HOBYM
OBSERVATORY

F/W 3.5.9

2024/04/02

Titan TCS
User Manual

TITAN TCS

HOBYM
OBSERVATORY

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1. Key Features of the TiTaN Telescope Control System

1. TitanTCS operates with a specialized control processor (120MHz / 32bit) for mathematical operations and control, alongside a dedicated processor for user interface and communications. This configuration ensures readiness to accommodate a wide range of demanded functionalities.

2. With its built-in database including the Messier, NGC, IC, Caldwell, and SH-2 catalogs, users can navigate to their desired objects using only the TCS, without the need for a PC.

3. It supports the Bluetooth Serial Protocol (SPP), enabling connectivity with various devices. This feature allows wireless connection between the TCS and a user's PC or mobile device via Bluetooth.

4. Supports automated microstep adjustment
The integrated stepper motor driver supports microsteps from 1/2 to 1/128, automatically optimizing the resolution for the device. In tracking mode, it shifts to a 1/128 microstep for optimal observation performance, while in high-speed slewing mode, it automatically adjusts to the best performing microstep. This enables smooth and precise tracking, along with high-speed slewing, with minimal power consumption. Additionally, the TCS dynamically controls voltage and current based on the motor's speed conditions.

5. The integrated motor driver's power supply efficiently generates an optimized voltage for motor operation from the input power. The power voltage for the motor is independently step-down or step-up from the input power, according to the motor's operating conditions, ensuring it is appropriately supplied to the 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. It supports the major commands of the Meade LX200 protocol, which are widely used in various astronomical software. This allows for connectivity between the TitanTCS and user devices in environments where the ASCOM driver for TitanTCS is not available or in non-Windows OS settings.

8. If the user correctly completes the Parking procedure before turning off the TCS, when the power is turned back on, the TCS automatically restores the telescope's last position, enabling more convenient and accurate observations.

9. The TitanTCS, with its compact and sturdy metal casing, offers enhanced portability and a wide range of functionalities.

10. It is equipped with a high-resolution color graphic OLED display, allowing users to monitor various information such as the current status of the telescope and the motor's power consumption. Unlike LCDs, which can have slower response

times in cold temperatures, the OLED display remains instantly responsive even in extremely cold conditions, down to -20°C.
(1.69" Diagonal Size, 160 x 128 Pixels, 16Bit Color)

11. The current supplied to the motor can be set separately for tracking and high-speed slewing modes. This allows for the minimization of power consumption, even in outdoor observation settings where power supply is limited.

12. In tracking mode, the current consumption may vary depending on the settings, but it can be reduced to a minimum of 0.35A. This feature proves to be a significant advantage for outdoor observations with limited power resources and can be quite useful.

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. Built-In Beeper
The controller can inform the user about its status and various error situations through melodies or beep sounds.

17. Guide Port Isolated with Optocoupler
The guide port is isolated from the internal circuit using an optocoupler, effectively blocking external electrical noise and shocks.
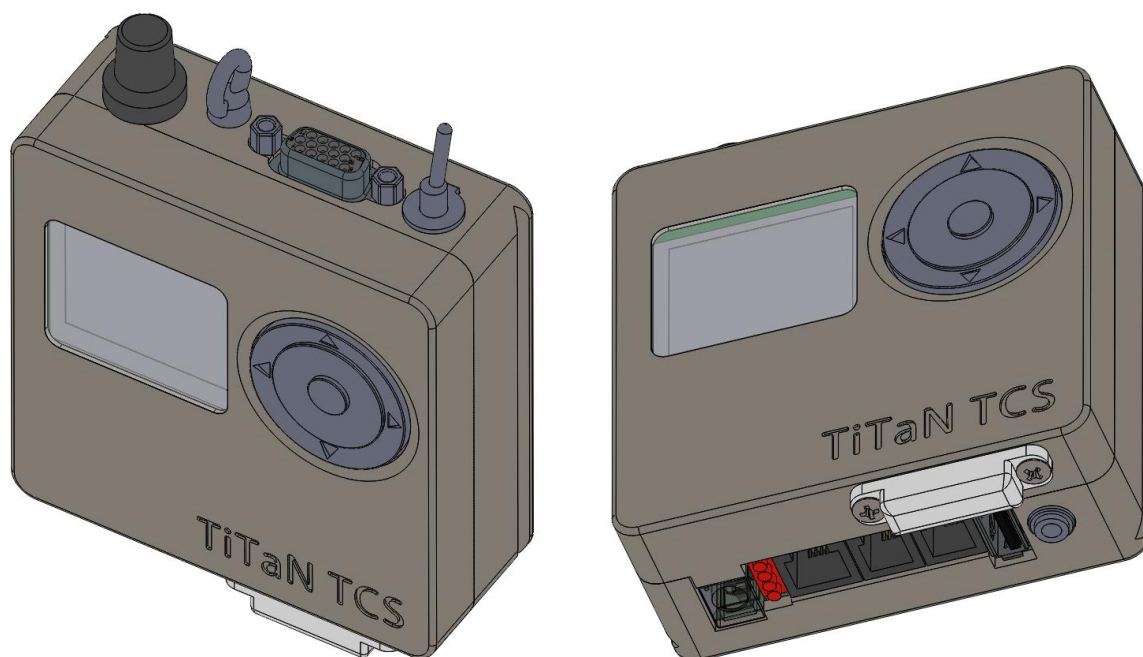
Notice

TitanTCS hardware comes in two versions, V1 and V2, and is further explained with illustrations on the next page.

1. V1 is connected to the motor using a circular connector.

2. V2 is connected to the motor via a D-Sub connector and includes an added camera shutter control function.

- Titan TCS V1
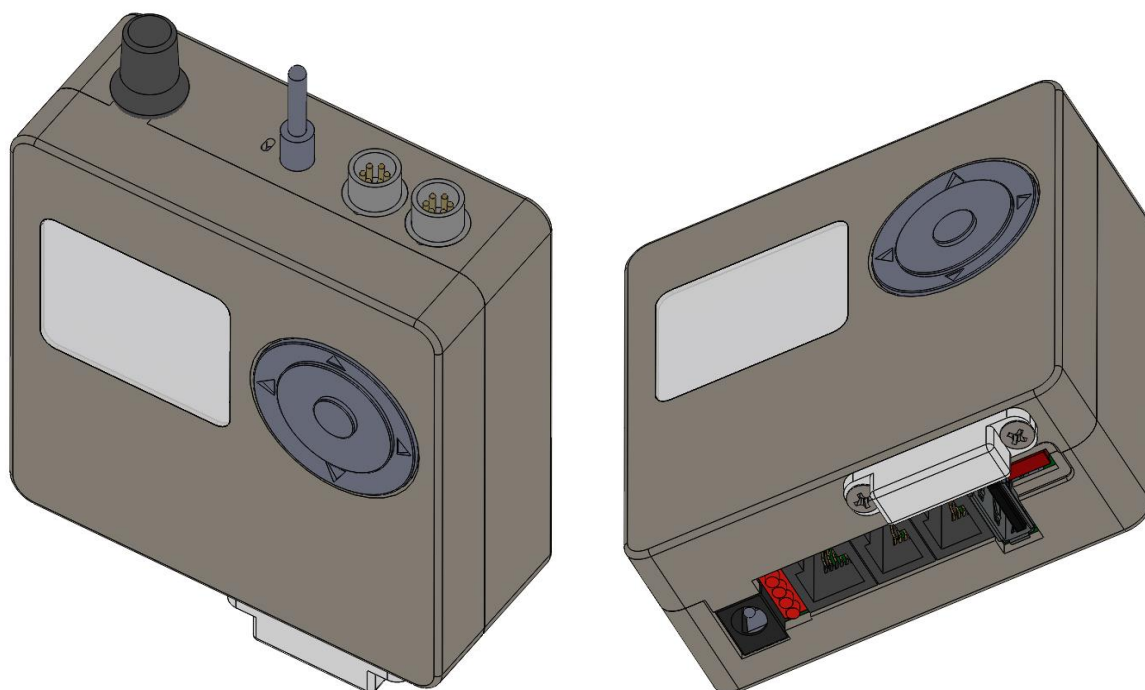
- Titan TCS V2

2. Using the Navigation Button & Wheel

The navigation button and wheel operate in two distinct modes:

1. Telescope Mode
   The up/down/left/right navigation buttons directly control the telescope, moving it in the respective directions.
   The center enter key is used to stop the telescope while it's in motion.
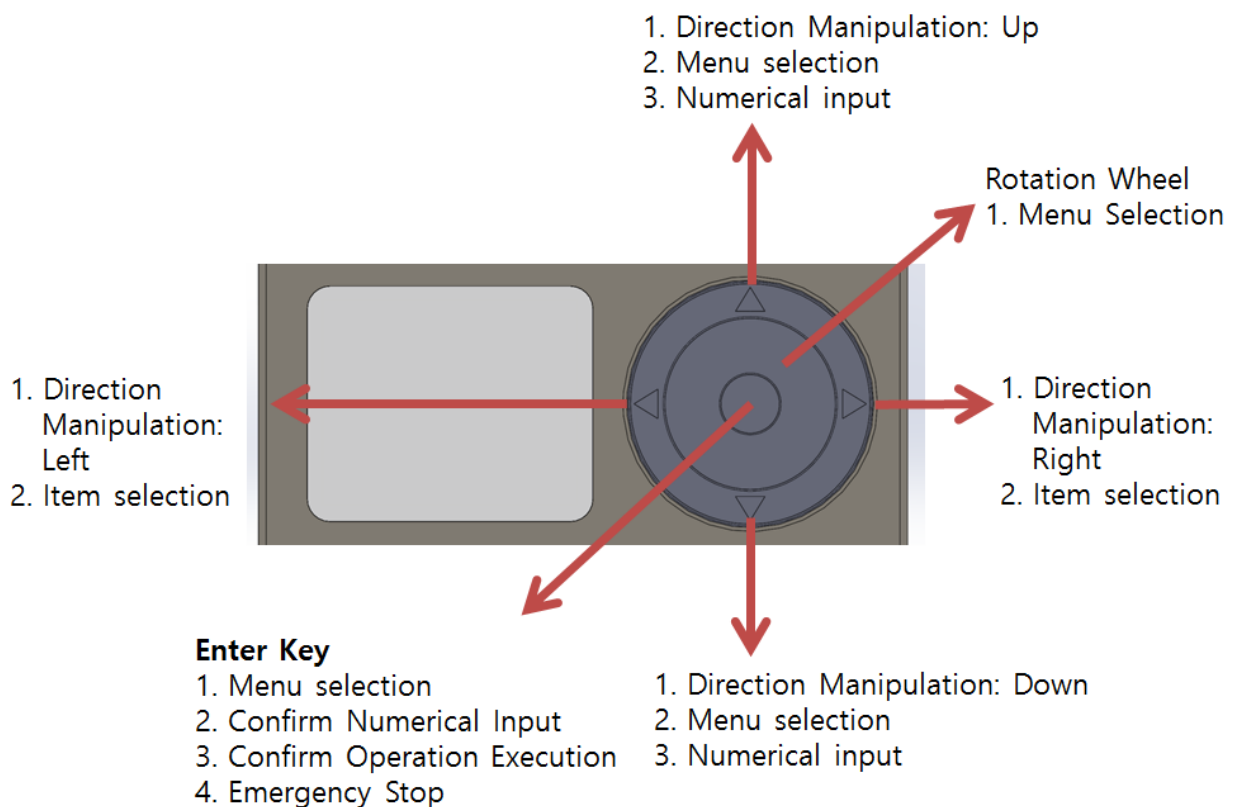   Holding down the center enter key for more than 2 seconds switches to Menu Mode.

2. Menu Mode
   The up/down/left/right navigation buttons navigate through the menu.
   The navigation wheel enables fast vertical scrolling through the menu.
   The center enter key enters a submenu of the currently active menu or executes the currently selected option.


