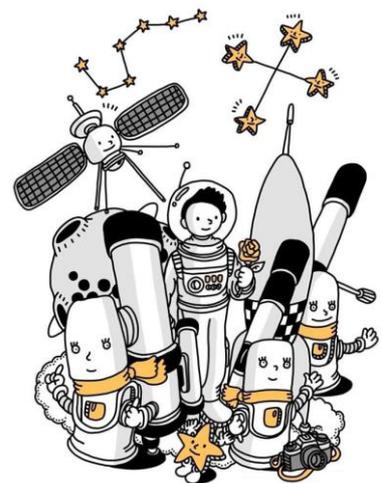
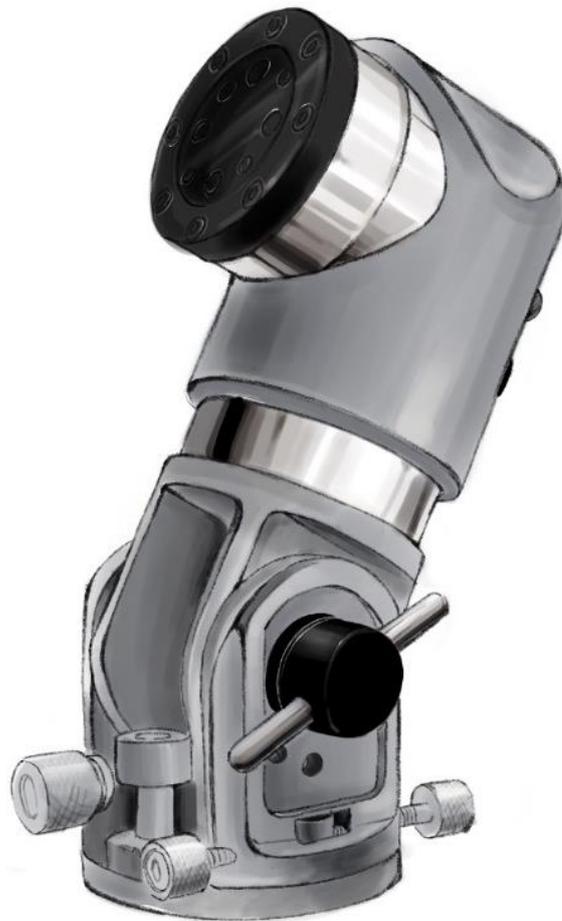




Crux140 Traveler User Manual



Ver 1.7

Thank you for choosing the Crux140 Traveler, an ultra-lightweight, portable equatorial mount with a highly advanced reducer system, the harmonic gear system. The Crux140 Traveler, despite its small size and lightweight of only 3kg, will showcase outstandingly precise processing and quick response time for full-fledged astronomical observation and astrophotography.

The Crux140 Traveler is smallest harmonic gear equatorial mount produced at HOBYM Observatory. A long time has been dedicated to its development as well; the points of improvement found from the field photography tests during the development process are closely reflected and will continue to be upgraded and developed. Designed and built for the consumers, the Crux140 Traveler is a portable device for expeditions and ensures the highest efficiency and ease of use. The Crux140 Traveler will be a perfect companion to your astronomical activities. HOBYM Observatory has succeeded in mass-production of the world's first small-sized harmonic gear equatorial mount, creating new standards, and will continue to launch competitive products through continuous research and development as an industry leader.

HOBYM Observatory Product Family



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4. Features of the Crux140Traveler



- ➔ Crux140 Tvr. adopts a harmonic gear system, which makes it powerful while using less driving force by using greater contact surface than the general worm wheel method. This allows a high payload compared to the light bodyweight of the equatorial mount.
- ➔ Crux140 Tvr. has no backlash, which provides quick feedback that allows a 0.1-second guide to be possible.
- ➔ Crux140 Tvr. is capable of time-lapse shooting by setting the rotating speed with Titan TCS.
- ➔ Crux140 Tvr. can be used as an alt-azimuth mount and supports GoTo and tracking function. Users can also use GoTo function and observe and photograph astronomical objects in situations where the polar alignment is not available.
- ➔ Crux140 Tvr. can be transformed into a free stop alt-azimuth mount by a simple operation and can be used without power. It can also be used for birdwatching and insect photography.
- ➔ Crux140 Tvr. is separated into mechanical parts and electronic parts so that each part can be upgraded separately.
- ➔ Crux140 Tvr. uses reliable harmonic gear produced in Korea and stepping motor produced in Japan for the stability and reliability.
- ➔ Crux140 Tvr. shows a stable guide and tracking performances even after passing the meridian. This allows a reliable autoguiding regardless of the location.
- ➔ Crux140 Tvr. maintains a constant contact surface and frictional force regardless of the temperature change thanks to its harmonic gear. Unlike other worm wheel equatorial mounts, the performance of Crux140 Tvr. is not influenced by the changes in a backlash resulting from temperature fluctuations.
- ➔ Crux140 Tvr. has a high payload compared to the bodyweight of the mount. It can mount up

to 8kg of load assuming the telescope's center of mass is 5cm away from the DEC mounting surface without counterweights, and the payload can be increased up to 13Kg when the user attaches an optional counterweight or a camera with ball head.

- Crux140 Tvr. is extremely useful in observational expedition including oversea observations. Although the equatorial mount in total body weighs only 3 kg, it can mount a 4-inch refractor (Vixen VSD, FSQ106), a 6-inch reflector or an 8-inch RC telescope with a cooling CCD.
- Crux140 Tvr. is as light as a piggyback mount but is as functional as a small-sized equatorial mount. It also supports the Time-Lapse shooting.
- Adopting harmonic gear reducer, Crux140 Tvr. does not have many factors to cause functional problems as it has a simple structure, shows consistent performance and is durable. This allows the mount to have a long product life unless there were severe damages from external factors.
- Crux140 Tvr. is equipped with Titan TCS, which makes it one of the most efficient portable mounts among all.
- Crux140 Tvr. reduces the periodic error using the P-motion control function of Titan TCS. This ensures the final periodic error value not to exceed about ± 8 arcsec. Therefore, for most of the short focus refractors, you can take photographs without any guide if you invest about 20 minutes in P-motion correction training at the initial set up.
- Crux140 Tvr. is controllable anytime and anywhere via Titan TCS. Titan TCS supports Bluetooth and WiFi (soon to be released) wireless environment and the user may choose which to use by a firmware update.
- Titan TCS accommodates ASCOM Driver and INDI Driver that enables the connection with various astronomical software.



