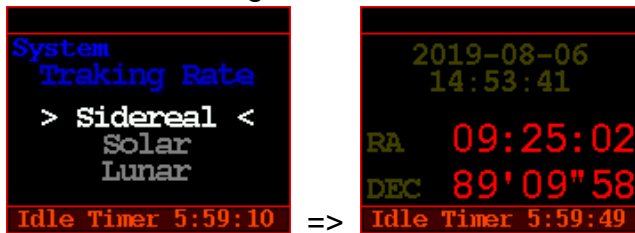
- PEC Menu



- Tracking Rate :

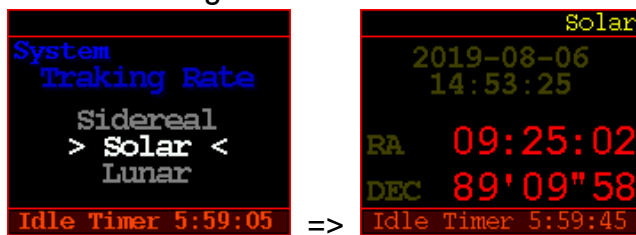
If the RA tracking rate is not Sidereal tracking rate, a yellow color “Solar” or “Lunar” is displayed at the top.

1. Sidereal tracking rate



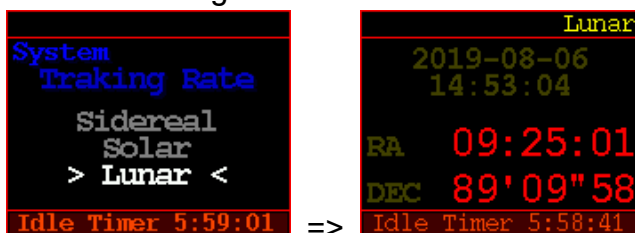
There is no status indication for Sidereal tracking rate.

2. Solar tracking rate



Status : “Solar”

3. Lunar tracking rate



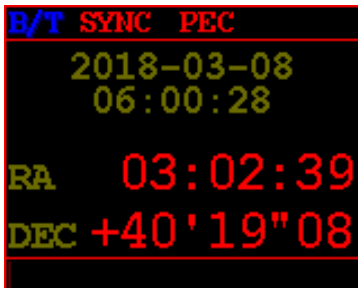
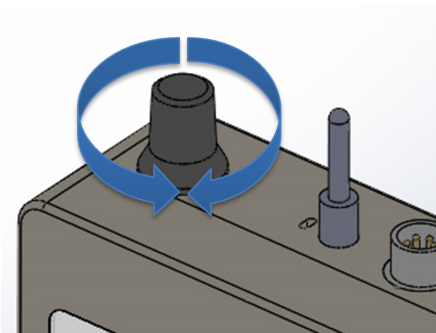
Status : “Lunar”

The tracking rate can also be changed using the “Object/Solar System/Goto” or “Object/Solar System/Sync” menus.

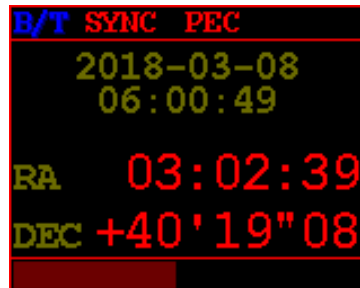
- Speed Volume :

The speed of the motor operated by the navigation button is displayed as a dimmed red bar at the bottom.

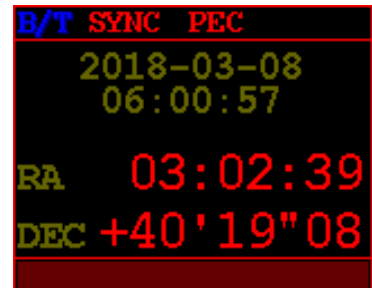
The Speed Volume affects only when slewing with the TCS navigation button.



Speed about 0%



Speed about 40%

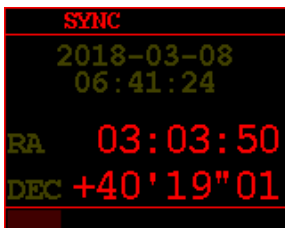


Speed about 100%

- Parking

Use the parking knob to enter the parking mode.

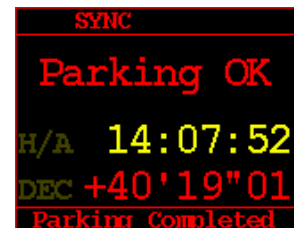
TCS stores the last harmonic and mount position in nonvolatile memory.



=>



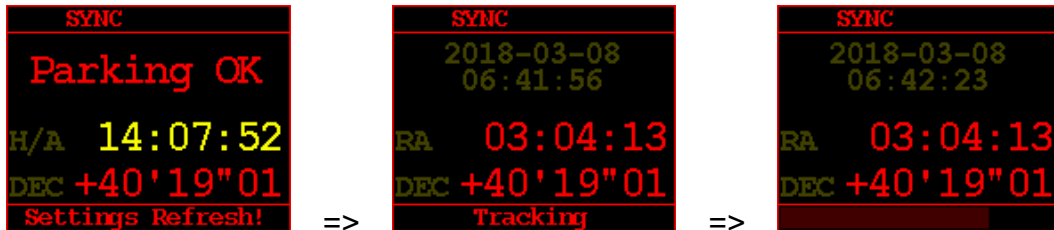
=>



The parking procedure is complete. You can turn off the power.

Later, when you turn on the power, you can see that the previously saved information has been restored.

The final position of the telescope, whether it is synced or not, and the PEC training results are restored to the same as before parking.



The TCS carefully moves the stepping position of the stepper motor to the origin and completes parking. However, if the power is turned off and on many times, the step position may change unintentionally.

For precise PEC, It is recommended to refresh the PEC training after many power cycles.

- Top menu screen



3. Object

It is possible to slew or synchronize to the desired object by directly choosing it from TCS menu

- Select celestial list type

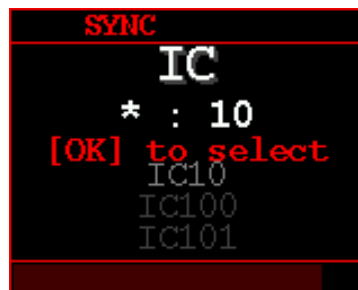


First, Select the type of celestial list type.

- Search screen (3 ways)



String Keyword



Number Keyword



Name List

After selecting a list type, a search screen appears to select for objects in the list.

There are two ways to search by keyword: search by string and search by number. On the other hand, the solar system can be selected from the list of names.

The maximum length of a keyword that can be entered is 4 characters. Typically, typing two characters will help you find exactly what you want.

Characters are not case-sensitive.

As keywords are searched in front of the string, they appear at the top of the list.

- Search screens

```

SYNC
Star Name
* : NE
[OK] to select
Nekkar
Alcyone
Arneb
    
```

```

SYNC
Caldwell
* : NE
[OK] to select
Blinking planetary
Bubble nebula
Bug nebula
    
```

```

SYNC
Messier
* : 10
[OK] to select
M10
M100
M101
    
```

```

SYNC
NGC
* : 10
[OK] to select
NGC10
NGC100
NGC101
    
```

```

SYNC
IC
* : 10
[OK] to select
IC10
IC100
IC101
    
```

```

SYNC
SH-2
* : 10
[OK] to select
sh2-10
sh2-100
sh2-101
    
```

```

SYNC
Solar System
1 / 9
> Sun <
Mercury
Venus
Mars
    
```

```

Manual
1 / 4
> West <
East
South
Current
Idle Timer 5:59:37
    
```

- Star Name : 240 stars
- Solar System : Solar system objects including the Sun and Moon.
- Messier : 110 objects
- NGC : 7840 objects
- IC : 5386 objects
- Caldwell : 109 objects
- SH-2 : 341 list of Sharpless

Use the arrow keys to input the keyword and press the Enter key.
Up to 100 results are displayed.