1. Direction Manipulation: Up
2. Menu selection
3. Numerical input

Rotation Wheel
1. Menu Selection

1. Direction Manipulation: Left
2. Item selection

1. Direction Manipulation: Right
2. Item selection

Enter Key
1. Menu selection
2. Confirm Numerical Input
3. Confirm Operation Execution
4. Emergency Stop

1. Direction Manipulation: Down
2. Menu selection
3. Numerical input

3. Parking & Speed Volume Knob

Speed Selection:
Adjust the slewing speed by rotating the volume knob. The current speed is displayed on the OLED screen, allowing for adjustment of the telescope's driving speed from 0 to 100% to suit your needs.

Parking:
Rotate the volume knob fully counterclockwise until you hear a clicking sound to park the telescope. The park/unpark function automatically saves and restores the previous telescope position, making operations easier for the next observation.
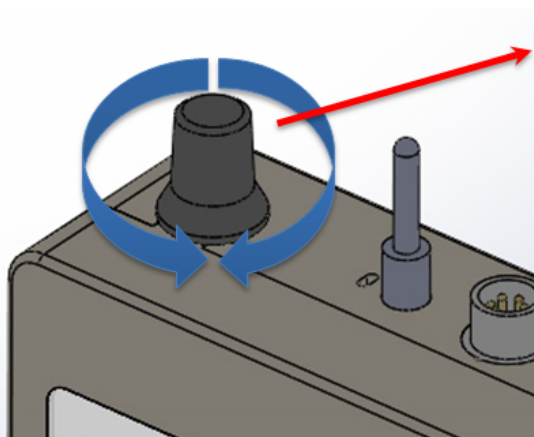
Parking
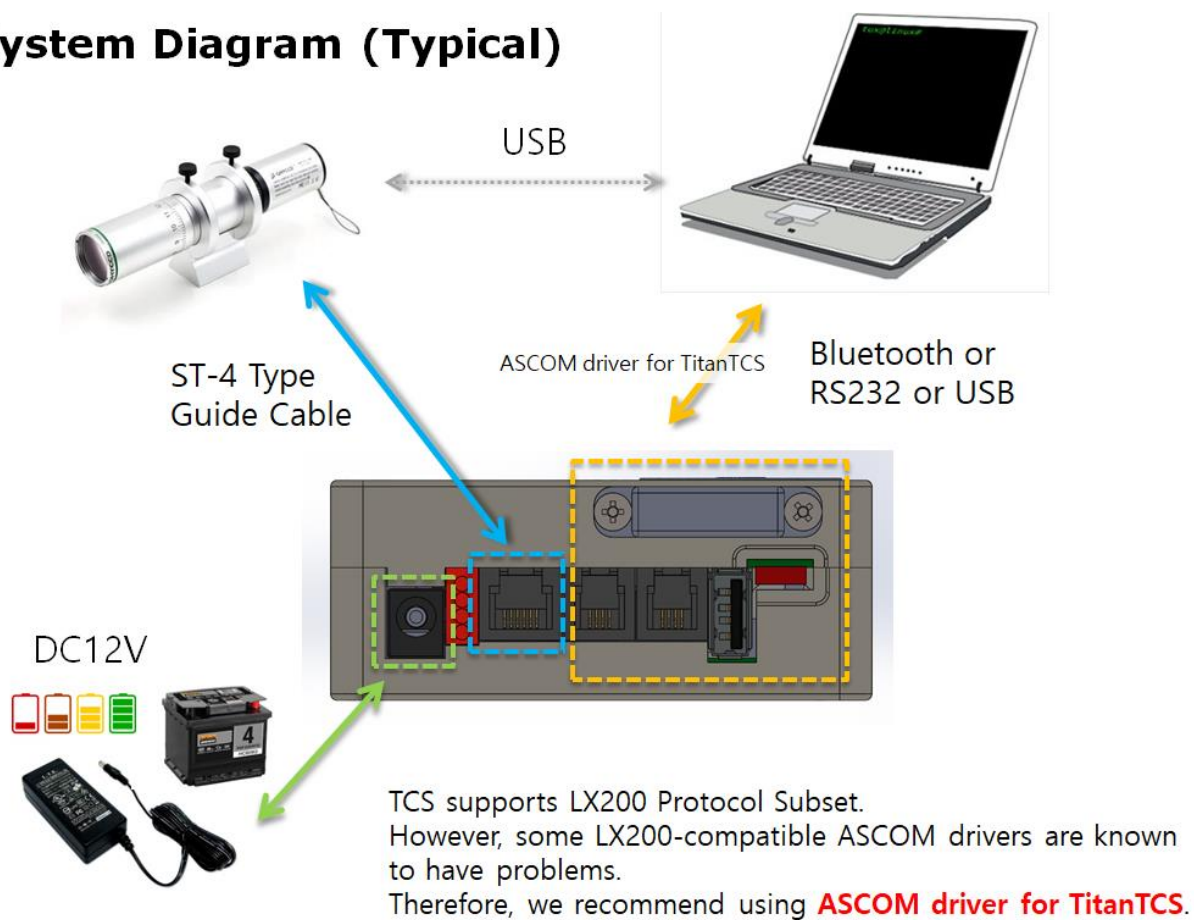Switch off : Parking Mode
on : Tracking Mode

Slewing Speed
CCW : Decrease slewing speed
CW : Increase slewing speed

.

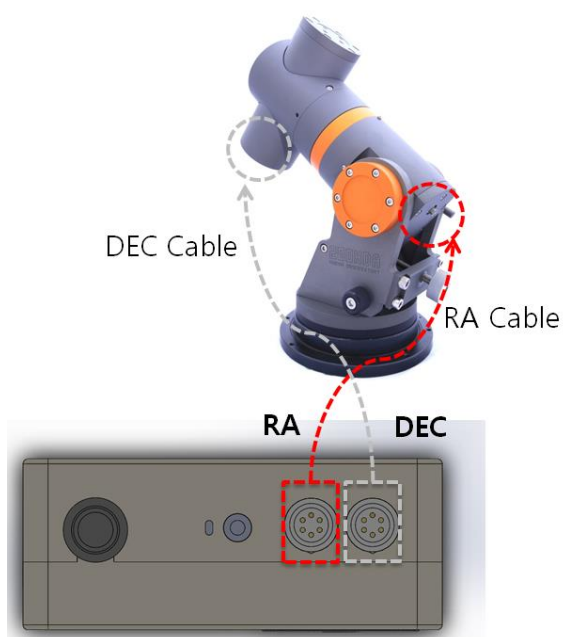## 4. System Configuration Diagram

> ➢ 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 an older operating system, such as Windows 7, you need to manually install the USB driver.
> 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, Titan TCS V1 Only**
> Although the Titan TCS V1 has both Micro USB Type B and USB Type A connectors, both are internally connected to the same USB port. NEVER CONNECT TO BOTH CONNECTORS AT THE SAME TIME!

> It is advisable to use the larger USB Type A connector when using a USB connection. The Micro USB Type B connector is very small and may result in frequent contact failures depending on the cables used. The Micro USB Type B should only be used for emergency or spare purposes.
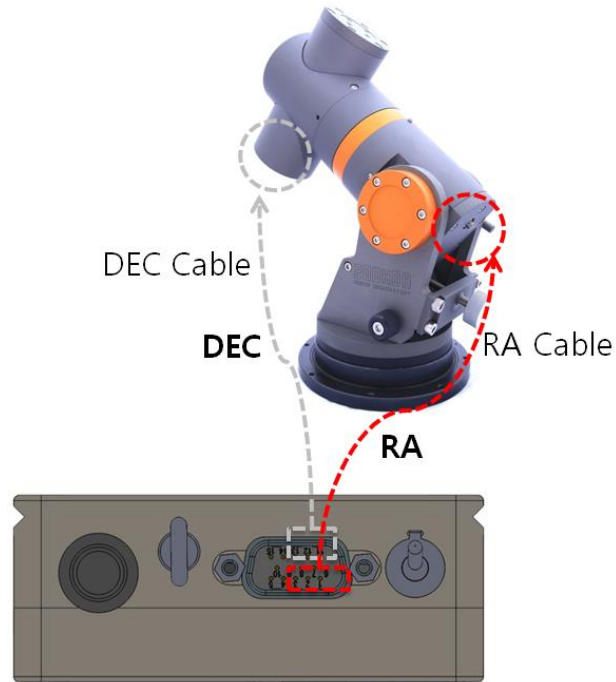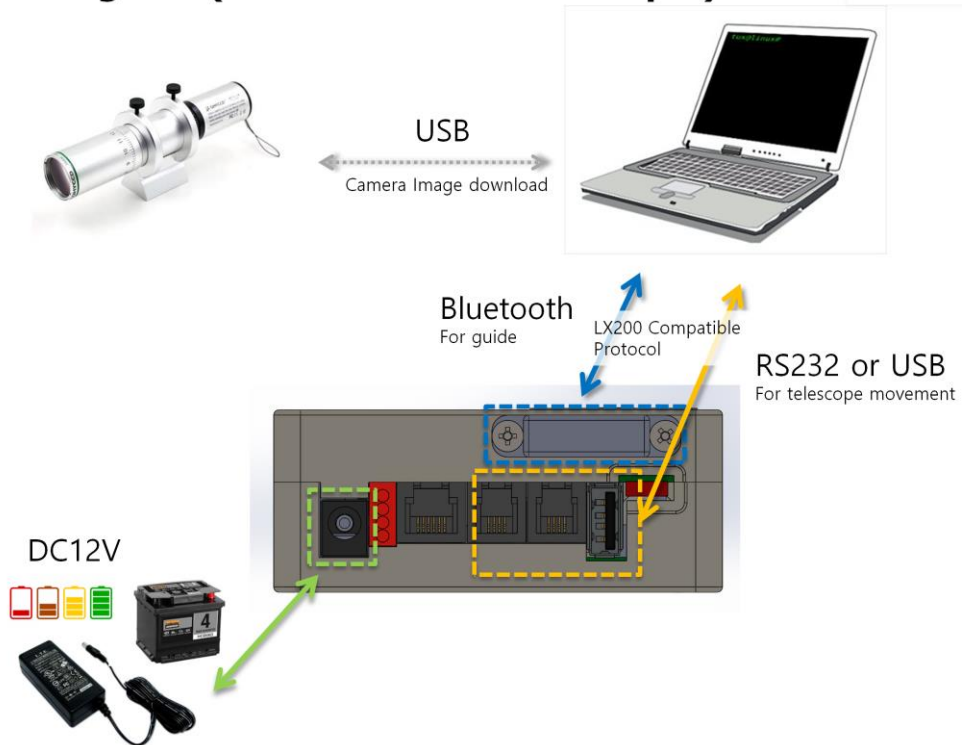
System Diagram (Typical)

USB

ST-4 Type
Guide Cable

ASCOM driver for TitanTCS

Bluetooth or
RS232 or USB

DC12V

TCS supports LX200 Protocol Subset.
However, some LX200-compatible ASCOM drivers are known
to have problems.
Therefore, we recommend using **ASCOM driver for TitanTCS**.