5. Product Details

Mount Mechanism

- Type: German-style equatorial type and alt-azimuth type using harmonic gear reducers at RA and DEC.
- RA drive: Harmonic gear reducer (SSHG14-100_2A) driven by a stepper motor with a microstep driver.
- DEC drive: Harmonic gear reducer (SSHG14-100_2A) driven by a stepper motor with a microstep driver.
- Azimuth adjustment: Fine adjustment of about 10° available
- Altitude adjustment: can be adjusted from 5° to 90°
- Payload: assuming the telescope's center of mass is 5cm away from the DEC mounting surface, the payload is 8kg without any weight. Can load up to 13 kg if the optional 1.8kg counterweight is attached.
- Equatorial mount total weight: 3kg (excluding the weight and Titan TCS)
- Polar Axis Alignment: available using QHY's Pole Master, sold separately.
- Operating temperature: -30 °C degrees to +40 °C degrees
- Parts Provided: Motor Cable, RS232 cable, USB Cable, DC power connection cable.
- Warranty: 5 years of mechanism
(Cost is at the user's expense if defects were caused by the user's fault.)

Motor drive system

- Drive system: RA motor - about 355 pps
DEC Motor - about 355 pps
- Operating area: Almost anywhere in the world, where the altitude is adjustable.
- Recommended fast slewing speed: about 800 times faster than sidereal rate
- Input voltage: 12V 3.0A or more
- GoTo: GoTo available both from the hand controller and PC.
- Warranty: 3 years of electronic parts
(Cost is at the user's expense if defects were caused by the user's fault.)

6. What's Included in the Box and Optional Parts

In-the-Box Items

- Crux140 Traveler (The appearance problem of the casting part is not an AS issue)
- Titan TCS
- PoleMaster Adapter
- Bubble level
- 5mm L-wrench
- M8x10 and M8X12, two each
- 6mm knob bolt
- Card USB Memory – Programs and Manuals
- Motor cable, RS232 cable, power cable, USB cable
- HOBYM Observatory Stickers variety pack
- Luxury Embroidery Bag for Crux140 Traveler (Not included in AS)

Optional Parts (Sold separately)

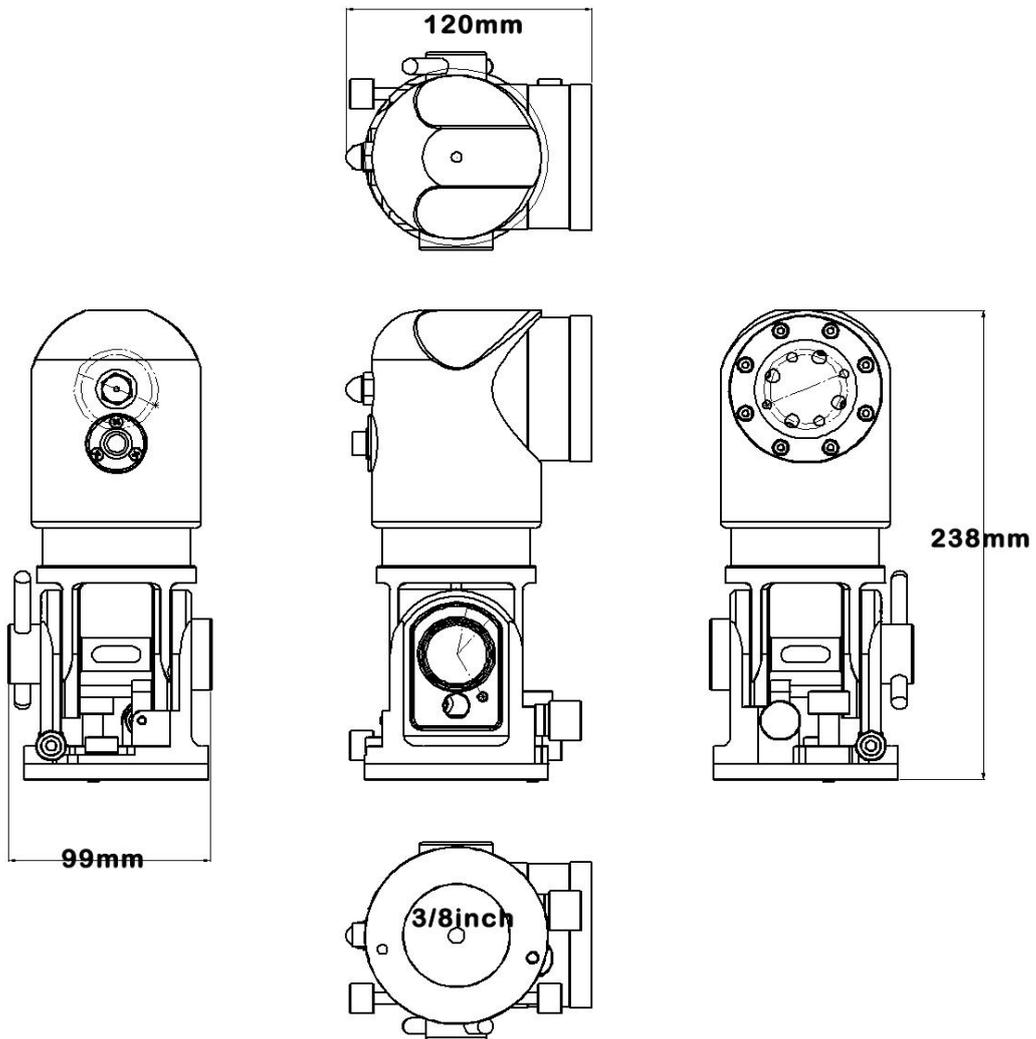
- Weight shaft (diameter-18mm)
- 1.8 kg stainless steel weight
- Ball head adapter