The list is white if the altitude of the celestial body is above the horizon and gray if it is below the horizon.

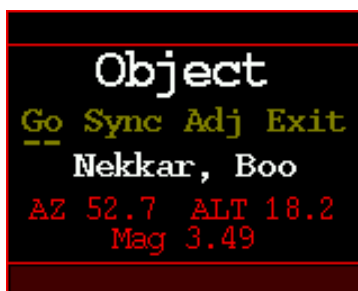
ex) "Nekkar" is above the horizon, "Alcyone, Arneb" are below the horizon.

In the displayed list, select the target using the up / down arrow keys and press the Enter key to display the Goto / Sync screen



When a low-altitude object is selected, the following Warning screen is displayed so that it cannot be goto / sync.

- Goto / Sync / Adjust position Function screen



Goto / Sync / Adj Screen

=>

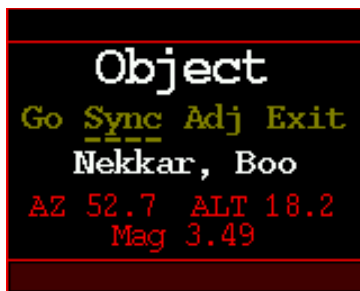


Goto Monitor

When the "Goto" function is selected, a window similar to "Telescope" Mode appears and displays the movement to the target.

Up / Down / Left / Right buttons do not work in this screen.

If you press Enter key at this time, the movement is immediately canceled and the screen returns to the previous screen.



Selecting the "Sync" function will synchronize the position of the selected object with the telescope.



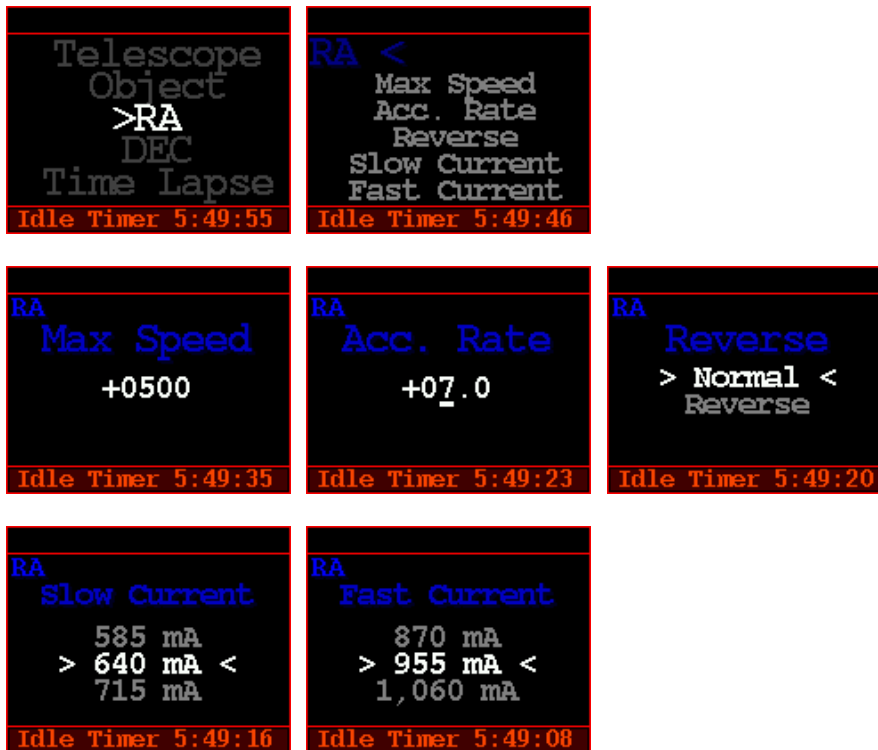
Selecting the "Adj", you can fine tune the position of the telescope by manipulating the directional keys.

Press [enter] to finish the "Adjust position" operation

4. RA

Sets RA speed and other variables.

- RA sub-menu

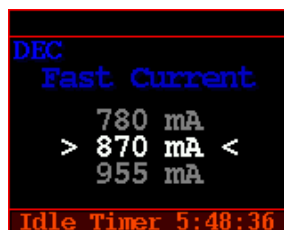
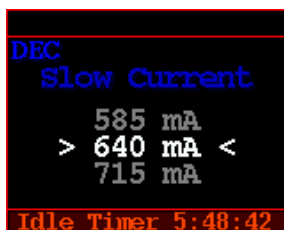
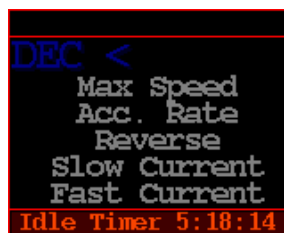


- Max Speed : Setting the maximum RA slewing speed.
- Acc. Rate : RA speed Acceleration / deceleration.
The lower the value, the slower the acceleration / deceleration.
Slowing the acceleration lessens the load on the mount and the motor.
Excessively high Acc. Rate requires a large current instantaneously at the moment of acceleration, and the drive system also requires a relatively high torque, which may cause of stall of the stepper motor.
- Reverse : Specify the direction of rotation of the stepper motor.
Specify in this menu when the direction of the telescope's direction does not match the command.
- Slow Current (Tracking Speed Current)
Specifies the current required for low speed drive.
This is mainly the current required for tracking.
In this case, the stepper motor operates in 1/128 microsteps.

- Fast Current (Slewing Speed Current)
Specifies the current required for high speed drive.
Torque required for acceleration, voltage boost for high-speed operation consumes a lot of current for a short time.
In this case, the motor operates in the microstep specified in the Fast microstep.

5. DEC : Sets DEC speed and other variables.

Same as RA settings.



6. Time Lapse

6.1. Az, Alt Speed

- Az : Moving speed of azimuth axis (=RA axis)
- Alt : Moving speed of altitude axis (=DEC axis)
- Minute : Duration of time lapse operation,
At the end of the time, the mount stops.
- Stop / Start : Time lapse operation command

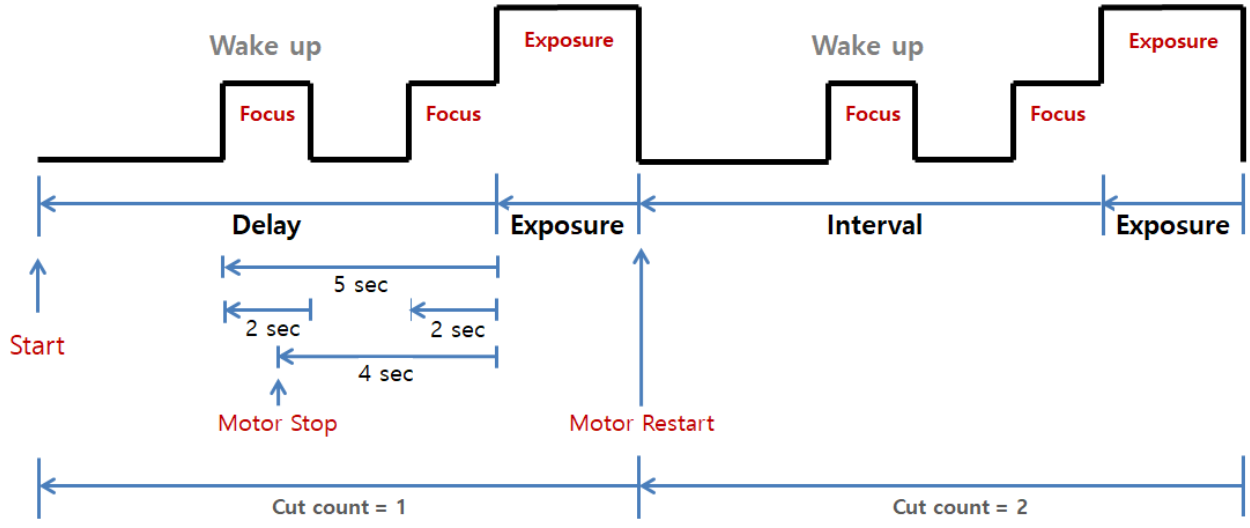


6.2. Interval Timer

**This menu is only supported on V2 models.*

- Delay
Time delay until 1st exposure. (unit : seconds)
- Exposure
Exposure time
- Interval
The time interval between each exposure.
- Repeat
The time interval between each set.
- Stop Mount
Stop the motor during exposure.
Motor stopping is about 4 seconds before exposure, and restarting is after exposure.
- Cut Count
Number of exposure in single set
- Set Count
Count of set,
Total exposure count is [Cut Count] x [Set Count]