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

DEC Cable

RA Cable

RA   **DEC**

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

DEC Cable

DEC

RA Cable

RA

System Diagram (Bluetooth Guide Example)

USB

Camera Image download

Bluetooth
For guide

LX200 Compatible
Protocol

RS232 or USB
For telescope movement

DC12V

System Diagram (USB Only Example)

USB
Camera Image download

USB
Telescope movement
Guide command

LX200 Compatible
Protocol

DC12V
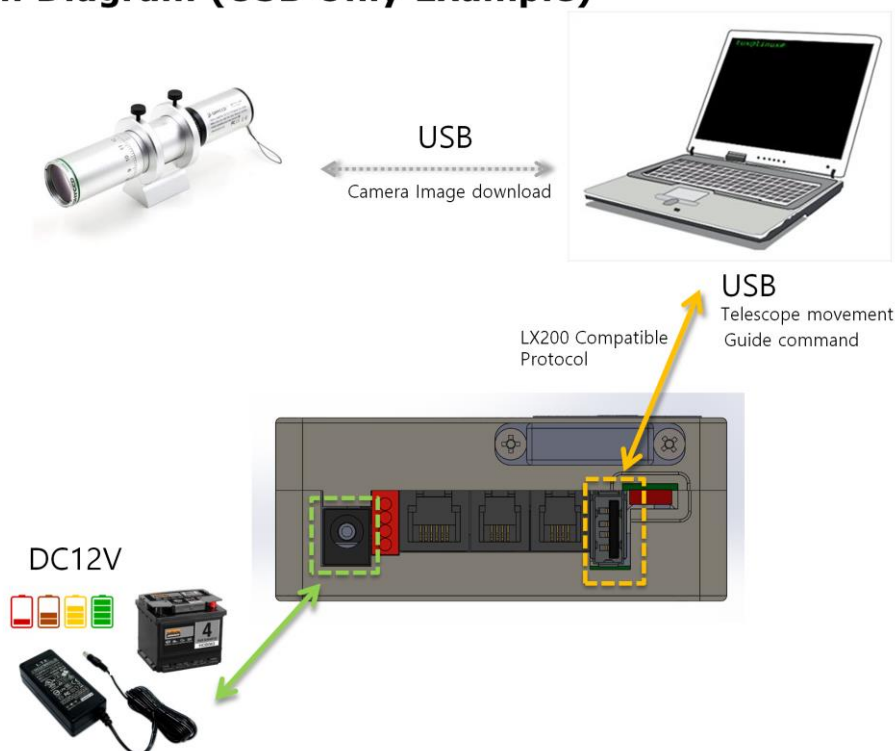
5. Operation Sequence of Titan TCS

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

A. Mount the telescope on the equatorial mount: Ensure that the weight is balanced as much as possible to prevent excessive leaning to one side.

B. Connect the motor cable to the Titan TCS.

C. Connect the power cable to the Titan TCS.

D. Turn on the power switch.

E. Choose a bright star: It does not matter if it is in the east or west. However, select a star near the celestial equator and at least 15 degrees away from the meridian. First, use the arrow keys of the TCS to bring the star into the field of vision of the telescope. Then, position it at the center of the eyepiece.

F. Enter the controller's menu and navigate to [Object] – [Star Name] – (Selected Star Name) - [Sync] to synchronize.

G. Slew to the desired celestial object and observe.

If the Parking function was used during the 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 motor cable to the Titan TCS.

C. Connect the power cable to the Titan TCS.

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 (Telescope Mode) In Equatorial Mode: Displays RA (Right Ascension), DEC (Declination), time, and TCS status. In Alt-Az Mode: Displays Azimuth (Az), Altitude (Alt), time, and TCS status.			
Object	Star Name	B	Alphabet	240 items
	Manual	B	Home / East / West / South / Current	Home: Telescope location (Northern Hemisphere) - Top & North Pole Telescope location (Southern Hemisphere) - Top & South Pole Current: The location currently displayed in TCS.
	Solar System	B	Sun / Mercury / Venus / Mars / Jupiter / Saturn / Uranus / Neptune / Moon	After synchronizing with or performing a GoTo operation to the moon or sun, the tracking rate will change to the lunar or solar tracking rate.
	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
	LBN	B	Number	1124 items
	LDN	B	Number	1800 items
	RCW	B	Number	182 items
	GUN	B	Number	94 items

	Barnard	B	Number	174 items
	Lower Object	B	Show / Hide	Shows or hides objects below the horizon.
RA / DEC	Max Speed	B	Input numerical values	Maximum slewing speed
	Acc. Rate	B	Input numerical values	Acceleration Rate
	Direction	E	Normal / Reverse	Specifies the rotation direction of the telescope's drive axis. The direction of rotation for the telescope's drive axis varies depending on the internal wiring, cabling, and mechanical design. (This varies by product model.)
	Slow Current	E	Current setting for slow speed (Tracking condition)	135mA ~ 955mA
	Fast Current	E	Current setting for high speed (Slewing condition)	135mA ~ 1,150mA
	Gear Aging	E	Start, Exit -> Reverse, Stop, Exit	Gear Aging: Idle rotation to smooth the tooth surface of the driving gear. Start: Starts Gear Aging. Reverse: Reverses the rotation direction of the motor.
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.	B	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	E	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	E	Edit name of current selected bank	

	Save Position	E	Save the current position as the parking position of the selected bank. * This menu cannot be selected when not in sync.	
	Parking Knob	E	Select the location to park with the parking knob.	Select bank
Safety	Meridian 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 "RA 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.
	Alt Limit	E	Stop tracking / Cancel Goto / Warning Only / Ignore	Specifies the operation of the TCS when the altitude limit is exceeded.
	Go below Horz (=GoTo below the horizon)	E	Enable / Disable	GoTo below the horizon. Enable: When the TCS executes a command that slews to the target, the telescope can be directed down the horizon.

				But, if the "Meridian Flip" is disabled, the command to slew the telescope down the horizon is ignored. Disable: The TCS ignores commands that slew the telescope below the horizon.
	Alt Lower Limit	E	Altitude of the horizon limit (Degree). This limit is affect only slewing final target position.	When [Go below horizon] option is enabled, you can adjust the altitude of the horizon.
	Alt Upper Limit	E	*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	E	Stop mount for long operation without any action.	A value of 0 disables idle timer. 1 ~ 999 minutes: 　Enable idle timer
	Sleep Timer	E	When the timer expires, the mount is stopped.	A value of 0 disables sleep timer. 1 ~ 999 minutes: Enable sleep timer
	Timeout Action	E	Stop Tracking / Park there / Park ASCOM	Specifies the action when a timeout occurs. In case of "Park ASCOM", park as specified in the ASCOM control window.
	Safe Power Off *This menu is only supported on V2 models.	E	Enable / Disable	If TCS is synced, make sure the power does not turn off even if you turn off the power switch before parking.
Meridian (Meridian	Flip	B	Enable / Disable	When GOTO is executed, if the telescope crosses the meridian, Meridian Flip is

Flip)				executed.

	Skip Once	E	Skip Once / Meridian Flip	Skip Once:
				  Bypass Meridian Flip 1 time when GOTO. Afterwards, when GOTO, Meridian Flip is performed normally.
				Meridian Flip:
				  Perform Meridian Flip normally when GOTO.

PEC	PEC	B	Enable / Disable	
	PEC Training	B	Start / Stop	
System	Mount Type	E	Mount Type	German Equatorial / Alt-Az *If you change the mount type, you must save and reboot.
	Meridian Free	E	Disable / German EQ / Meridian Free	
	Def Track Rate	E	Sidereal Rate / King Rate	Default Tracking Rate
	Night Vision	B	Yes / No	Display screen color in red only.
	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	B	Input numerical values (current)	If the total current consumption exceeds the set value, the TCS

	Limit)			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 current tracking rate	Sidereal / Solar / Lunar
	Beep Level		Select message beep level	Detail ~ Silent
	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	E	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 consumtion for low power system.
	Guide Port	E	Ignore ST-4 guide port.	Guide port(RJ-12) can be ignored using this menus. TCS has pulse guide function using ASCOM or LX200 protocol.
Bluetooth	TCS Name	B	Enter name of TCS for Bluetooth connection.	Up to 12 characters
WiFi	WiFi Mode	B	None / Station / AP	
	AP SSID	B	Enter SSID of AP	SSID of TCS itself operating in AP mode

	AP Password	B	Enter SSID of AP	Password of TCS itself operating in AP mode
	STA SSID	B	Enter SSID for external WiFi service	SSID of WiFi service to which TCS will connect
	STA Password	B	Enter Password for external WiFi service	Password of WiFi service to which TCS will connect
	Detail	B		It shows the current WiFi settings and connection status.
	WiFi Reboot	B	Yes / No	Reboot the WiFi module.
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 number of TCS	Model, version, date Serial Number
	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.

"Bluetooth" / "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 45°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 Mode

    The first state after power up is Telescope mode.
    Displays basic information, including current date and time, RA and DEC, current status.
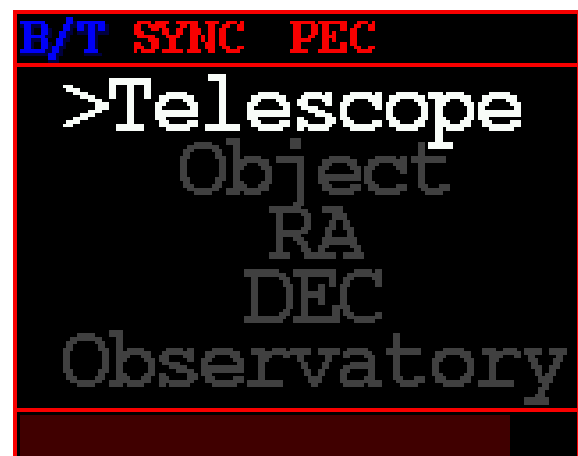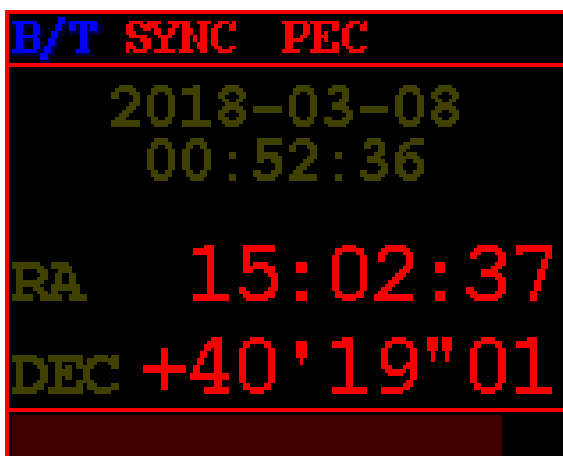
-   B/T : When Bluetooth is connected to the TCS, "B/T" is displayed at the top.

-   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
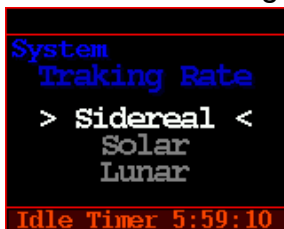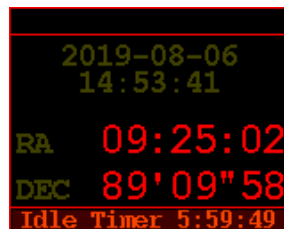
There is no status indication for Sidereal tracking rate.

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 knob:
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.
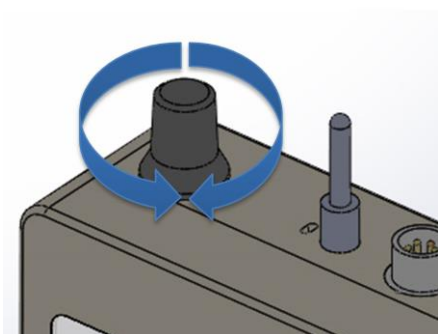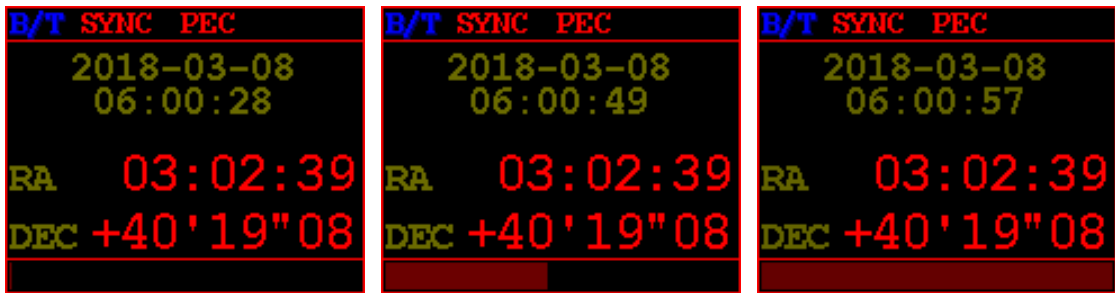
| Speed about 0% | Speed about 40% | Speed about 100% |

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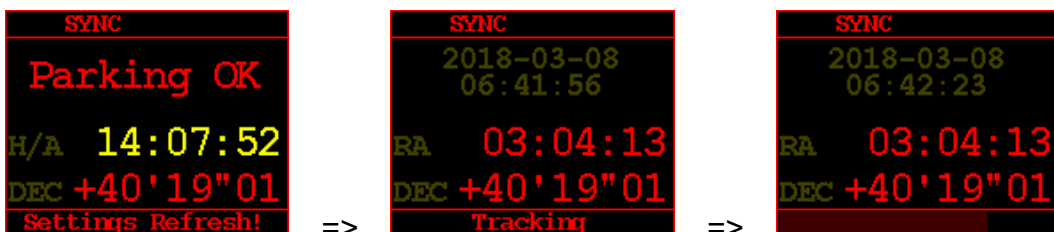
The TCS carefully moves the stepping position of the stepper motor to the origin and completes parking. However, if the power is turned off and on many times, the step position may change unintentionally.