7. Mount Layout

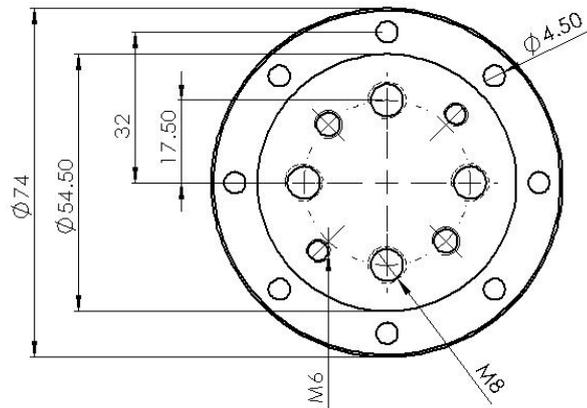


1. Adaptor Specification: M8x2_PCD35 / M6x2_PCD35 / M5x2_PCD41
2. RA-DEC housing: the main part that contains two motors and two harmonic gears. Precise casting and powder coating create the elegant curves and has a variety of color options.
3. Altitude adjustment lock nut: a handle to loosen when adjusting altitude and tighten after completion.
4. Altitude adjustment knob: turn clockwise to lower altitude and counterclockwise to increase altitude.
5. Azimuth adjustment lock bolt: locking bolts to tighten after azimuth adjustment, one in front and one in back.
6. Altitude adjustment lock handle: a handle that unlocks before adjusting the altitude and locks after adjusting.
7. Azimuth adjustment knob: push and pull to adjust azimuth.
8. Weight shaft / Ball head Adapter Mounting Bolts: a 3/8-inch screw and can be equipped with a weight shaft or ball head adapter.
9. Motor cable connection jack: connect the motor cable with one cable.
10. Altitude adjustment support auxiliary bolt: a bolt that penetrates through the adjustment support auxiliary bolt block that moves horizontally and supports it.
11. Altitude adjustment support auxiliary bolt extraction hole: a hole that makes it easy to extract the bolt when used in high latitude or low latitude regions or when used as an alt-azimuth mount.
12. Alt-azimuth Mode fixing bolt mounting tap: for fixing by attaching the handle bolt to it after matching M6 tap hole with an inner hole.
13. Mount base
14. PoleMaster Adapter: An adapter that can attach a PoleMaster.

8. Dimensions of the Mount



Equatorial Mount Head Size



9. Precautions for Use

1. If you forcibly mount a large telescope, it may damage the equatorial mount. The payload may vary depending on the size of the telescope, even in the case that the telescopes have the same weight.
2. When using bolts other than the supplied M8 bolt, pay attention to the length of the bolts and use only the ones with the proper length. If the bolt is too long, it may damage the parts protecting the harmonic gear system.
3. Adjust the altitude azimuth after loosening the fixing handle. Forcibly adjusting with a wrench in a tightly joined state will cause damage to the mount.
4. Do not supply more than the specified voltage. (DC 12V)
5. Please refrain from using the equatorial mount in case of excessive moisture and rain.
6. Since the driving torque is strong, make sure to fully understand the safety zone function of Titan TCS and carefully set it up at the initial set up.
7. Avoid applying excessive shock to the mount or dropping it. In these cases, the axis may bend, or the tooth surface of the harmonic gear may be damaged, causing a decrease in its accuracy.
8. Tripods and piers should be sturdy. Especially, tripods for general photography have a narrow angle compared to astronomical use. We recommend using an astronomical tripod.
9. Do not loosen the altitude adjustment lock handle too much when adjusting the altitude. If you loosen it too much, the polar axis may deviate after locking.
10. In case of using GoTo function frequently, lower the slewing speed to prevent the motor from overheating. When operated at the highest speed for a too long time, it may lower the performance of the motor due to the overheating.

10. How to Set Up Telescope

How to set up in Equatorial Mode

1. Set up a tripod on a firm, level surface and place one of the tripod legs toward the north or south pole.



3. Level the mount by adjusting the tripod legs using a bubble level.



2. Mount a bubble level (included in the package) on the tripod.



4. The Crux140 Traveler has a 3/8-inch female screw tap on the bottom. Crux140 Traveler can be mounted on any tripod as long as it has a 3/8-inch bolt.



5. After attaching to the tripod, loosen the fixing handle on the right side and adjust the altitude adjustment knob to match the altitude displayed on the side to the current latitude. If you slightly press down the head of the equatorial mount with your left hand, you can move it to the target angle more easily.



6. Attach the dovetail holder. At this time, two M8X10 and M8X12 are included in the package. Secure with a suitable bolt. Be careful when tightening with a long bolt as the mounting tabs on the telescope connection head may be damaged.



7. Attach the weight shaft and weight. The weight should always be at all the way bottom. (A weight shaft and weight are optional items.)



8. Connect the motor cable of Titan TCS to the connecting jack on the rear of the equatorial mount's weight shaft.



9. Determine the telescope's approximate center of mass. This is to minimize the load on the equator during operation.



10. Secure the telescope to the dovetail holder.



11. Attach the PoleMaster. The adapter is included in the package, so there is no need for a separate purchase. Please refer to PoleMaster's manual for detailed instructions.

12. Plug in the Titan TCS to power, and you are ready to go. The telescope in the photo below is headed for due east. In the Titan TCS Object menu, select Manual > East > Sync. Use GoTo function targeting the celestial object you know using the Titan TCS Object menu. The telescope will move near the selected target. Then center your target using TCS's keypad and sync.



How to Set Up in Alt-Azimuth Mode

1. Set up a tripod on a firm, level surface and place one of the tripod legs toward the north or south pole.



3. Level the mount by adjusting the tripod legs using a bubble level.



2. Mount a bubble level (included in the package) on the tripod.



4. The Crux140Traveler has a 3/8-inch female screw taps on the bottom. Any tripod can be mounted as long as it has 3/8-inch bolt.



5. Adjust the altitude adjustment knob to match the M6 tap hole to the small hole inside.



6. Insert the provided M6 knob bolts into the M6 holes next to the fixing handle. M6 knob bolts can remain inserted while operating the mount.



7. Secure the handle tight. If the M6 knob bolts become interrupts fastening, rotate the left Altitude adjustment lock nut at the equatorial mount to find the proper position.



8. Level using the supplied bubble level. Adjust the tripod's legs so that the water droplet locates in the center. This step improves the GoTo and tracking accuracy of the alt-azimuth mount via a one-star alignment.



9. Install the weight shaft and weight. The weight should be located farthest from the mount.



10. Mount the telescope and connect the Titan TCS. The telescope and mount should be positioned as shown below:



11. Plug in the power and you are ready to go.



12. The installation position and simple instructions for Titan TCS in alt-azimuth mode are as follows. Please refer to the manual for Titan TCS for more detailed information.

- Menu > System > Mount Type > Alt-Az mode > Enter
- Menu > Save > Save & Exit > Enter
- Restart the Titan TCS.
- The telescope should be to the south and the pier to the north.
- Point the telescope to the due east.
- In the Titan TCS Object menu, select Manual > East > Sync
- Use GoTo function targeting the celestial object you know using the Titan TCS Object menu. The telescope will move near the selected target. Then center your target using TCS's keypad and sync.

Now you can observe any object using GoTo.