- Wake up
Camera wake-up function.
Turn off the camera power saving function by sending a focus signal 5 seconds before exposure.
- Stop T-Lap. (Stop Time-lapse)
The entire exposure is completed, turn off the Time-lapse function.
TCS returns to tracking mode.
- F/S Swap (Focus / Shutter Swap)
Depending on the release cable, the Focus / Shutter wiring may have changed.
Focus and Shutter signals are interchanged and output.
- Start
Start interval timer
- Cancel
- Time chart about action
(example case : single set, two cuts, wake up, stop mount)



7. Observatory
Current Date/Time and location setting



- Date/Time : Set current date and time. Current date and time will always retained by internal Real Time Clock(RTC.)

If the current date and time are cleared each time the power is turned off, try moving the battery tray back and forth several times.

Moisture or other causes may cause poor contact.

If this does not improve, replace the CR2032 button cell.



- Site :
Select a site from the site list. The number of sites in the list is four.

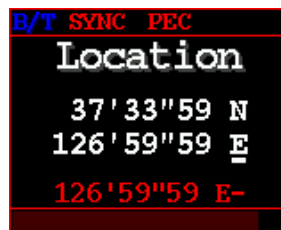
“Location”, “Time zone”, and “Site Name” are information corresponding to the selected site.



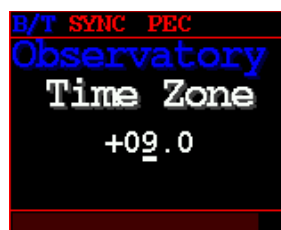
- Site Name :
Enter the name of the site selected in the “Site” menu.
Up to 12 characters can be entered, and blank characters cannot be entered consecutively.



- Location : Enter the location of the site selected in the “Site” menu.
Set the Latitude and Longitude of current site.



- Time zone : Enter the time zone of the site selected in the “Site” menu.
Set the standard time zone in current site.



8. Safety



- Meridian Stop :

Enable :

In tracking mode, RA tracking automatically stops when the RA axis(=Telescope Direction) passes near the meridian. The auto stop position can be specified in the "RA Limit" menu.

In case RA auto stopped, "RA Auto Stop!" message is displayed at the bottom of the OLED.



- Meridian Limit : Adjust the " Meridian Stop" position in degrees.
If it is negative, it will stop before passing the meridian. In case it is positive, it will stop after passing.



- Landscape (RA tracking stop)
When “Landscape” mode is selected, RA tracking stops immediately and "Stop! Landscape" message is displayed at the bottom of the OLED.



“Sky view mode” is normal tracking mode.



- Go below Horz. (Go below the Horizon)



Enable :

When the TCS executes a command that slews to the target, the telescope can be directed down the horizon.

The lowest altitude of the telescope is aimed at is -15 [deg].

But, if the “Meridian Flip” is disabled, the command to slew the telescope down the horizon is ignored.

Disable :

The TCS ignores the command that directs the telescope below the horizon.

9. Meridian

Set the operation related to the meridian.



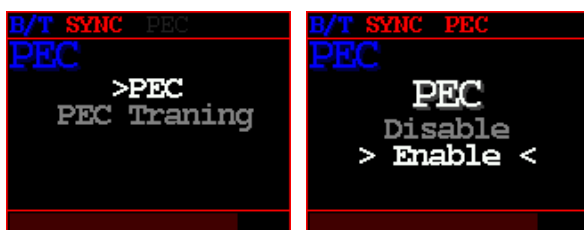
- Meridian Flip : Disable or enable automatic meridian flipping by choosing this option.
By limiting the movement of the RA, the collision between the telescope and the tripod or pier can be prevented.

10. PEC

It corrects periodic error of harmonic reducer and enables high precision guiding for astrophotography and high magnification observation.



- PEC : Select whether to enable Periodic Error Correction through Disable / Enable option. The PEC function can only be activated when stored PEC data is valid.



- PEC Training : It performs measurement of periodic error and calculation of correction data by using internal microprocessor.
PEC Training function is only available during operation of auto guide system using a guide CCD, a guide telescope, and PC.

When you select [start] and start training, it usually collects data of 2 cycles. If the training was successful, the PEC function is automatically activated. If the period of two cycles is too long or it is impossible to learn by variables such as clouds, the user can stop training by selecting “PEC Training” / “Stop”. In this case, the PEC function is available only if training has been completed for more than one cycle.

PEC training will always be kept up-to-date. If new training is performed, the old training data will be deleted automatically and new training data will be used for PEC function.

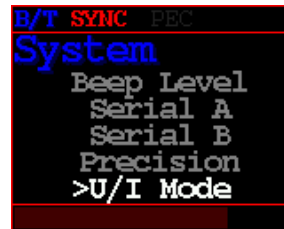
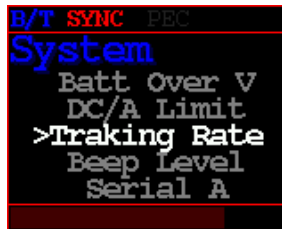
During PEC training is running, yellow color “PEC/T” is displayed at the top. TCS shows the progress of PEC training in percentage at the bottom of the screen



Ex) PEC Training progress examples

11. System

Guide Speed, power-related and communication speed settings.



- Max Bright
Maximum OLED Brightness(20~100 %)

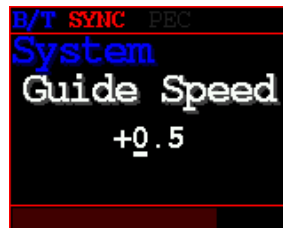


- Min Bright
Minimum OLED Brightness (20~50%)

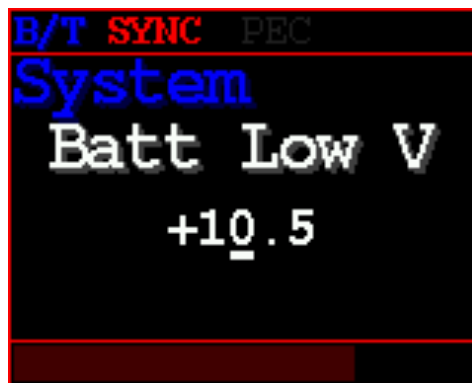


- Guide Speed : The guide speed can be set from 0.1 to 0.9 and it is the setting to maintain the optimum guide condition.
For example, when the guide speed is set to 0.5, the right ascension (RA) motor is driven at a speed of 0.5~1.5 times, and the deceleration (DEC) motor is driven at a speed of -0.5 ~ +0.5 times.

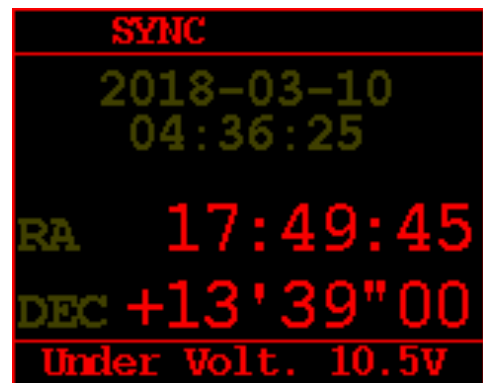
For reference, increase Guide Speed for short focal length guides and decrease guide speed for long focal length guides.