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

- Top menu screen
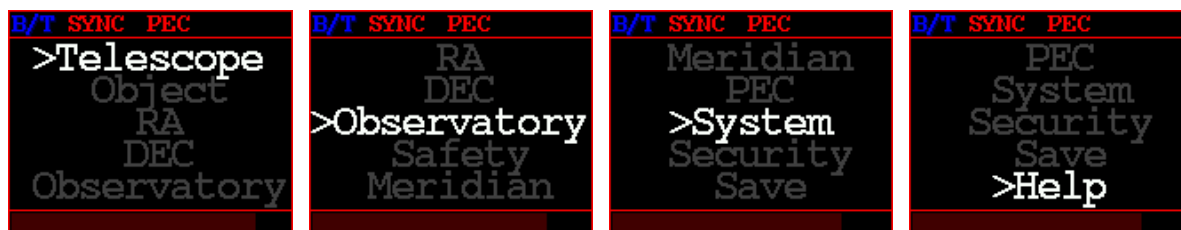
3. Object

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

   ● Select celestial list type
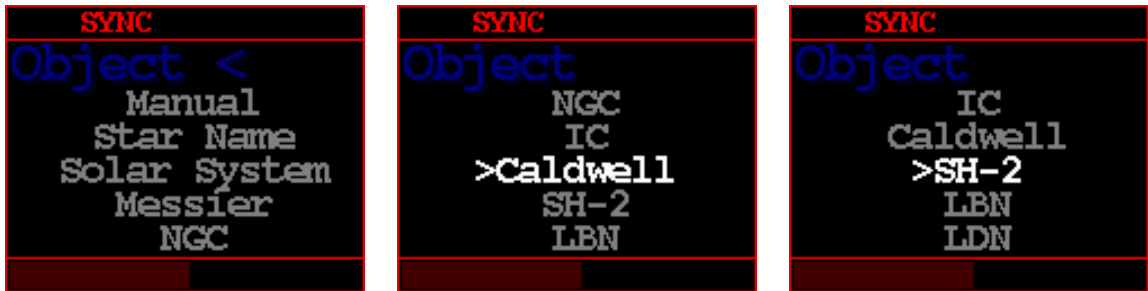
   First, select the type of celestial list.

   ● Search Screen: Provides three methods based on the selected celestial list type.
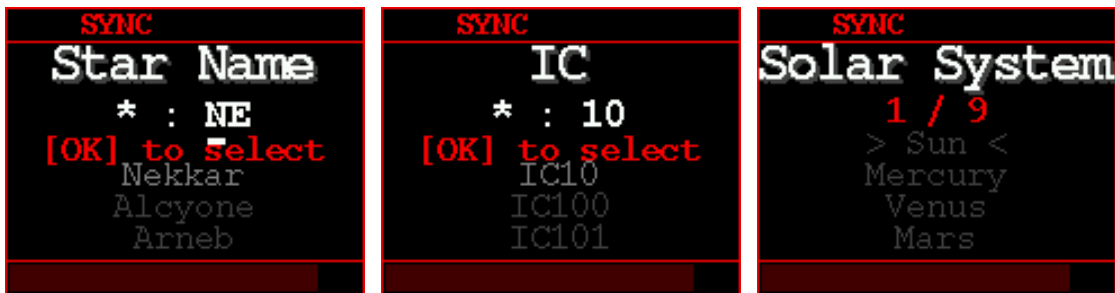
   String Keyword   Number Keyword   Name List

   After selecting a list type, a search screen appears, allowing you to select objects from the list.

   There are two methods to search by keyword: by string and by number. Alternatively, objects within the solar system can be selected from the name list.

   The maximum length for a keyword is 4 characters. Typically, typing two characters is sufficient to find exactly what you are looking for.

   Keywords are not case-sensitive and are searched at the beginning of the string, making them appear at the top of the list.

![HOBYM OBSERVATORY logo]

- 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
```

```
LBN
All : 0001
[OK] to select
   LBN 140
   LBN 1
   LBN 10
Idle Timer 5:55:19
```
```
LDN
All : 0001
[OK] to select
   LDN 1
   LDN 10
   LDN 11
Idle Timer 5:58:54
```
```
RCW
All : 001
[OK] to select
   RCW 1
   RCW 10
   RCW 11
Idle Timer 5:58:44
```
```
GUM
All : 001
[OK] to select
   GUM 1
   GUM 10
   GUM 11
Idle Timer 5:58:38
```

```
Barnard
All : 001
[OK] to select
   Barnard 1
   Barnard 10
   Barnard 11
Idle Timer 5:58:13
```

```
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

- LBN : Lynds' Catalogue of Bright Nebulae

- LDN : Lynds' Catalog of Dark Nebulae

- GCW : Rodgers, Campbell & Whiteoak

- GUM : An astronomical catalog of 84 emission nebulae in the southern sky.
    It was made by the Australian astronomer Colin Stanley Gum.

- Barnard

- Manual

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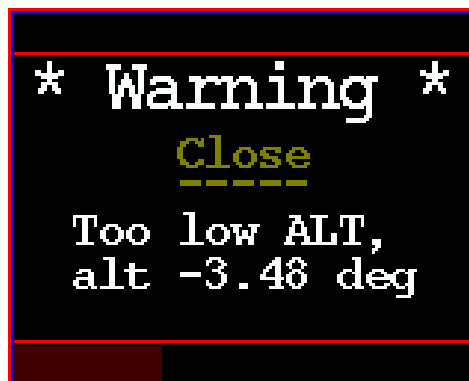
When a low-altitude object is selected, the following Warning screen is displayed so that it cannot be goto / sync.

- Goto / Sync / Adjust position function screens.

    =>

   Goto / Sync / Adj Screen   Goto Monitor

When the 'Goto' function is selected, a window similar to 'Telescope' mode appears, displaying the movement to the target.

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

If you press the 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.

 =>
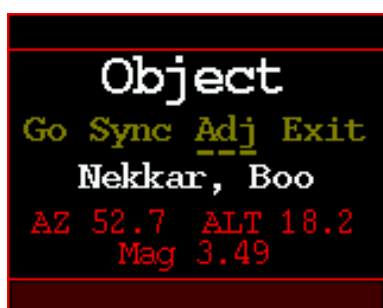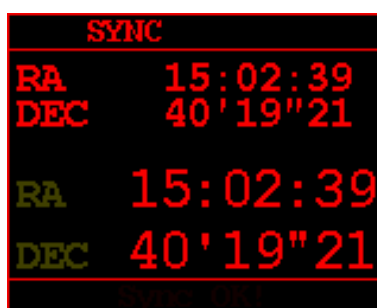
By selecting 'Adj', you can adjust the position of the telescope using the directional keys.
Press the Enter key to finish the "Adjust position" operation.

- Manual Mode

    When aligning in the East / West / South / Home direction, the telescope and the pier should be in the designated position.

 ~
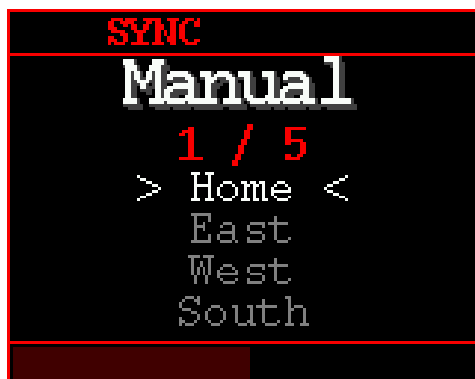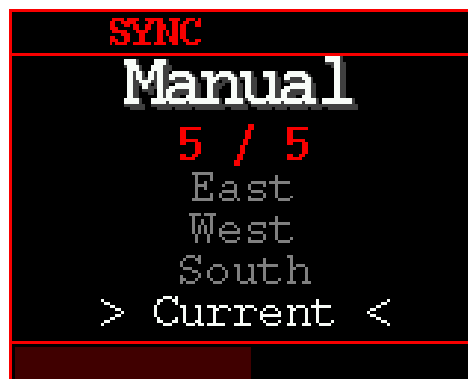
1. Home: Set the telescope's DEC axis to face the polar point and position the RA axis at the top.

2. South: Telescopes should be to the west, and piers to the east.

3. East: The telescope should be to the south and the pier to the north.

4. West: The telescope should be to the north and the pier to the south.

5. Current: These are the current coordinates displayed on the TCS Screen.

4. RA
Sets RA speed and other variables.

- RA sub-menu

=>

  ~

- Max Speed: Sets the maximum RA slewing speed.
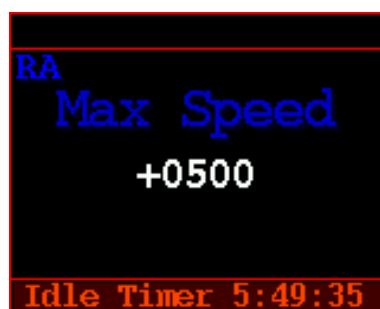
- Acc. Rate: Adjusts the RA speed's acceleration and deceleration. The lower the value, the slower the acceleration and deceleration. Slowing down the

acceleration reduces the load on the mount and motor. An excessively high Acc. Rate requires a large current instantaneously at the moment of acceleration and relatively high torque from the drive system, which may cause the stepper motor to stall.

```
RA
   Acc. Rate

      +07.0



 Idle Timer 5:49:23
```
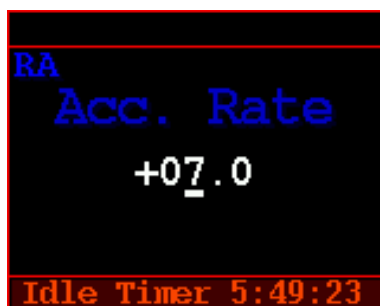
● Direction: Specifies the rotation direction of the stepper motor. Use this menu option when the telescope's actual direction does not match the command.

```
        SYNC
RA
    Direction
   > Normal <
     Reverse
```

● Slow Current (Tracking Speed Current): Specifies the current required for low-speed operation, primarily used for tracking. In this setting, the stepper motor operates at 1/128 microsteps.

```
RA
   Slow Current

       585 mA
     > 640 mA <
       715 mA
 Idle Timer 5:49:16
```
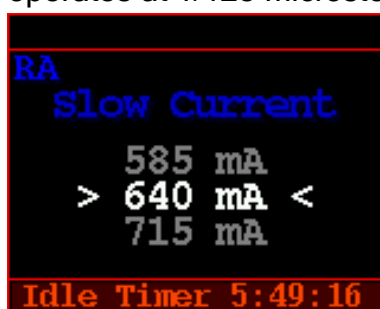
- Fast Current (Slewing Speed Current): Specifies the current required for high-speed operation. The torque needed for acceleration and the voltage boost for high-speed operation consume a significant amount of current in a short time. In this setting, the motor automatically operates in the 'Fast Microstep' mode calculated by the system

```
RA
  Fast Current

    870 mA
 > 955 mA <
  1,060 mA

Idle Timer 5:49:08
```
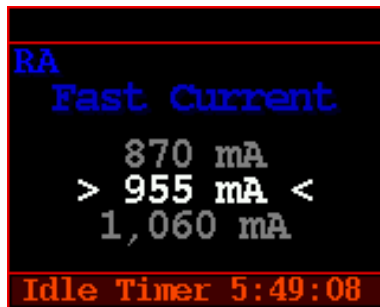
- Gear Aging:
Occasionally, some users age the gears in the mount to improve tracking performance. Therefore, a function has been added to idle the drive system. Once the Gear Aging function starts, the drive axis begins rotating at maximum speed. If it exceeds +180 degrees or -180 degrees, the rotation stops and reverses. This function does not stop until [Stop] is selected.