Changing altitude to low latitude

- Default position: 24° ~ 90°
- Low latitude: 5° ~ 46°

1. If you have a knob bolt attached while in Alt-Azimuth mode, remove it.



2. Adjust the altitude adjustment knob so that the bolt head is centered in the large hole below the logo.



3. Disassemble the bolt counterclockwise using the provided wrench.



4. Grab the base with the left hand, grab the body with the right hand, and adjust the altitude to match the two holes.



5. Adjust the altitude adjustment knob to match the hole in the altitude adjustment support auxiliary bolt block.



6. Check all holes to be matched



7. Reassemble by inserting the altitude adjustment support auxiliary bolt. Be careful not to overtighten.



8. Insert the long part of the L-wrench into the bolt head to tighten it.



9. Use the altitude adjustment knob to adjust the altitude.



11. Features of Titan TCS

Titan Telescope Control System (TCS) is compact but one of the most powerful equatorial mount control system. Titan TCS comes with a list of nearly 14000 objects that can be used by all astrophotographers in its memory.

- List of Objects -

IAU-approved Star Name 240 items

New General Catalogue 7840 items

Messier Catalogue 110 items

IC (Index Catalogue) Objects 5386 items

Caldwell catalogue 109 items

Sharpless catalog 341 items

RCW 182 items

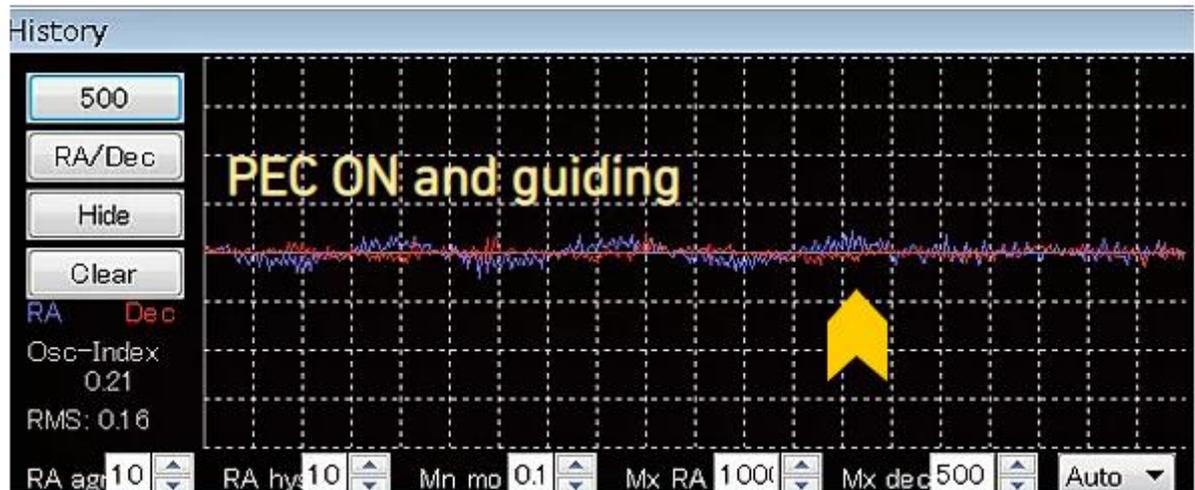
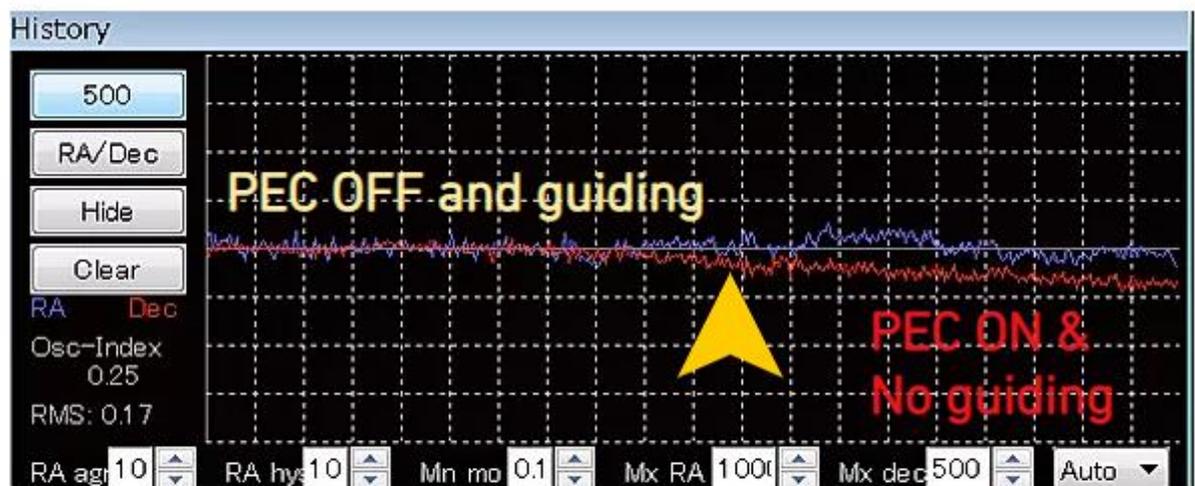
Gun 94 items

Barnard 174 items

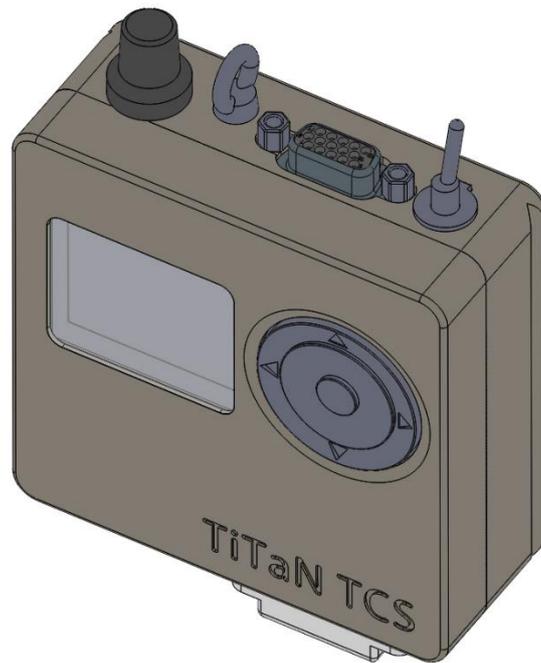


1. Titan TCS equipped with controlling CPU (120MHz / 32bit) and 32bit CPU for communication and user interface to secure the expandability
2. Titan TCS has a total of 5 megabytes of memory. It stores an embedded object list for GoTo,
3. Bluetooth and Wi-Fi (soon to be released) compatible, User may choose which to use by firmware update.
4. Uses microstep (1/4 ~ 1/128): It controls the current and voltage according to the speed of the motor, which results in maximum efficiency with less power consumption.
5. Voltage boost and current control up to 30V by internal self-boosting function: maximizes the power of stepper motor and enables powerful and smooth driving.
6. Titan TCS supports LX200 compatible protocol, which makes it compatible with many kinds of astronomical software.
7. Remote observation through built-in parking function
8. Compact Size of 88mm x 108mm x 35mm with high density PCB design.
9. Titan TCS is specialized for the harmonic gear mounts; all of the CRUX mounts can take photographs without guide up to 400 ~ 500mm focal length by using Titan TCS PEC function.
10. Small graphic high-resolution OLED display: High resolution OLED to monitor the current consumption of motor and various information on the current state of the mount. (1.69 "Diagonal Size, 160X128 Pixels, Full Color)
11. Input power (12V / 3A): DC Adapter should be 12V/3A or have higher current.