- **Batt Low V** : Set Battery low voltage warning
You can set the minimum battery voltage value for warning.
- When a under voltage situation occurs, a under voltage message will be displayed on the screen with the beep sound.



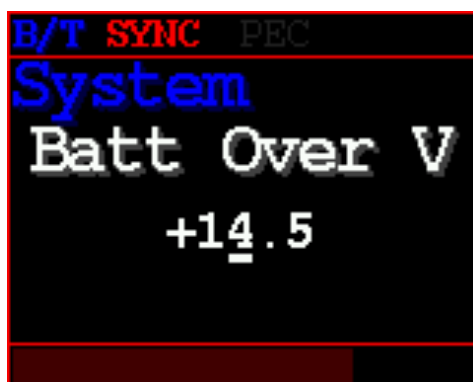
=>



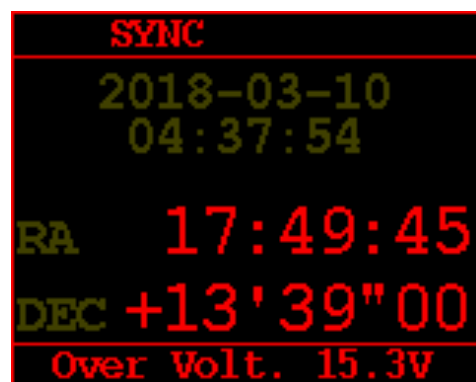
Ex) Under voltage condition

- **Batt Over V** : Set Battery over voltage warning
You can set the maximum battery voltage value for warning.

When an overvoltage situation occurs, a over voltage message will be displayed on the screen with the beep sound.



=>



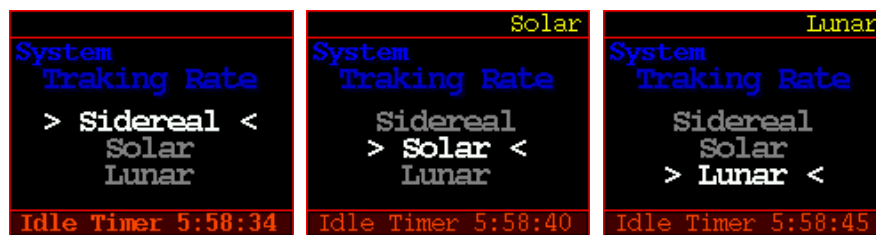
Ex) Over voltage condition

- DC/A Limit : Set DC Current Limit
The total current consumption is monitored.
If the TCS consumes more current than the set value, motor speed acceleration is automatically lowered to reduce current consumption.
Nevertheless, the actual consumption current may exceed the specified set value even if the consumption current decreases by lowering the acceleration amount.

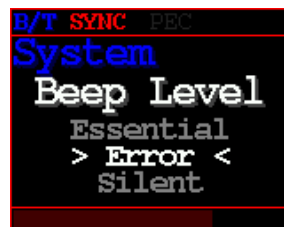


Ex) Over current condition

- Tracking Rate : Select RA tracking rate
Sidereal / Solar / Lunar



- Beep Level : Select message beep level



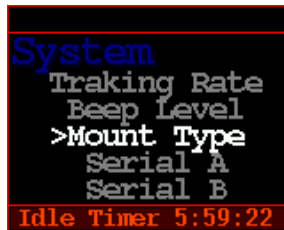
- Mount Type

If you change the mount type, you must save and reboot.

The mount type must match the mechanical type of the mount.

For Equatorial Mount, the coordinates are based on RA and DEC.

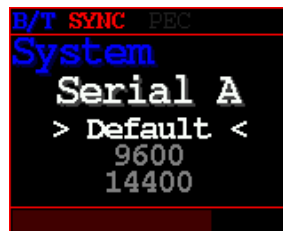
For Alt-Az Type, the coordinates are based on Az and Alt.



- Serial A : RS-232 A

You can set the communication speed with the astronomical simulation software and Serial port A.

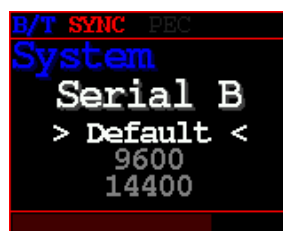
The factory default setting is 115,200 bps, no parity, 8 data bits, and 1 stop bit. User can select from 9,600 ~ 115,200 bps.



- Serial B : RS-232 B

You can set the communication speed with the astronomical simulation software and Serial port B.

The factory default setting is 115,200 bps, no parity, 8 data bits, and 1 stop bit. User can select from 9,600 ~ 115,200 bps.



- U/I Mode : Select U/I menu level

Beginner / Expert

This setting is not reflected until reboot.



=>



Ex) Expert Mode Menu



=>



Ex) Beginner Mode Menu

12. Save

The manipulated setting values can be stored in the nonvolatile memory of the TCS.

Once saved, the settings will not be erased even after the power is turned off and can be used when the power is turned on again.

- Save Menu



- Save, Exit

The TCS stores the last settings to internal memory and goes out to "Telescope" mode.



- Backup
Save last settings to backup memory



- Restore
Restore settings from backup memory

```
B/T SYNC PBC  
Save  
Save, Exit  
Backup  
>Restore  
Reboot
```

- Reboot
TCS will reboot itself. If you use parking, please park first.

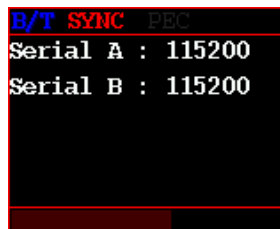
```
B/T SYNC PBC  
Save  
Reboot  
> Yes <  
No
```

13. Help

The connector assignment of TiTaN TCS and current communication speed can be checked.



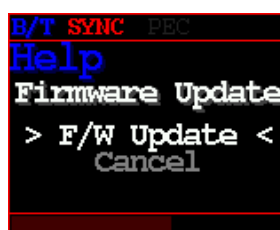
- Serial BPS : Display the speed of serial port A/B (Display only)



- Version
Display firmware information.



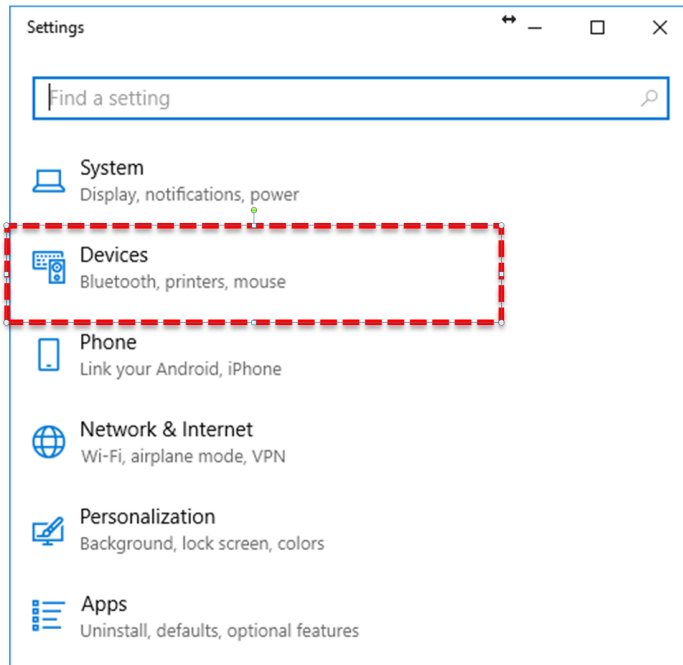
- Firmware Update : Enter firmware update mode
To terminate this function, turn the power off and on.
But, Never turn off the power while updating the firmware.