Caution: During the operation of the Gear Aging feature, rotations exceeding 360 degrees will be repeated, so it is essential not to have the telescope mounted. If the telescope is mounted, a collision with the pier is unavoidable.
Additionally, ensure good ventilation for the TitanTCS to prevent overheating, and operate it for no more than 30 minutes.
During the operation of this function, always ensure that the device is functioning properly and check for any warnings or errors.

```
    SYNC
DEC
   Acc. Rate
   Direction
  Slow Current
  Fast Current
 >Gear Aging
```
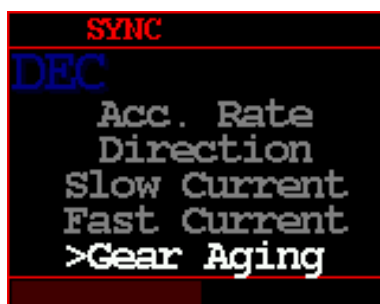
5. DEC : Sets DEC speed and other variables.
   Same as RA settings.

 =>

 ~
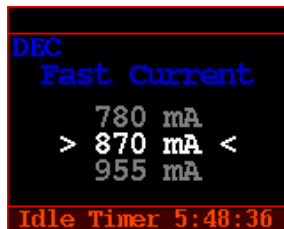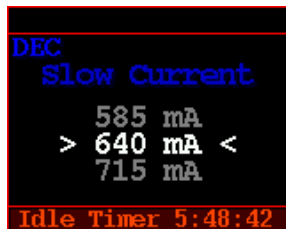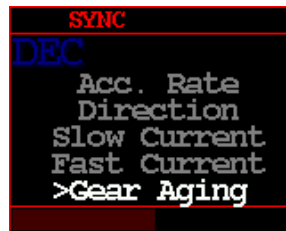
6. Time Lapse

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)
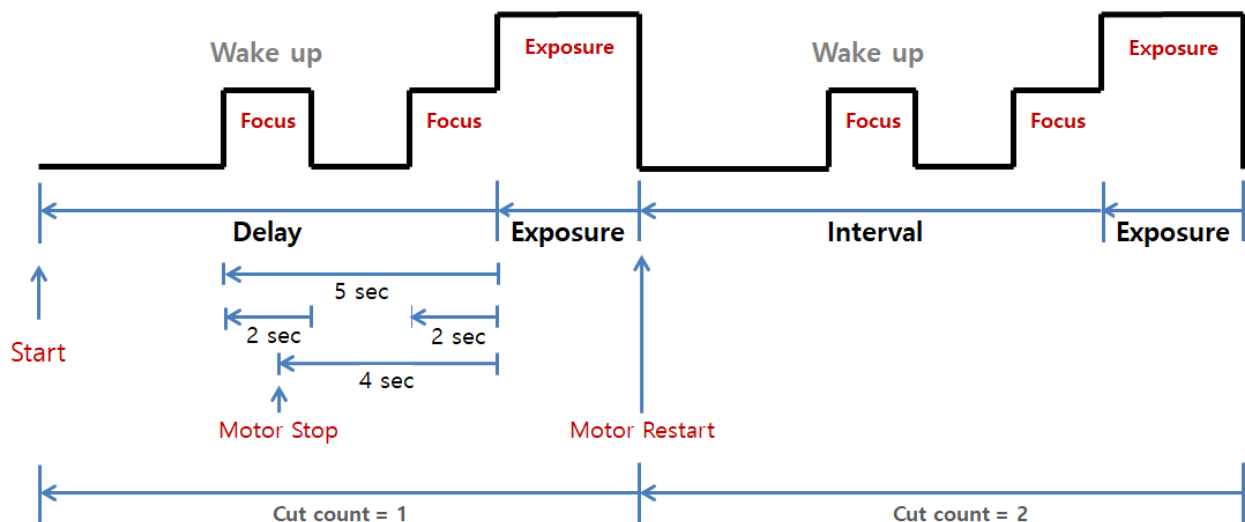
7. Observatory
   Current Date/Time and location setting

 =>

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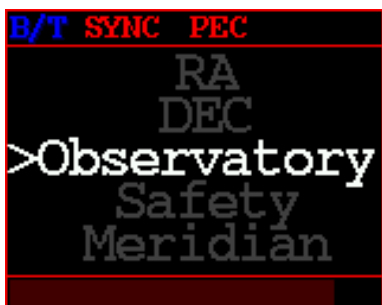
- Date/Time : Set current date and time. Current date and time will always retained by internal Real Time Clock(RTC.)

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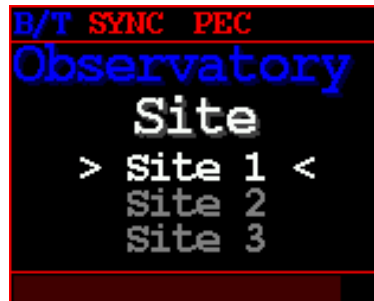
● Site Name :
Enter the name of the site selected in the "Site" menu.
Up to 12 characters can be entered, and blank characters cannot be entered consecutively.

● 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.
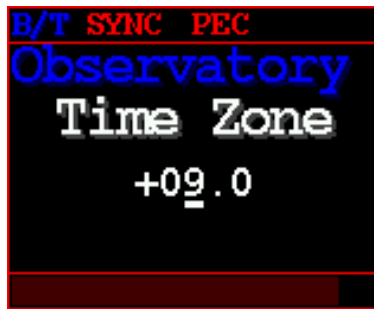
8. Safety
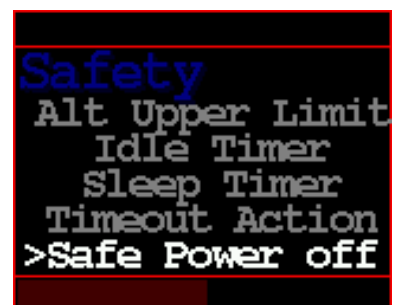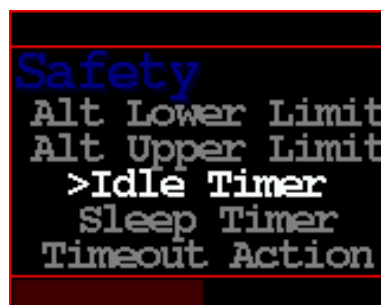
- Meridian Stop :
  Enable :
  In tracking mode, RA tracking automatically stops when the RA axis(=Telescope Direction) passes near the meridian. The auto stop position can be specified in the "RA Limit" menu.

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.

- Alt Limit (Altitude Limit Action)
  Stop tracking :
  > Stops tracking when the specified altitude is exceeded.
  Cancel Goto :
  > Ignores the Goto command if the specified altitude is exceeded.
  Warning Only :
  > Only displays a warning when the specified altitude is exceeded.
  Ignore :
  > Ignores if the specified altitude is exceeded.

- Go below Horz. (GoTo below the Horizon)
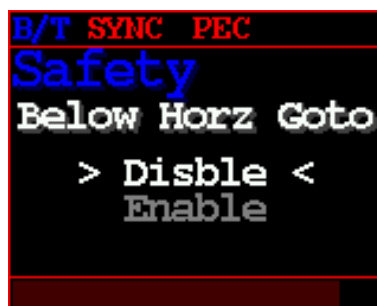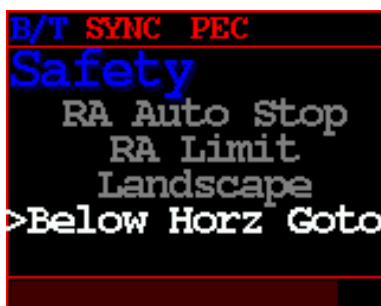
Enable :
When the TCS executes a command that slews to the target, the telescope can be directed down the horizon.
The lowest altitude of the telescope is aimed at is -15 [deg].
But, if the "Meridian Flip" is disabled, the command to slew the telescope down the horizon is ignored.
Disable :
The TCS ignores the command that directs the telescope below the horizon.

- Alt Lower Limit :
  Altitude of the horizon limit (Degree).
  This limit is affect only slewing final target position.

● Alt Upper Limit
Altitude limit for slewing target position.
This limit is affect only slewing final target position.

```
WiFi
Safety
  Go below Horz
 Alt Lower Limit
>Alt Upper Limit
  Idle Timer
  Sleep Timer
Idle Timer 5:59:24
```

```
WiFi
Safety
Alt Upper Limit

      05

Target Alt. range
   ALT 5 ~ 85 deg
Idle Timer 5:59:52
```

```
WiFi
Safety
Alt Upper Limit

      00

Target Alt. range
   ALT -2 ~ 90 deg
Idle Timer 5:59:56
```

● Idle Timer
Stop mount for long operation without any action.

```
WiFi
Safety
 Alt Lower Limit
 Alt Upper Limit
>Idle Timer
 Sleep Timer
 Timeout Action
Idle Timer 5:59:21
```

- Sleep Timer
  When the timer expires, the mount is stopped.

A value of 0 disables idle timer.

1 ~ 999 minutes : Enable idle timer

● Timeout Action
Specifies the action when a timeout occurs.

In case of "Park ASCOM", park as specified in the ASCOM control window.

● Safe Power Off
When the TCS is synchronized, it prevents the user from turning off the power using the power switch before parking. To avoid loss of synchronized information, the user should turn off the power after parking.

However, this feature does not operate if the external power supply is disconnected or if it is not synchronized.

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.

- Skip once :|

  Skip Once: You can select [Skip one] to ignore the Meridian Flip triggered by a GoTo command just once. This feature automatically clears after one GoTo command is executed, regardless of whether the Meridian Flip occurs. While this feature is active, the message 'Meridian Flip is disabled.' is displayed on the TCS screen.

  Meridian Flip: You can deactivate this feature by selecting [Meridian Flip] from the menu.

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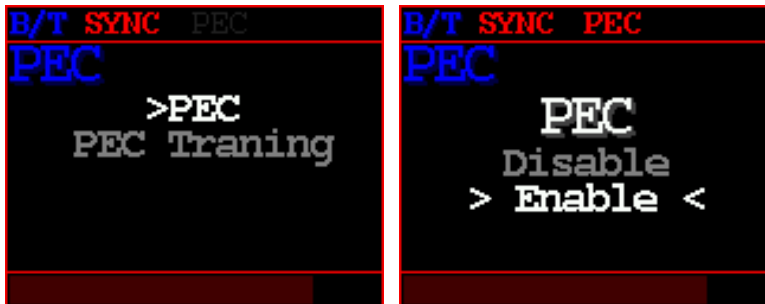
● PEC Training : It performs measurement of periodic error and calculation of correction data by using internal microprocessor.
PEC Training function is only available during operation of auto guide system using a guide CCD, a guide telescope, and PC.

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

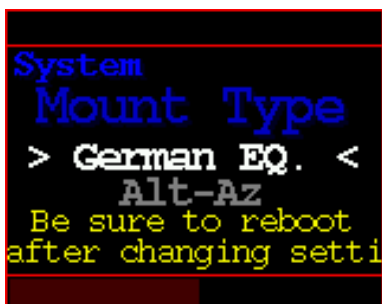Ex) PEC Training progress examples

11. System

Guide Speed, power-related and communication speed settings.
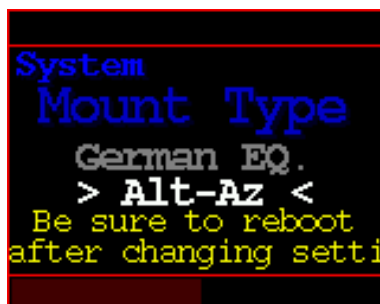
 =>

- 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.