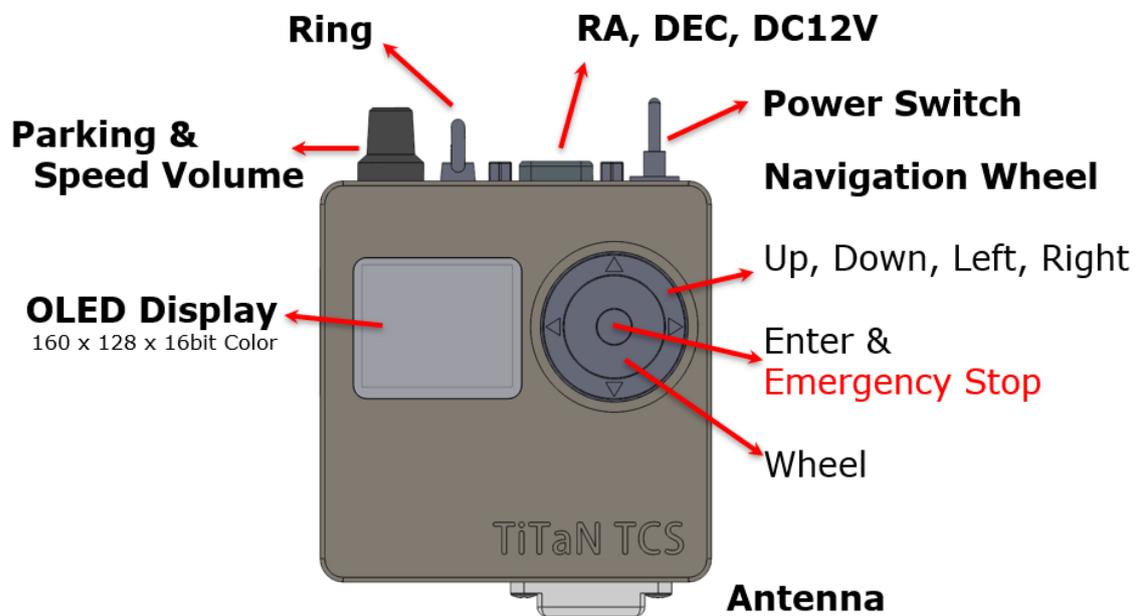
12. Minimal power requirement for star tracking (0.5A ~ 0.7A).
13. USB port supports two virtual serial connection: can be directly connected to PC
14. Equipped with a small LED light indicating the guide situation in real time.
15. Built-in beeper notifies a job completion of the controller and allows a simple melody alarm function.
16. The guide port prevents electrical damage incurring from external surge using optocoupler.
17. The latest Titan TCS (HW Ver2.0) has a built-in camera shutter release that allows the user to control the camera such as DSLR.
18. The latest firmware has added the alt-azimuth mount mode to existing Titan TCS.