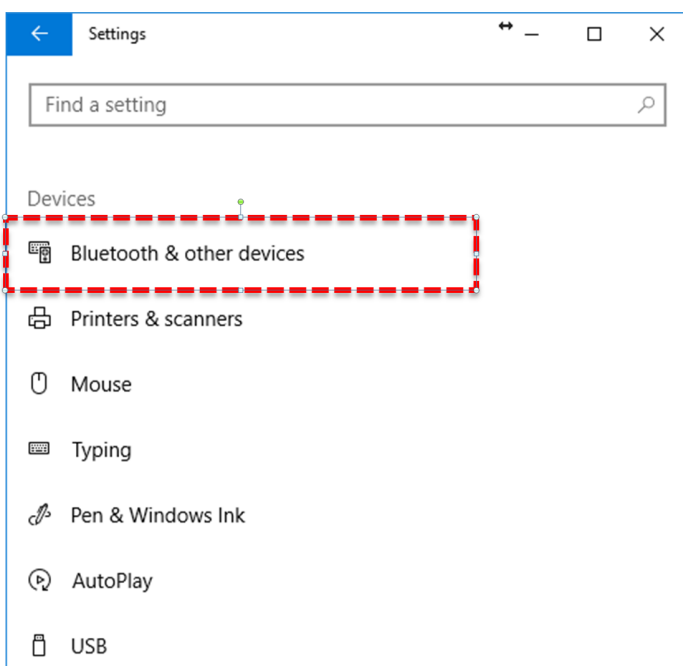
8. Bluetooth

8.1. How to connect TiTaN TCS to your PC via Bluetooth (Standard: Win10)

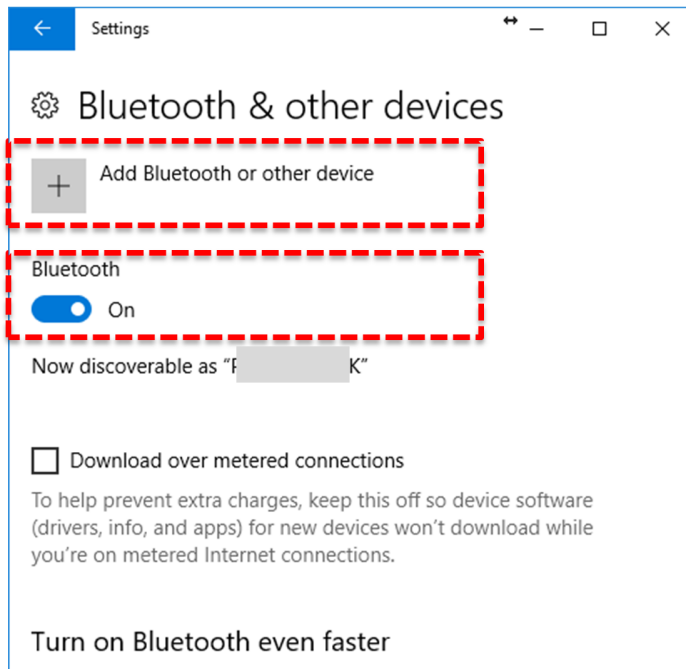
1. Select "Devices" in Windows Settings.



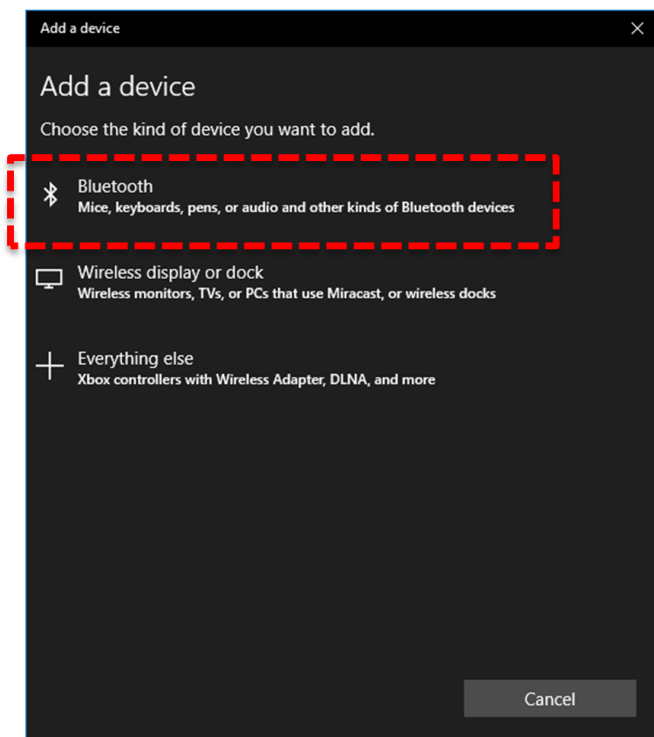
2. Select "Bluetooth & other devices" of the left menu bar.



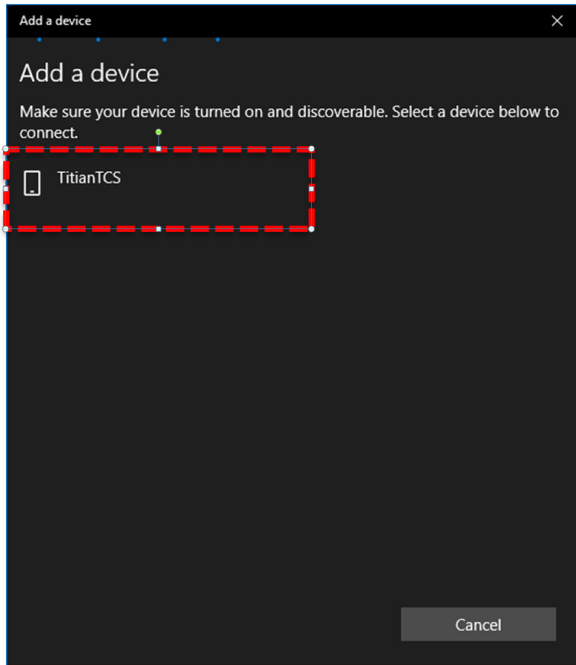
3. Make sure Bluetooth is on and select "Add BT".



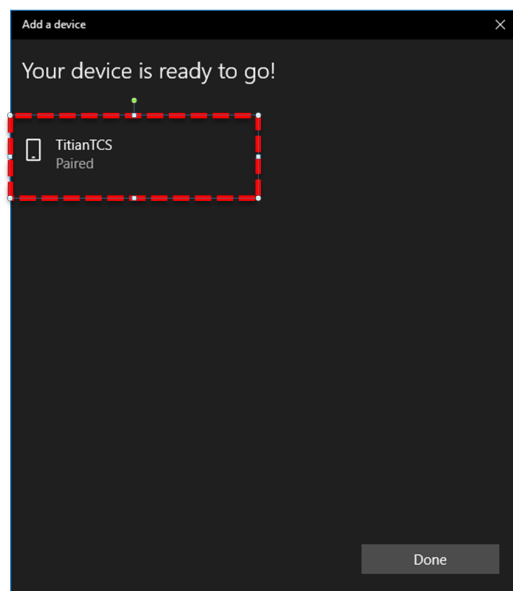
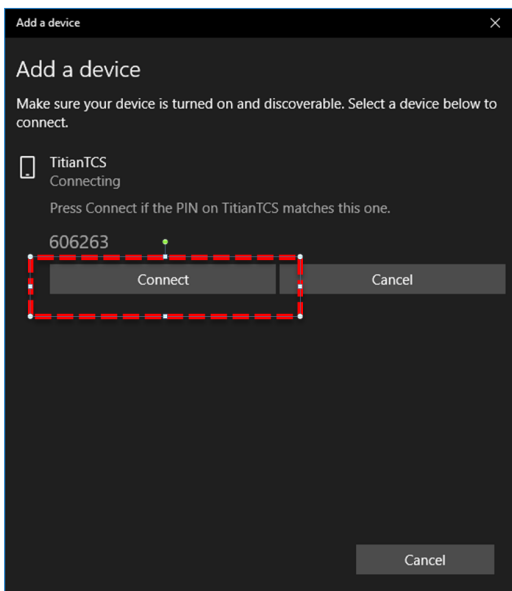
When the "add device" screen appears, select bluetooth.