German Equatorial Mode

Alt-Az Mode

● Meridian Free

WARNING: The Meridian Free function is a special function created for uninterrupted photography without using Meridian Flip.
When GOTO or tracking, there is a possibility that the eyepiece or telescope collides with the pier, so you must sufficiently check the movement of the telescope before use.
If you are not familiar with Meridian Free features, we recommend not using it.

When synchronizing for the first time after installing the telescope, you should position the telescope above the weight and synchronize while looking at the western star.

When Meridian Free is enabled and the telescope is pointed east, the telescope will be positioned below the weight.

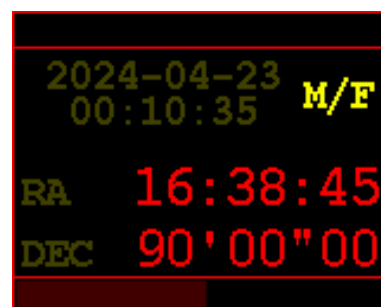Therefore, there is a possibility that the eyepiece may be placed close to the pier or collide with it.

■ Disable :
Does not use the Meridian Free feature.

■ German EQ :
This is a traditional German Equatorial mode that does not use the Meridian Free feature.

"GEq" appears on the screen.

■ Meridian Free :
Use the Meridian Free feature.

"M/F" appears on the screen.

● 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.
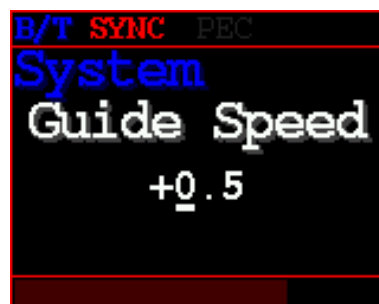
- Batt Low V : Set Battery low voltage warning
  You can set the minimum battery voltage value for warning.

- 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.
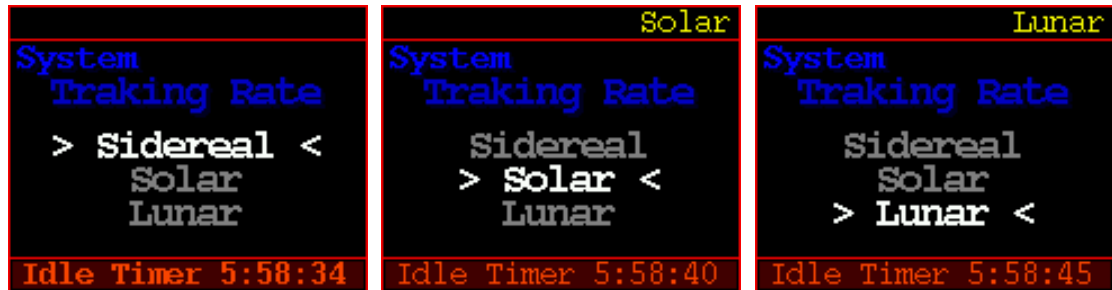

Ex) Over voltage condition

- 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.
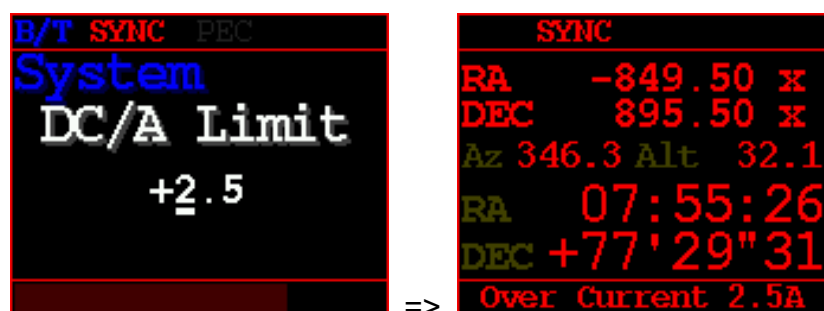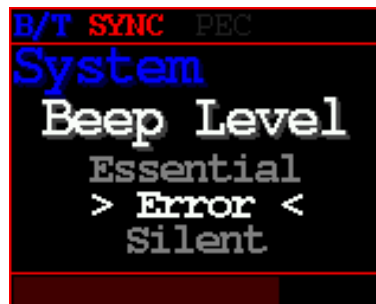

Ex) Over current condition

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

System	Solar System	Lunar System
Traking Rate	Traking Rate	Traking Rate
> Sidereal <	Sidereal	Sidereal
Solar	> Solar <	Solar
Lunar	Lunar	> Lunar <
Idle Timer 5:58:34	Idle Timer 5:58:40	Idle Timer 5:58:45

● Beep Level : Select message beep level

B/T SYNC PEC
System
Beep Level
Essential
> Error <
Silent

● 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.
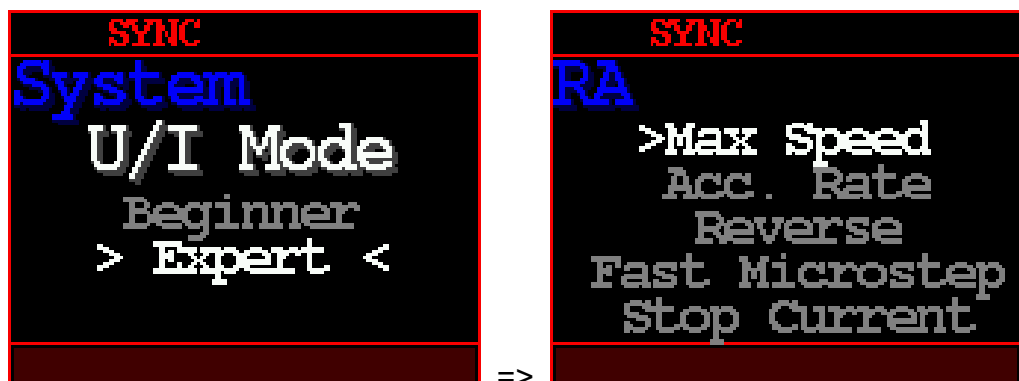
B/T SYNC PEC
System
Serial A
> Default <
9600
14400
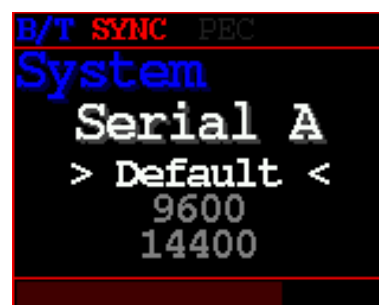
● Serial B : RS-232 B
You can set the communication speed with the astronomical simulation software and Serial port B.

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.
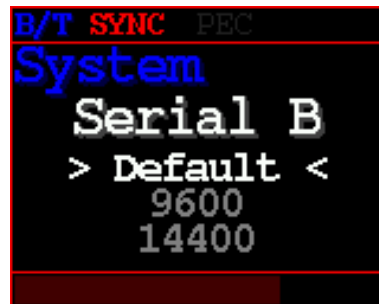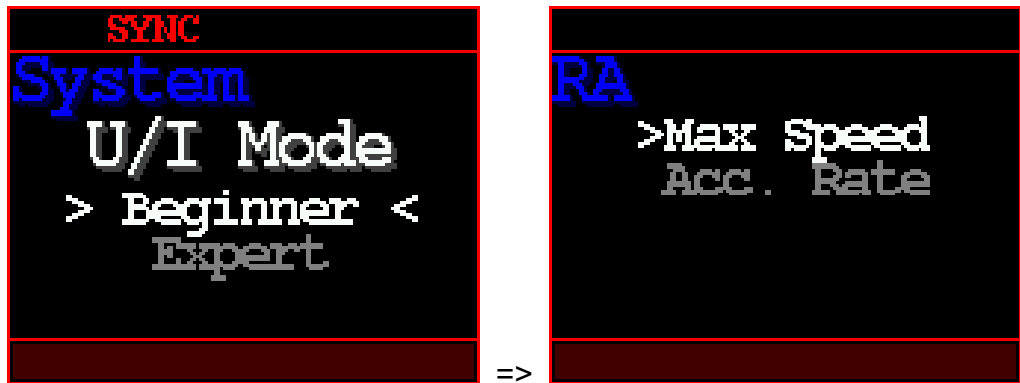

● U/I Mode : Select U/I menu level
Beginner / Expert

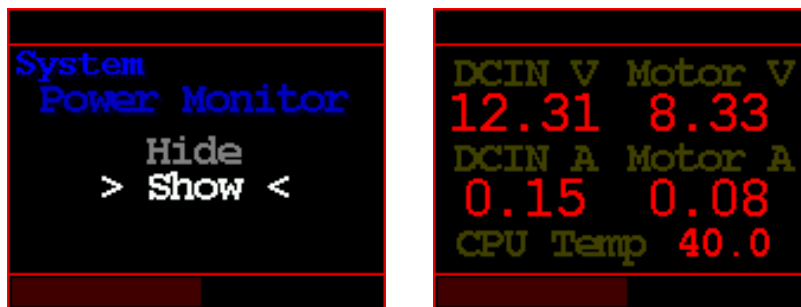This setting is not reflected until reboot.

 =>

Ex) Expert Mode Menu

Ex) Beginner Mode Menu

- Power Monitor
In Telescope Mode, switch the display to a screen for monitoring voltage and current.

- Deceleration
Deceleration rate is proportional to [Acc. Rate]

If greater than 1, deceleration is faster than acceleration. If this value is 1, acceleration and deceleration are the same.

Generally, a lot of current or torque is required for acceleration.

Since the deceleration load is usually small, the deceleration ratio may be higher than the acceleration ratio.

12. Bluetooth & WiFi

Users can choose to install one of the firmwares for either Bluetooth or WiFi. Since the firmwares are separate, the two functions cannot be used simultaneously.

1. Bluetooth

There are no mandatory settings that users must input for Bluetooth. However, users can specify their own TCS name to use as the Bluetooth device name. If not specifically designated, the device name will be displayed as TitanTCS-*, where "*" is filled with the TCS's serial number.

Any device name entered by the user will also be used as the SSID in WiFi's AP mode."

2. WiFi

TitanTCS offers WiFi functionality in two distinct modes: AP Mode and Station Mode.
TitanTCS supports Wi-Fi 802.11 b/g/n protocols and operates in the 2.4GHz

band.

A. AP Mode :

In this mode, TitanTCS functions as a WiFi Access Point. Users' PCs or mobile devices connect to the TitanTCS as clients, forming a local wireless network without internet access.

Users can specify an SSID and password for AP Mode on the TitanTCS. If not specifically set by the user, the default SSID for AP Mode is 'TitanTCS,' and the password is an empty string.

The IP address of the TitanTCS is always fixed at 192.168.4.1, and the port used for connections is 4030.

B. Station Mode :

Unlike AP Mode, in Station Mode, the TitanTCS operates as a client that can connect to an external WiFi router. External devices could be a mobile device supporting WiFi tethering, a PC with a HotSpot feature, or a WiFi router. TitanTCS's WiFi can communicate wirelessly with users' PCs or mobile devices through the external WiFi router.

In this mode, users must accurately enter the SSID and password of the external WiFi router into the TitanTCS's WiFi Station Mode settings. The entered strings are case-sensitive.

TitanTCS receives an IP address assigned by the external WiFi router. This information can be viewed in the WiFi menu under the 'Detail' section of the TitanTCS."