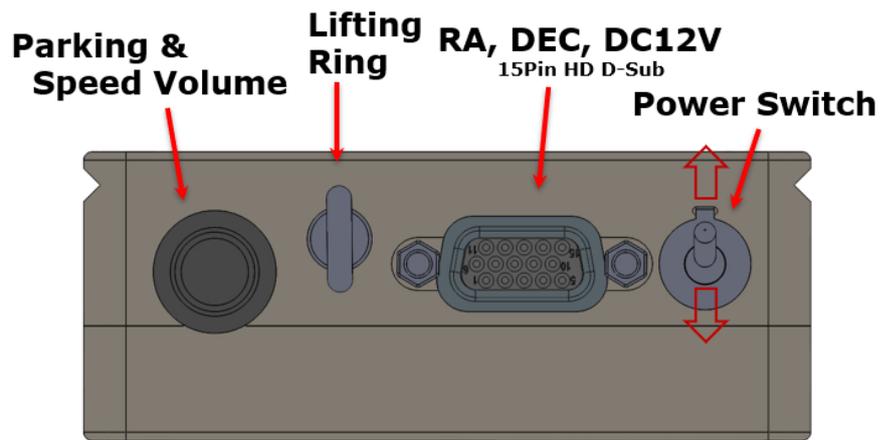
12. TitanTCS (V2) Quick Manual



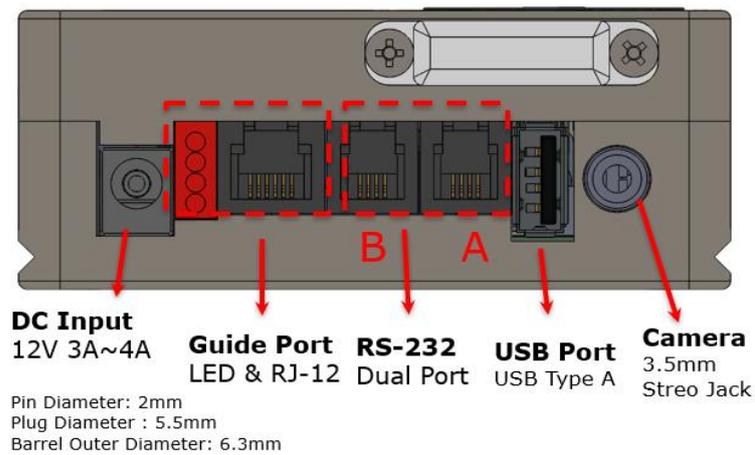
Front View

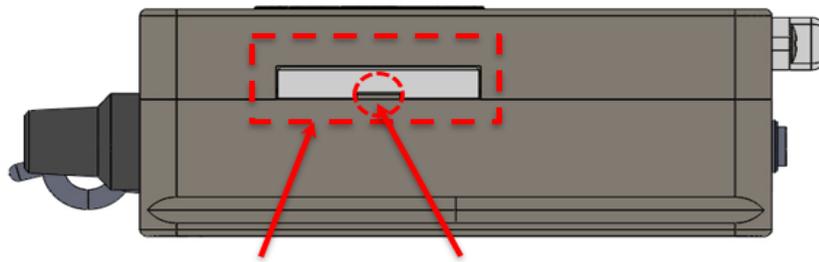


Top View



Bottom View

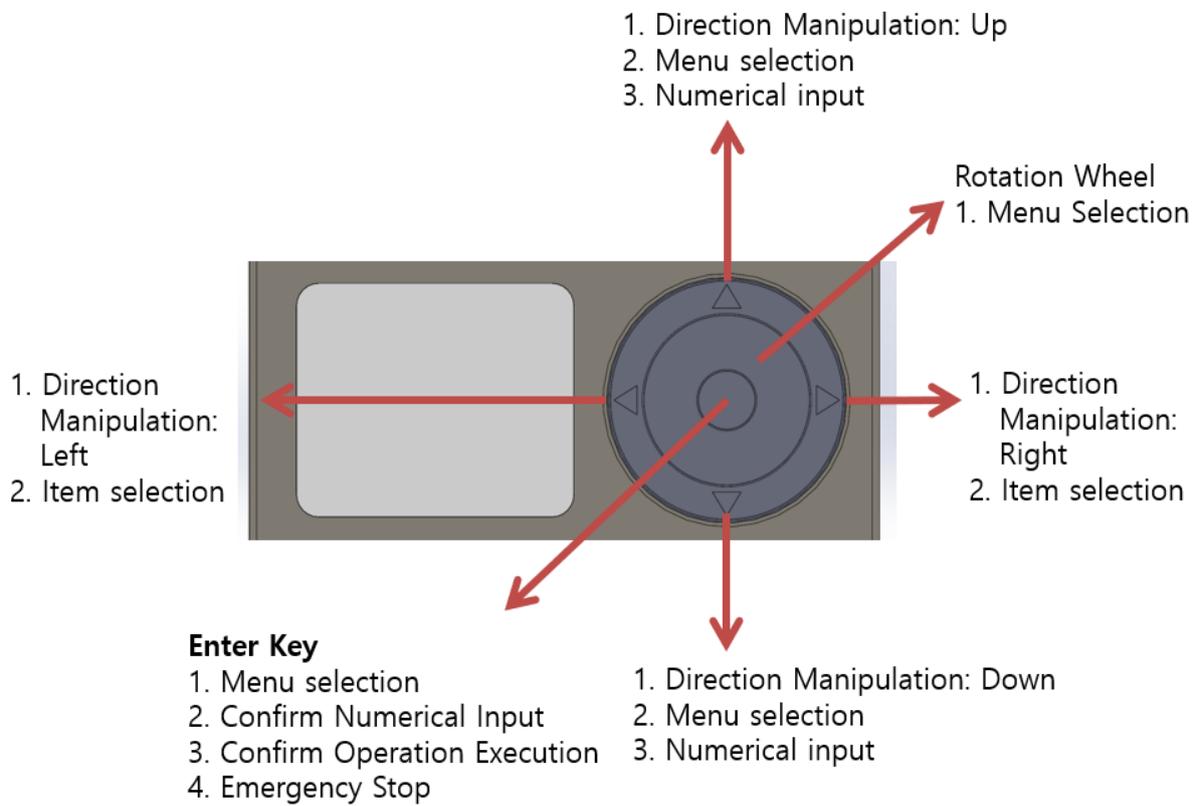




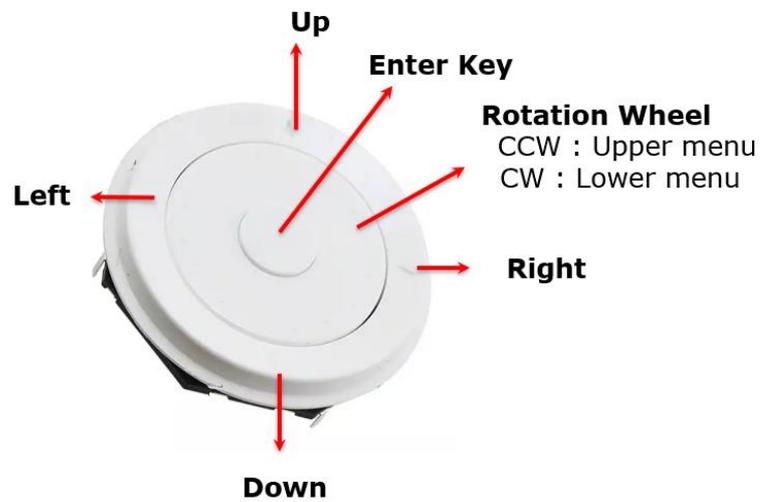
CR2032 Battery Tray

Eject Hole

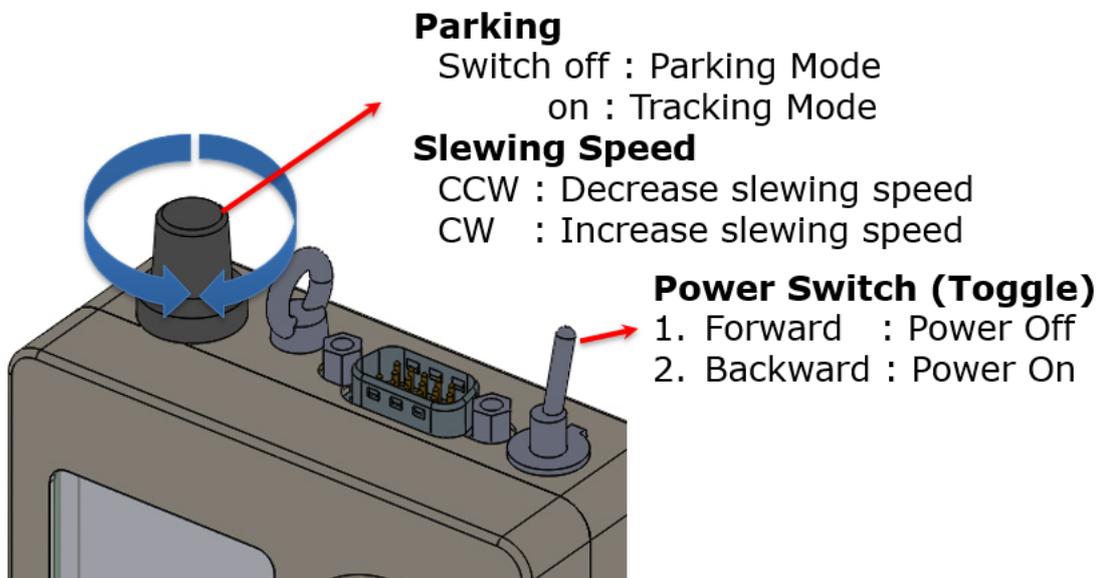
Use small slot head screwdriver



Navigation Switch



Volume Knob (Parking & Speed)