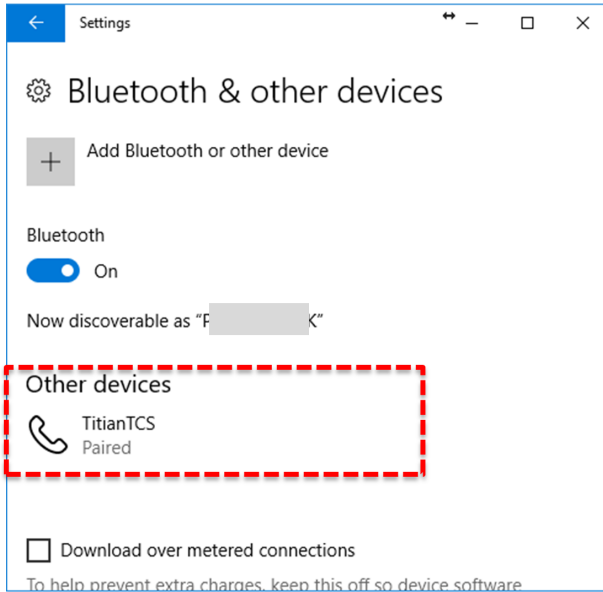
4. If the Titan TCS is powered on, it will take a moment and display "Titan TCS".
If you entered a different name in the [Security] menu in TCS, the name will be displayed.
It may take several tens of seconds to display the device.
Click the [TitanTCS] button or ["custom name"] button.



5. "Compare Password" window will appear. If you click the [Yes] button, Bluetooth will be automatically connected.
The password is randomly generated and changes every time.



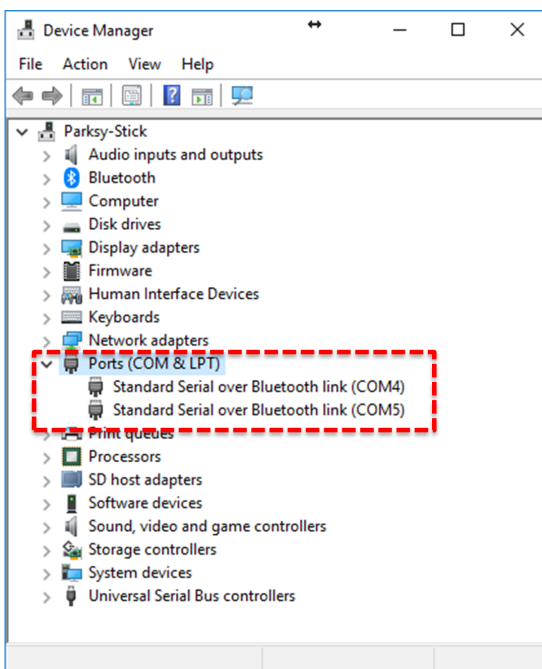
6. When the connection is successfully completed, the message "Paired" will be displayed.



7. There will be two "Standard Serial over Bluetooth link" generated, but only the top one can be used.

In the example of the figure, only COM4 can communicate.

After connection, use as the same way as normal serial communication.



8.2. How to remove TiTaN TCS from Bluetooth connection (standard: Window 10)

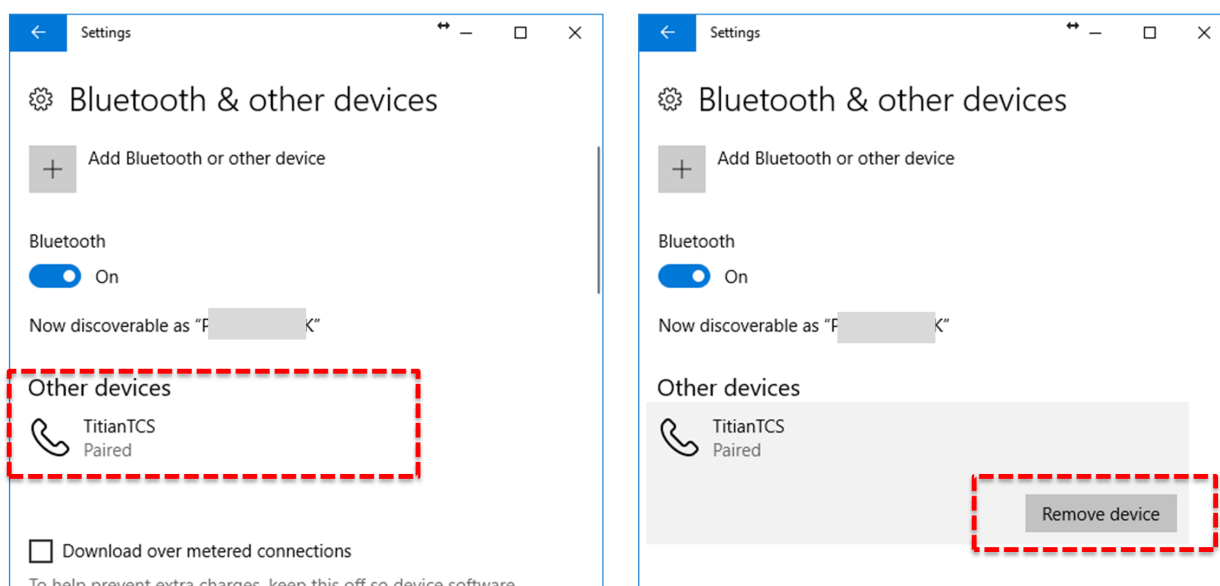
Normally, the Bluetooth device needs to be installed only once.

However, if you connect the TCS to another PC, you may need to reinstall it on the previous PC. In this case, you can resolve the problem by removing and reconnecting the TCS Bluetooth from device.

Remove it with the [Remove Device] button in the "Bluetooth Device Management" window.

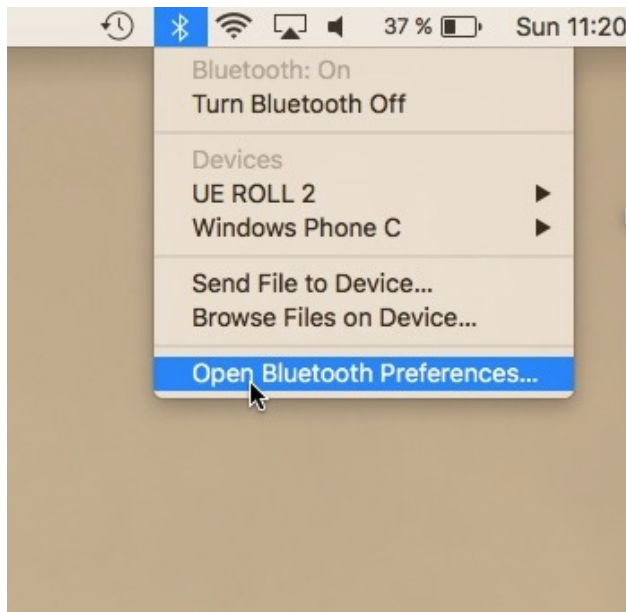
Wait for a moment after removing the device. The "Titan TCS" device will be displayed again.

Click [Connect] button to install again.