13. 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
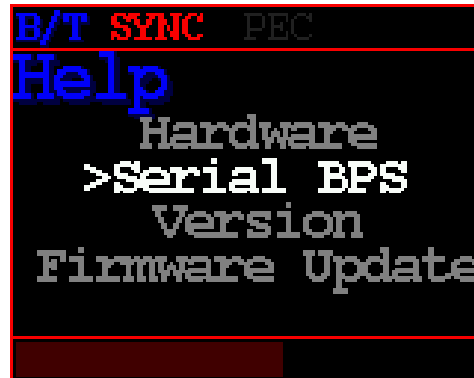
- Restore
  Restore settings from backup memory

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

14. Help

The connector assignment of Titan TCS and current communication speed can be checked.
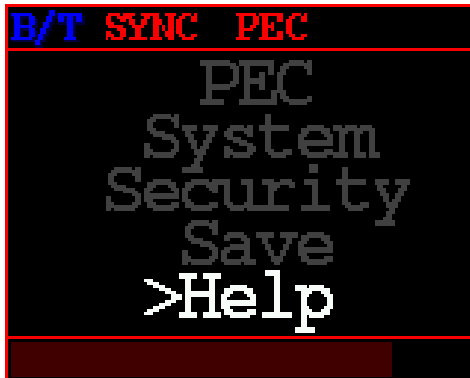
- Serial BPS : Display the speed of serial port A/B
  (Display only)
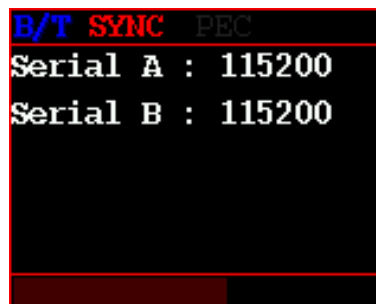
- Version
  Display firmware information.

- 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.
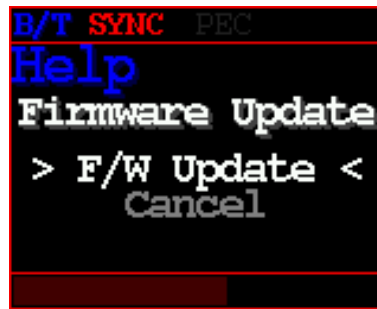
8. Bluetooth

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

1. Select "Devices" in Windows Settings.
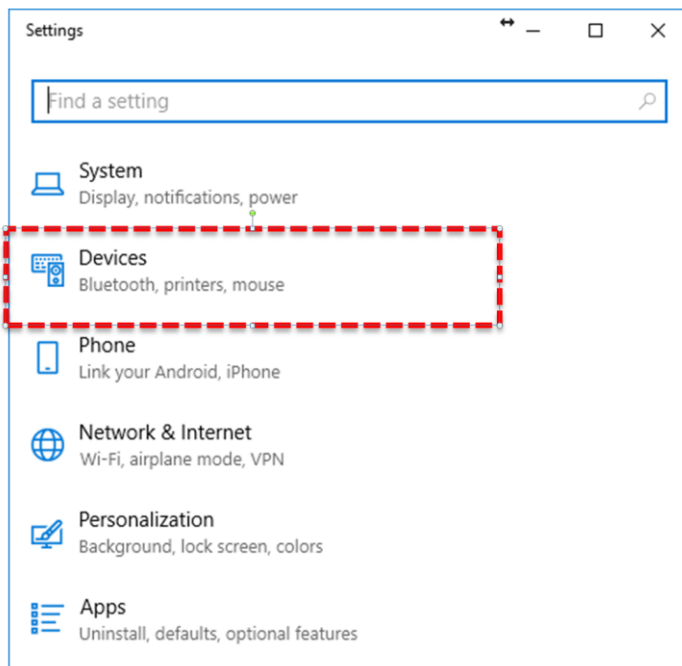
2. Select "Bluetooth & other devices" of the left menu bar.
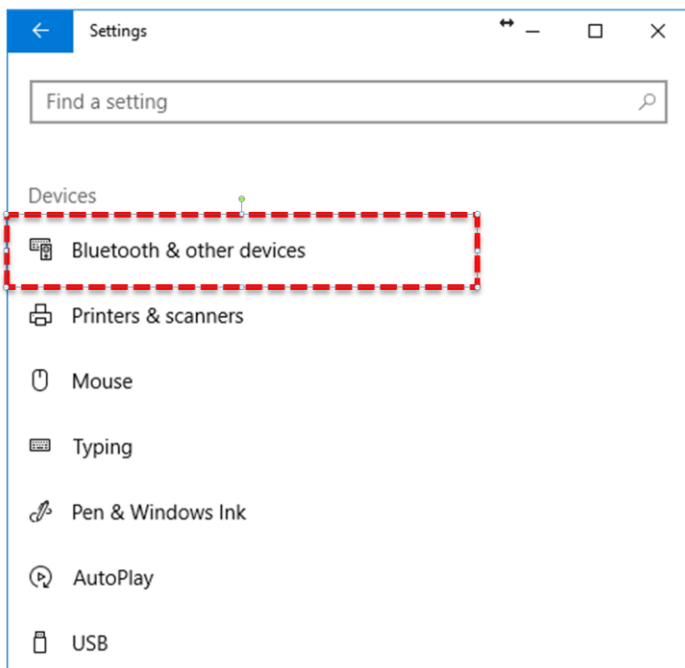
3. Make sure Bluetooth is on and select "Add BT".
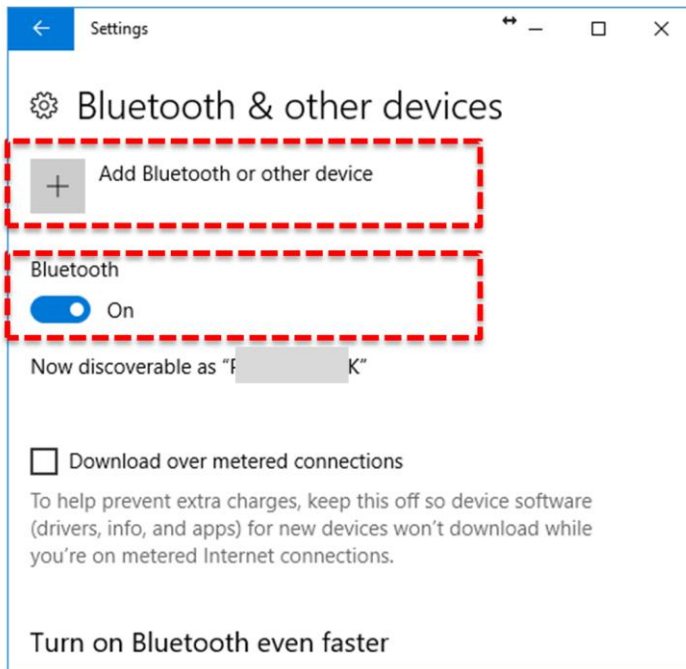
When the "add device" screen appears, select bluetooth.
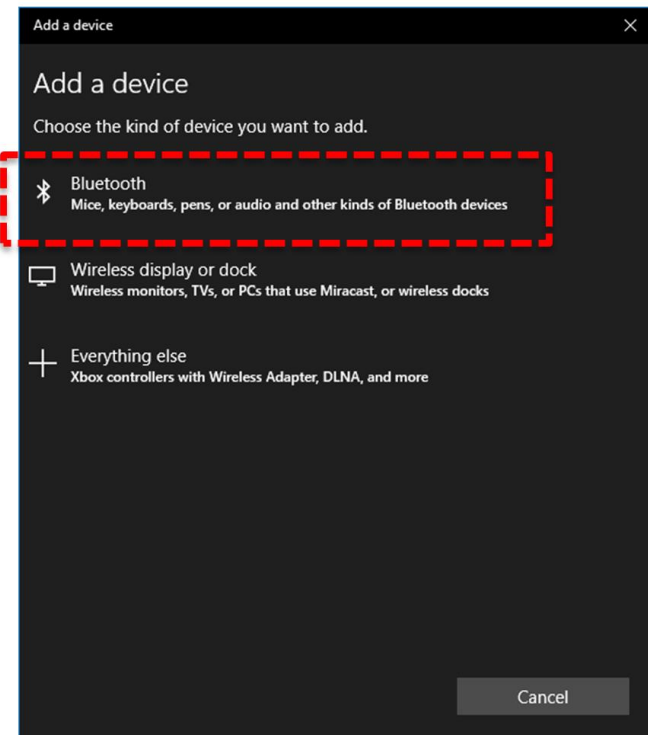
4. If the Titan TCS is powered on, it will take a moment and display "Titan TCS".
If you entered a different name in the [Bluetooth] menu in TCS, the name will be displayed.
It may take several tens of seconds to display the device.
Click the [TitanTCS] button or ["custom name"] button.
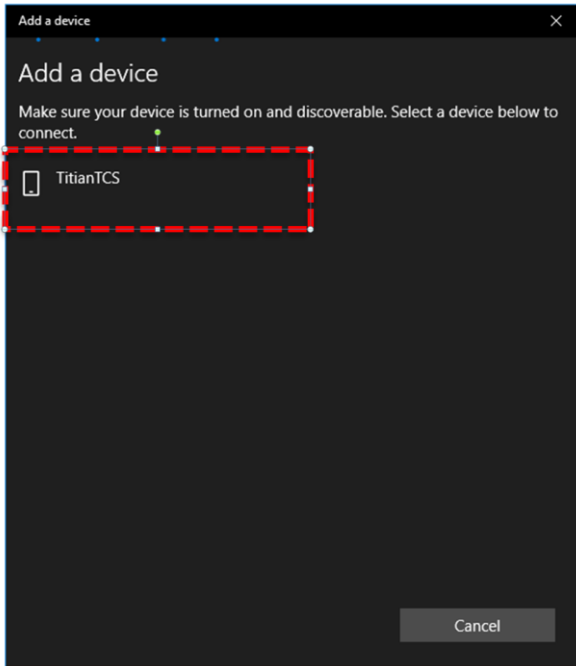
5. "Compare Password" window will appear. If you click the [Yes] button, Bluetooth will be automatically connected.
The password is randomly generated and changes every time.
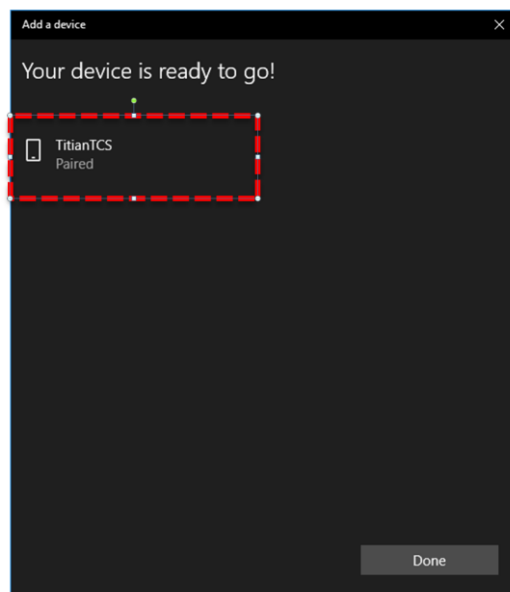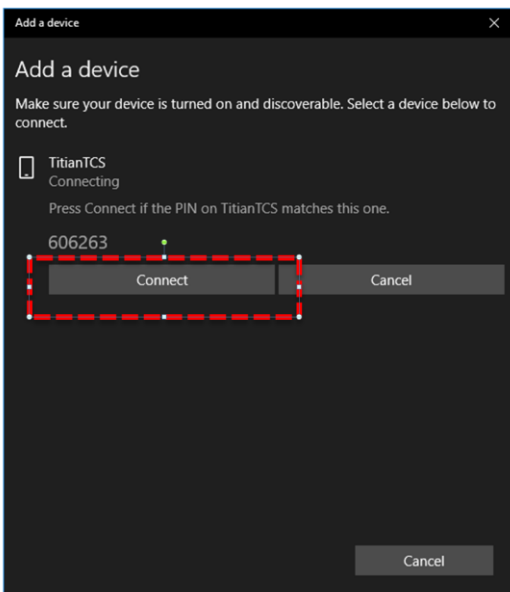
6. When the connection is successfully completed, the message "Paired" will be displayed.
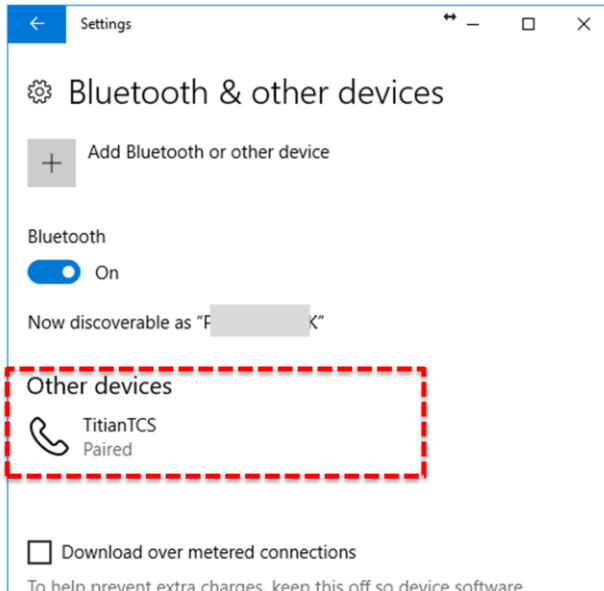
7. There will be two "Standard Serial over Bluetooth link" generated, but only the top one can be used.