Date/Time Setup



1. Power on (move to backward power switch)
The display turns on after a few seconds.
2. Turn volume knob until right end position.
Release parking & slewing speed up(100%)
3. Press the Enter key for more than 3 seconds.
Menu screen is displayed.
4. Select "System" Menu
using navigation wheel or Up/Down button.
Press "Enter" button.
5. Select "Date/Time" submenu in "System".
Press "Enter" button to input Date/time.
6. After input your new local time, press "Enter" button.
New date & time will apply to TCS.
Also, you can cancel input using wheel rotate CCW 1 click.
7. Select "Telescope" menu using wheel or
up/down key, then press "Enter" button.
Telescope screen is appeared.

Observatory Location Setup



1. Power on (move to backward power switch)
The display turns on after a few seconds.
2. Turn volume knob until right end position.
Release parking & slewing speed up(100%)
3. Press the Enter key for more than 3 seconds.
Menu screen is displayed.
4. Select "Observatory" Menu
using navigation wheel or Up/Down button.
Press "Enter" button.
5. Select "Location" submenu in "Observatory".
Press "Enter" button to input new location.
6. After input your new location, press "Enter" button.
New location will apply to TCS.
Also, you can cancel input using wheel rotate CCW 1 click.
7. Input time zone information same way.
8. Select "Telescope" menu using wheel or
up/down key, then press "Enter" button.
Telescope screen is appeared.

Start (Power on)



1. Power on (move to backward power switch)
The display turns on after a few seconds.
2. Turn volume knob until right end position.
Release parking & slewing speed up(100%)
3. Move telescope using Navigation button.
Aim the stars you know well..
(You must know the star name)
4. Press the Enter key for more than 3 seconds.
Menu screen is displayed.
5. Select "Goto(Object)" Menu
using navigation wheel or Up/Down button.
Press "Enter" button.
6. Search & select the star name you aimed.
7. Goto/Sync/Cancel appeared.
Select "Sync", then press "Enter" button.
8. Sync Complete, You can hear melody.
9. Select "Telescope" menu using wheel or
up/down key, then press "Enter" button.
Telescope screen is appeared.

Finish (Power off)



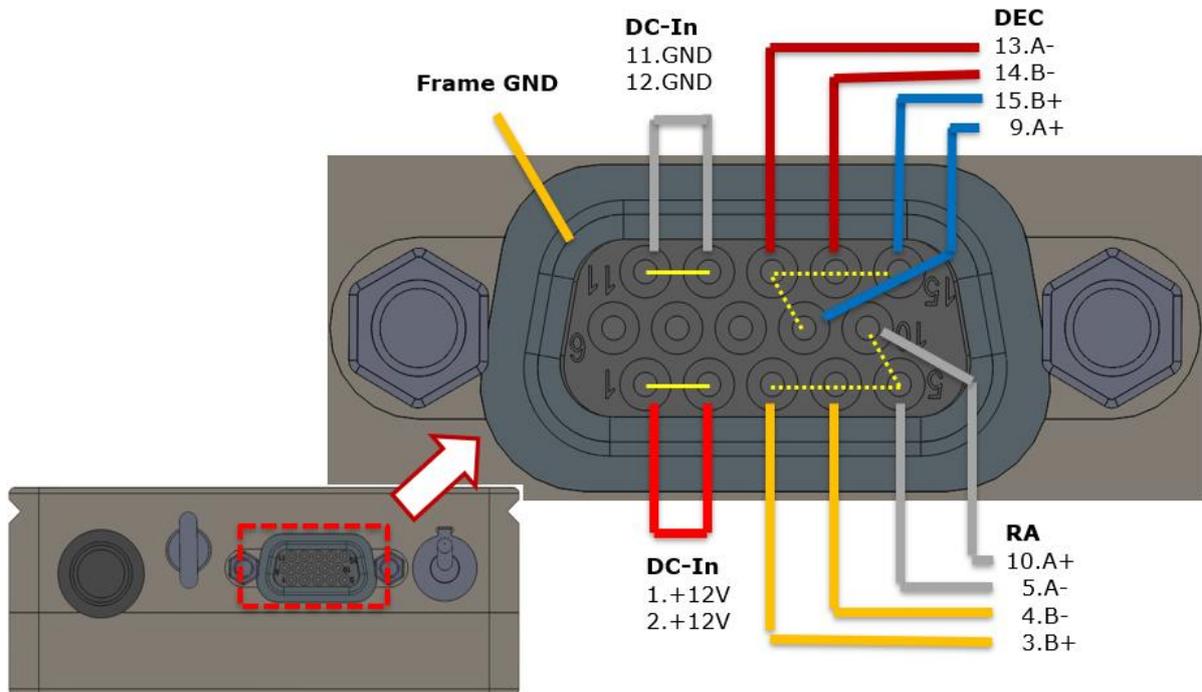
1. Turn volume knob until left end switch off.
2. Wait until "Parking OK" message.
3. Power off (Move power switch to forward)
The display turns off immediately.

Caution : Case is connected to DC-In GND.

**When user make custom D-Sub cable,
the GND of the cable must be connected to the D-Sub shell.**

Pins 11 and 12 must be connected together to provide sufficient current.

Pins 1 and 2 must be connected together to provide sufficient current.



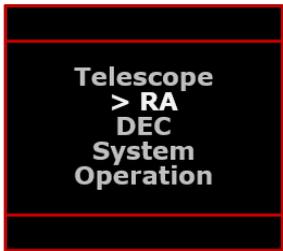
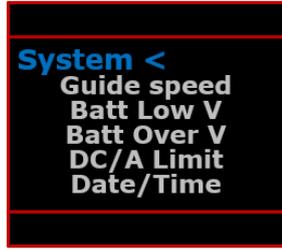
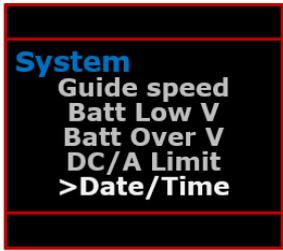
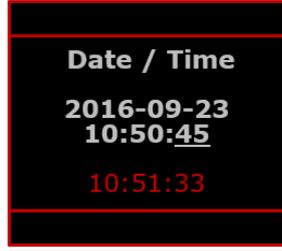
CAUTION:

When user makes/modifies the power line, it is necessary to first check that the Titan TCS is properly turned on, without connecting other devices to the Titan TCS before turning on the power.