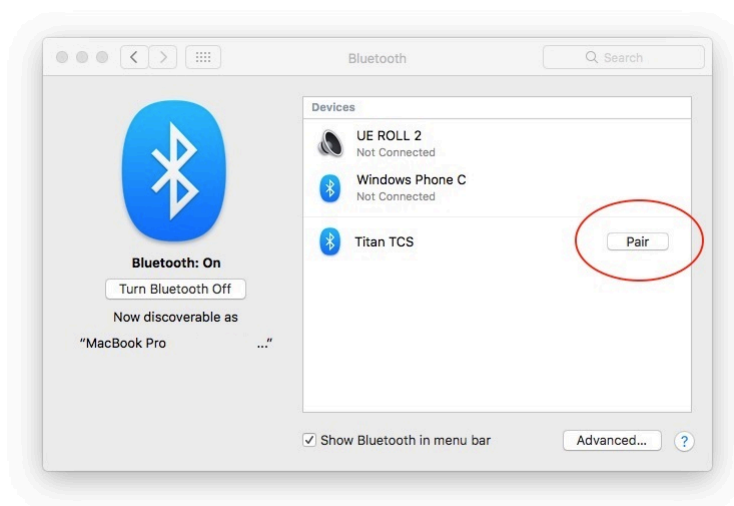


8.3. How to connect TiTaN TCS to your MAC (OSX)

1. Select "Open Bluetooth Preferences..." in status menu.



2. If the Titan TCS is powered on, it will take a moment and display "Titan TCS". If you entered a different name in the [Security] menu in TCS, the name will be displayed. It may take several tens of seconds to display the device. Click the [Pair] button.



After a while, you will succeed Bluetooth pairing. Unlike windows, mac shows only one connection and can use it.

9. Technical Specifications

Power supply	12V, 4A Built-in reverse voltage protection circuit, built-in 2.6A Polyswitch for overcurrent protection.
Current consumption	About 250mA to 700mA when tracking 0.7 ~ 2.5A when high-speed slewing, depending on operational status
Microprocessor	Main Control : 32bit 120MHz U/I : 32 Bit 240MHz dual-core
Internal power	3.3V, 5V, Motor power(~30V) Over Voltage shut off function
USB Power supply	5V 0.6A Over Voltage shut off function
Motor/microstep	Two-phase bipolar stepper motor 1/128 on tracking, 1/4~1/32 on high-speed slewing depending on the setting.
Motor PWM frequency	About 45 KHz
Display	OLED 2.69", 160 x 128 x 16 Bit
Serial port	RS-232 2 Port 1.GND, 2.NC, 3.Tx, 4.Rx
Guide port	RJ-12, 4 status LED (Red) 1.NC, 2.GND, 3.RA-, 4.DEC-, 5.DEC+, 6.RA+
DC jack	Barrel outer diameter: 6.3mm Pin diameter: 2mm
Bluetooth	Supports Serial Port Protocol (SPP 1.2) Windows 10, OSX, Android are tested. iOS are not currently support.
Wi-Fi	Hardware ready for 802.11 b/g/n/e/i, Planned to be supported.
USB	TitanTCS V1: Micro Type A & USB Type A connector (CAUTION : cannot be used simultaneously) TitanTCS V2: USB Type A connector
Built-in Real Time Clock (RTC)	Built-in low-power RTC (current draw about 350 ~ 700 nA)
Replaceable battery	Lithium button cell battery (CR2032)
Motor connector	TitanTCS V1: Two Circular Connector RA : A+, A-, B+, B-, NC, NC (6 pin) DEC : A+, A-, B+, B- (4 pin) TitanTCS V2: High Density D-Sub 15 Pin RA : A+, A-, B+, B- (4 pin) DEC : A+, A-, B+, B- (4 pin) DC-In GND (2 Pin)

	DC-In +12V (2 Pin)
Camera Shutter Control	3.5mm Stereo Jack for camera focus & shutter signal * TitanTCS V2 only

CAUTION: If AC power is supplied to the TiTaN TCS, it will be damaged. Make sure to use only at a limited voltage of DC 12V. User is responsible for the damage of the controller due to user's incautiousness.

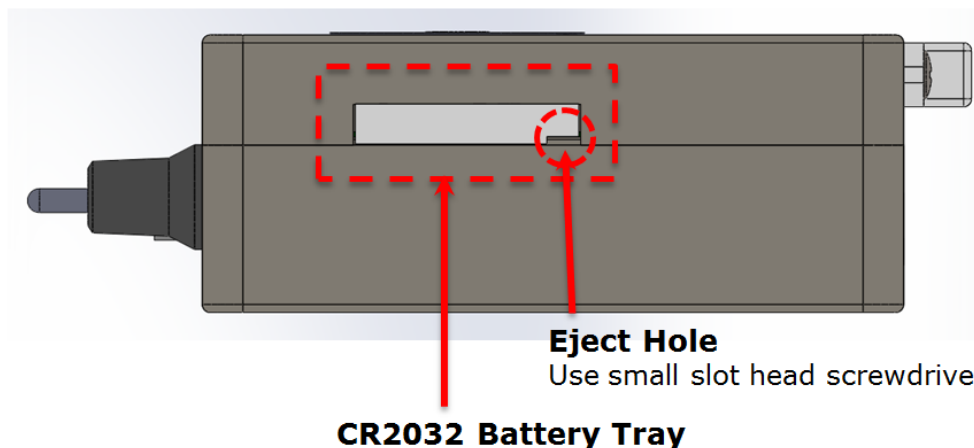
10. LX200 Commands supported

Command	Explanation	
:CM#	Synchronizes the telescope's position	
:MS#	Slew to target object	
:SdsDD*MM:SS# :SrHH:MM.T# :SrHH:MM:SS#	Set object target	
:GD#, :GR#	Get telescope position	
:SdsDD*MM:SS# :SrHH:MM.T# :SrHH:MM:SS#	Set target object	
:GS#	Get the Sidereal Time	
:GC#, :GL#	Get local Date, Time	
:SCMM/DD/YY# :SLHH:MM:SS#	Set local Date, Time	
:GG#	Get UTC offset time (Time Zone)	
:SGsHH.H#	Set UTC offset time (Time Zone)	
:Gg#, :Gt#	Get current site Longitude, Latitude	
:SgDDD*MM# :StsDD*MM#	Set current site Longitude, Latitude	
:RC#, :RG#, :RM#, :RS#	Set slew rate	
:Me#, :Mn#, :Ms#, :Mw#	Move Telescope at current slew rate	
:Q# :Qe#, :Qn#, :Qs#, :Qw#	Halt Slews	
:U#	Toggle precision positions	

11. Replacing the battery

For some information and internal clock, the TCS has a built-in CR2032 battery. The battery tray is on the left.

The battery tray can be removed using a small slot head screwdriver.

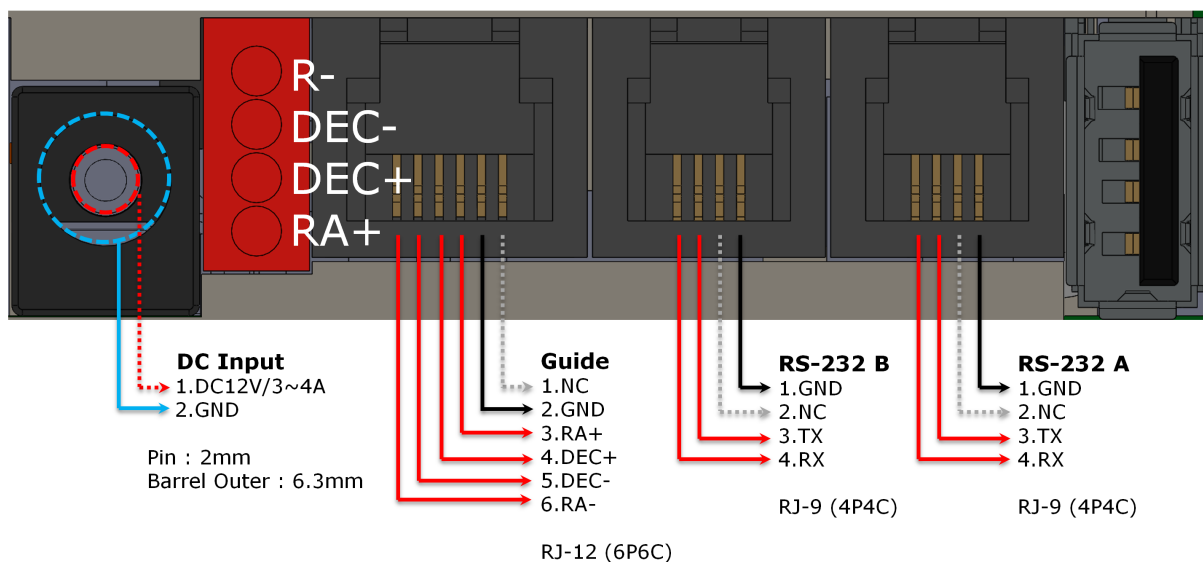


If the battery tray does not draw easily, you can slightly loosen the bolt on the back of the case within 3 turns to make drawing easier.