In the example of the figure, only COM4 can communicate.
After connection, use as the same way as normal serial communication.
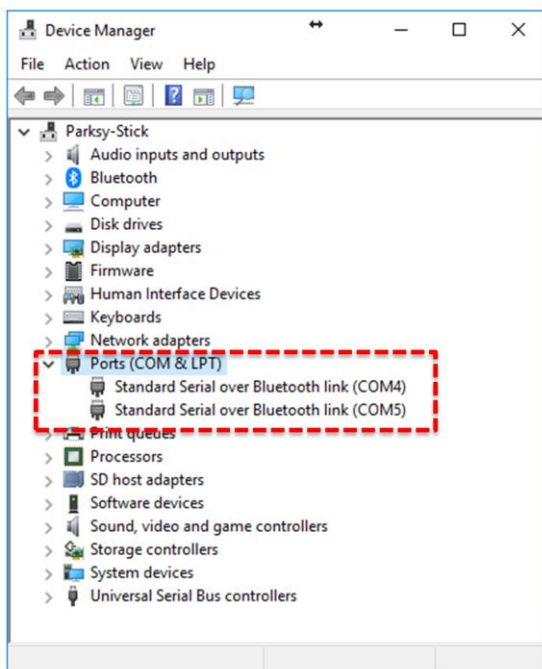
8.2. How to remove Titan TCS from Bluetooth connection (standard: Window 10)

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.

![HOBYM Observatory logo]
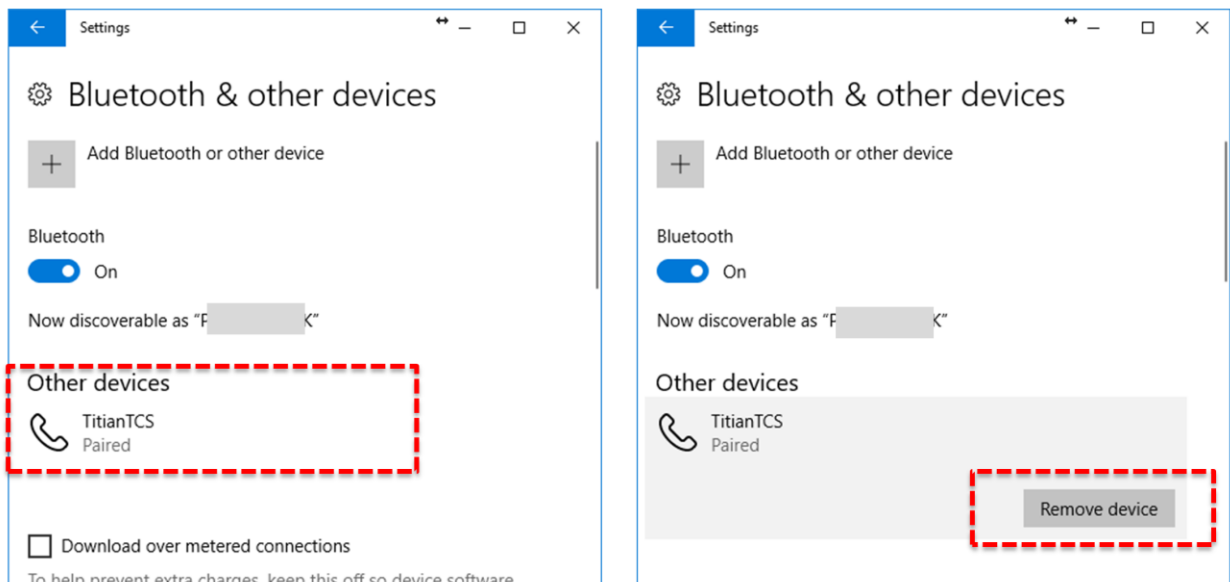
8.3. How to connect Titan TCS to your MAC (OSX)

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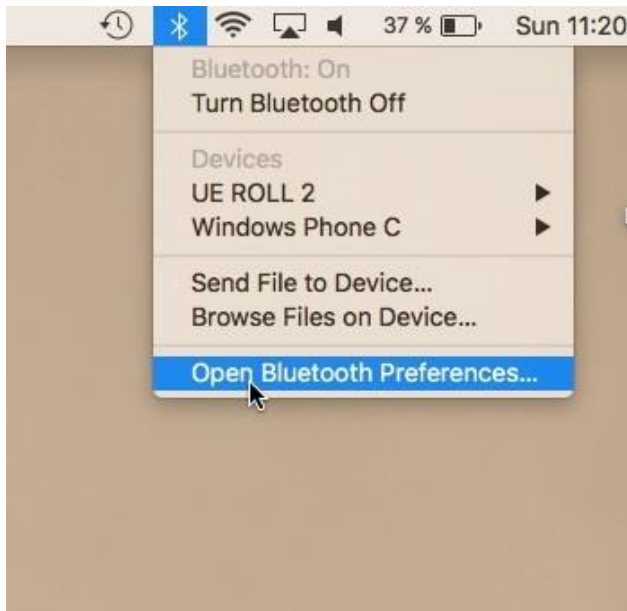

2. If the Titan TCS is powered on, it will take a moment and display "Titan TCS".
   If you entered a different name in the [Bluetooth] menu in TCS, the name will be displayed.
   It may take several tens of seconds to display the device.
   Click the [Pair] button.
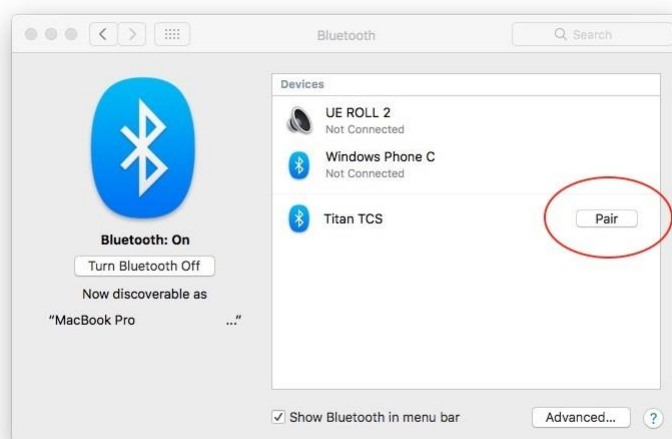
After a while, you will succeed Bluetooth pairing.
Unlike windows, mac shows only one connection and can use it.

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 Streo 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.

Eject Hole
Use small slot head screwdriver

CR2032 Battery Tray
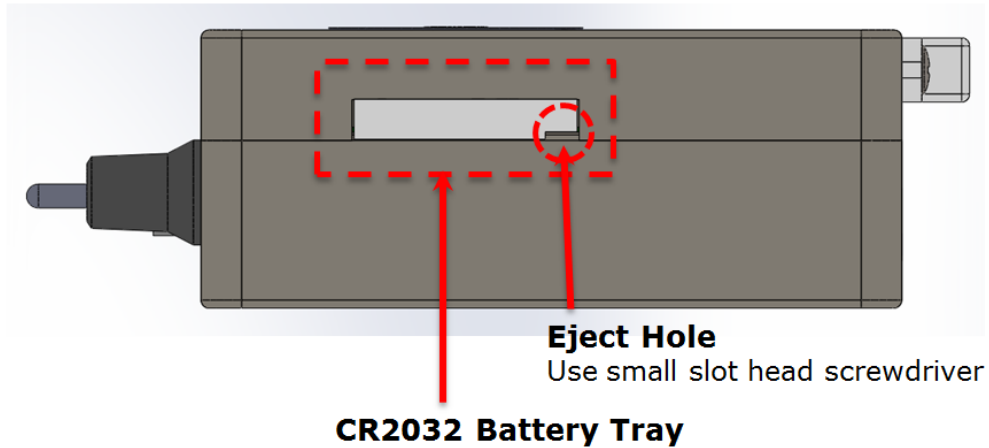
If the battery tray does not draw easily, you can slightly loosen the bolt on the back of the case within 3 turns to make drawing easier.

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

R-
DEC-
DEC+
RA+

DC Input
1.DC12V/3~4A
2.GND

Pin : 2mm
Barrel Outer : 6.3mm

Guide
1.NC
2.GND
3.RA+
4.DEC+
5.DEC-
6.RA-

RJ-12 (6P6C)

RS-232 B
1.GND
2.NC
3.TX
4.RX

RJ-9 (4P4C)

RS-232 A
1.GND
2.NC
3.TX
4.RX

RJ-9 (4P4C)

![HOBYM OBSERVATORY logo]
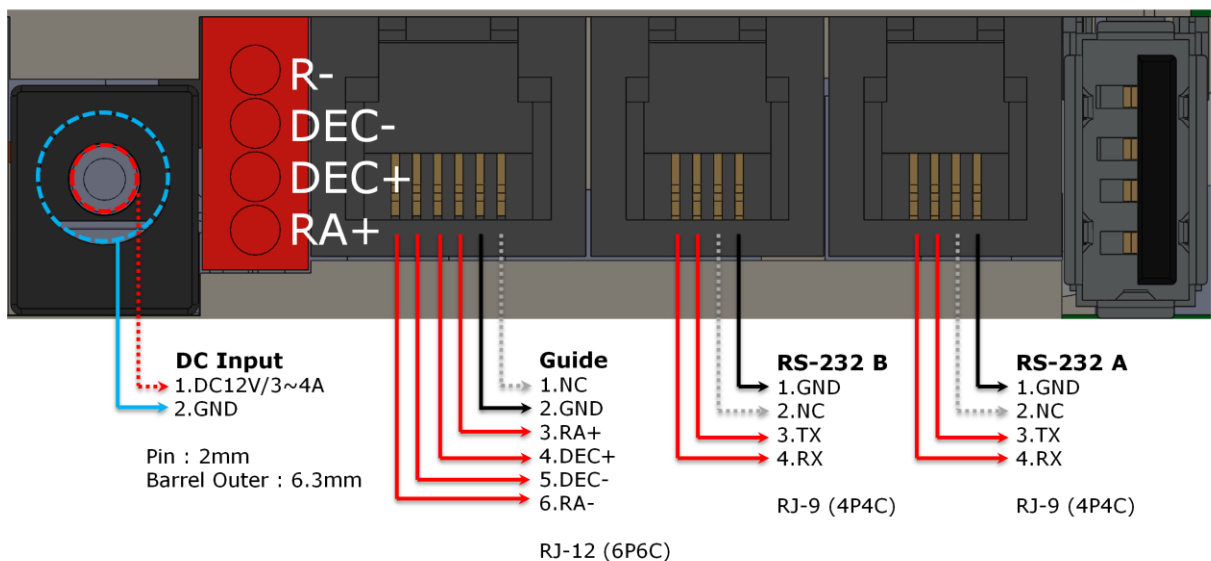
13. FAQ

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 distributer.

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