If the bolt is turned more than four turns, the bolt may be taken out and the internal parts may be detached.

12. Pin Map

Bottom View



13. FAQ

a. GOTO is not precisely done.

- The synced star has to be exactly at the center of the eyepiece.
- Check the polar alignment.
- Check whether there is error message displayed on TCS.
- If previous two are not the case, contact the manufacturer or the seller. Such problem may occur due to the incorrect factory default setting such as gear ratio.

b. Telescope moves toward wrong direction after GOTO.

- Check the current date/time setting.
- Check the observatory location data.
- Sync should not be done when telescope is located lower than the counterweight.

TCS is programmed to sync when telescope is at higher position than the weight.

If it is synced when the telescope is at lower position than the weight, it recognizes the telescope to be at the opposite direction.

- Sync again at proper position before using.
- Check whether there is an error message displayed on TCS during GOTO operation.
- Make sure that the direction of rotation of the RA or DEC axis is correct.
- Make sure that the RA and DEC cables are correctly connected.
- When malfunctioning continues, contact the manufacturer or the seller.

Such problem may occur when the direction of rotation of the RA and the DEC axis is reversed.

c. GOTO takes too much time.

- For accurate pointing, it slows down near the target point.
Check the current coordinate values from OLED.
- Check whether the speed volume is at or near parking.

- Check the maximum speed setting.
- d. When accelerating at maximum or high speed, the motor is noisy and does not move.
- Motor is stalled, caused by the mechanical overload due to lower temperature or low current under too much load.
 - Disconnection due to the aging of the RA / DEC cable.
 - Low DC input current / voltage.
 - Excessively imbalanced counterweight and the telescope.
 - Check the [Acc. Rate] setting. The load increases if the set value is high.
 - In this case, decrease the set value of maximum speed and acceleration speed and balance the weight of the telescope before operating.
- e. Bad connection with the simulation programs.
- When connecting with serial port.
Make sure to use an RS-232 cable dedicated to TiTaN TCS.

The RS-232 cable used by TCS is not a standard cable, and the pin connections are different for each manufacturer. Be extremely careful.

Even if the connectors are the same shape, never use unidentified serial cables.

There is a potential for permanent damage to the TCS or PC.
 - Check the serial communication speed for TCS.
The default baud rate is 115,200 bps. You can change the baud rate to suit your needs in the [System] menu.
You can check the communication speed at [Help]-[Serial BPS]
 - Check USB, Bluetooth and the COM port number: number of serial port of TCS in Device Manager.
 - When connecting via Bluetooth, a blue color “B/T” indication should appear at the top of TCS.
 - Confirm that communication protocol is selected as LX200 in the astronomical programs. Please note that the setting method for each program is slightly different. Follow the manual provided by software distributor.

- f. The time and location of the simulation program does not match with the ones of TCS.
- Check the settings of the simulation software: Some simulation software supports a function to download the data such as time and location of PC to TCS.
 - If it is difficult to set the date / time and observatory location by software, use the functions of TCS itself and set it same as software.
 - TCS does not allow to enter the time before 2017. Therefore, date / time information only after 2017 is available.
- g. Poor guide performance
- Try to adjust the guide speed from the System menu. Lower the guide speed for long focal length guiding, and increase the guide speed for short focal length guiding.
 - Check the status of the LED at the bottom of the TCS.
LEDs directly connected to the guide signal are arranged as RA +, DEC +, DEC-, RA-.
Confirm whether all LEDs respond to the signal or not.
 - Make sure that the mount, telescope and guide scope are securely fastened.
You can also check by gently shaking the tip of the telescope by hand.
 - Try to turn off the PEC function.
In rare cases, the guide signal and PEC processing may interfere.
- h. Date and time is not maintained between power downs.
- Open the battery cover of the side of device to replace the battery.
Replace with new CR 2032 lithium button cell.
 - Normally, the battery should be maintained for more than 2 years after purchase.
If the problem suddenly occurs before expected battery life ends, contact the manufacturer or the seller.
 - If the current date and time are cleared each time the power is turned off, try moving the battery tray back and forth several times.
Moisture or other causes may cause poor contact.
- If this does not improve, replace the CR2032 button cell.

- When replacing the battery, please refer to the above explanation

- i. When automatic meridian flip function is undesired for photographing.
 - Select Disable from [Meridian]-[Meridian Flip] Menu
 - When disabling the meridian reversal function, always be careful of moving the telescope.
In this case, it is programmed to reject the GOTO command which goes below the horizontal line.

- j. When it automatically stops with a melody sound while tracking.
 - The RA Auto Stop function operated.
Check the time and location settings to accurately calculate the meridian information.
 - Check the RA Auto Stop function.
 - Please check the message at the bottom of the screen

- k. When TCS receives a command from Object / GOTO, the error message is displayed without moving.
 - Check time and location setting.
 - The first star has to be synced and Object / GOTO.
 - Do not GOTO near the horizon.

- l. PEC is turned off but dimmed gray color "PEC" appears in display.
 - It is normal. Indicates that the PEC function is disabled, but has valid PEC training information.
If there is no "PEC" indication, you cannot use the PEC function until you refresh the PEC training.

- m. Turning PEC on worsens the guide performance.
 - In a case the load on telescope caused a slip after PEC training.
 - In a case that the position was lost due to the stall of motor.
 - In a case that the power was turned off without Parking.

- In previous three cases, arrange properly according to the presence / absence of the home sensor.

If there is no home sensor (CRUX 170, etc.):

Refresh the PEC Training. The PEC function uses newly trained PEC data.

If there is home sensor (Early CRUX 200, etc.):

Turn the power off and reboot. Move RA axis from east to west, then west to east across the home sensor. Each time moving from east to west or west to east, the melody will sound twice: once when the mount passes the home sensor (touch message will appear with melody), and once when it moves away from the sensor (touch out message with melody). Repeat this movement more than twice. Make sure you hear both touch in and touch out melody each time you move RA axis across the home sensor.

When the home sensor is recognized properly, the melody will sound and "H/S" will be displayed at the top of the screen.

If PEC data is valid, the PEC function will be automatically activated.

If PEC function is not activated automatically, redo PEC Training and use newly trained data to operate PEC function.

n. When using a low rated power supply

- DC power supply is recommended to be rated 12V 4A or higher.

When using a low rated power supply, the current must be limited through the [DC/A Limit] function in the [System] menu to prevent damage to the power supply.

It is also recommended to lower the acceleration / deceleration values through the [Acc. Rate] function in the [RA] and [DEC] menus.

o. When the telescope is moving, the TCS reboots or suddenly stops and the melody sounds.

- This is caused by a voltage drop, when using a low rated power supply. Change the setting to the lowest possible acceleration setting and the lowest possible maximum speed. Replace with a fully rated power supply.
- It may be caused by poor contact of the power input DC Jack. Make sure the power input is loose. The specifications of DC Jack
Pin Diameter: 2mm, Barrel Outer Diameter: 6.3mm