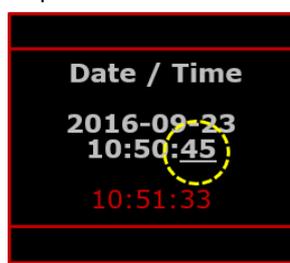
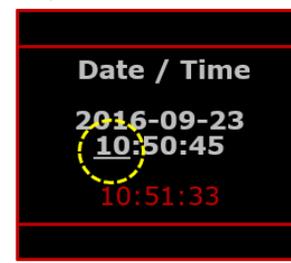
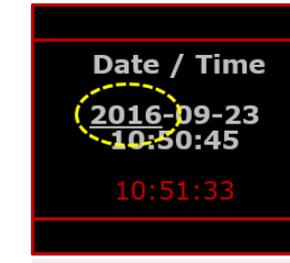
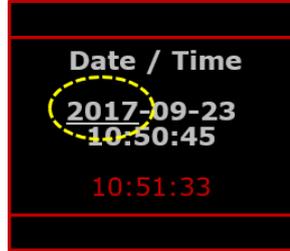
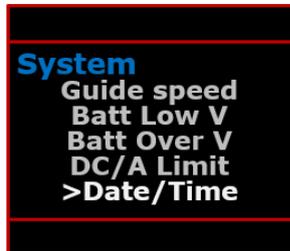
If the polarity of the power is reversed or there is a problem, the TCS will not be turned on.

Incorrect power connections can cause serious permanent damage to the Titan TCS as well as other devices connected to the TCS.

Menu Operation / Date & Time (1/3)

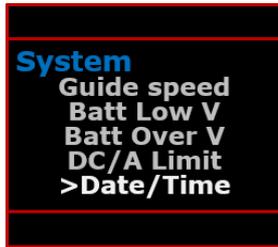
<p>Top / Telescope</p>  <p>Quickly Rotate Wheel 1 turn -> Menu Mode</p>	<p>Menu Mode</p>  <p>Up/Down Key -> Highlight menu item</p>	<p>Select menu</p>  <p>Center Key -> Select menu</p>
<p>System</p>  <p>Up/Down Key -> Highlight menu item</p>	<p>System > Date/Time</p>  <p>Center Key -> Select Sub-menu</p>	<p>Input new date & time</p>  <p>Input Menu has cursor(under line)</p>

Menu Operation / Date & Time (2/3)

<p>Input new date & time</p>  <p>Left/Right Key -> Move cursor</p>	<p>Input new date & time</p>  <p>Left/Right Key -> Move cursor</p>	<p>Input new date & time</p>  <p>Up/Down Key -> Change value</p>
<p>Input new date & time</p>  <p>Up/Down Key -> Change value</p>	<p>Write data to TCS</p>  <p>Center Key -> Apply New Date/Time & exit input menu</p> <p>Also, you can cancel input using wheel rotate CCW 1 click.</p>	

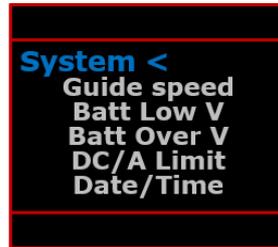
Menu Operation / Date & Time (3/3)

Return to Telescope



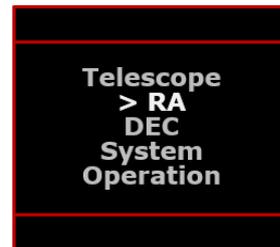
Up Key or Rotate Wheel CCW
-> Select upper menu

Return to Telescope



Center Key
-> Select Sub-menu

Return to Telescope



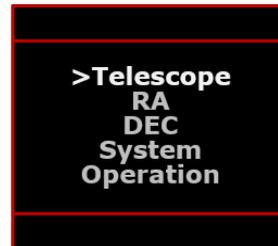
Up/Down Key
-> Highlight menu item

Return to Telescope



Center Key
-> Select menu

Return to Telescope



Center Key
-> Select Telescope Menu

Top / Telescope



Telescope Menu

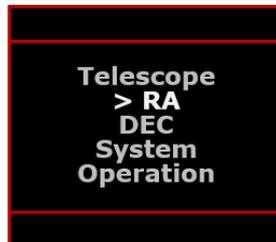
Menu Operation / RA Max Speed (1/3)

Top / Telescope



Quickly Rotate Wheel 1
turn -> Menu Mode

Menu Mode



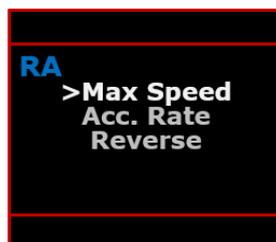
Up/Down Key
-> Highlight menu item

RA



Up/Down Key
-> Highlight menu item

RA > Max Speed



Center Key
-> Select Sub-menu

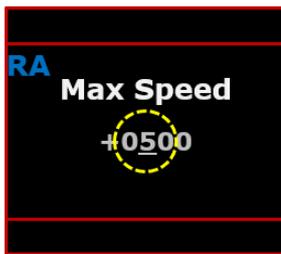
Input



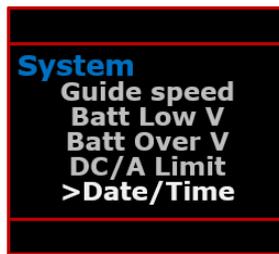
Input Menu has
cursor(under line)

Menu Operation / Date & Time (2/3)

Input



Left/Right Key
-> Move cursor



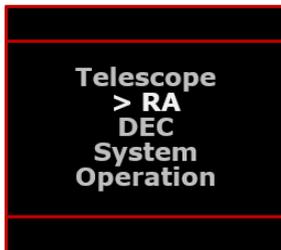
Center Key
-> Apply New Date/Time
& exit input menu

Return to Top Menu



Up/Down Key
-> Highlight menu item

Return to Top Menu



Up/Down Key
-> Highlight menu item

Save Setting



Up/Down Key
-> Highlight menu item

Save Settings



Up Key or Rotate Wheel CCW
-> Select upper menu

Menu Operation / Date & Time (3/3)

Save & Apply Settings



Up/Down Key
-> Select action item

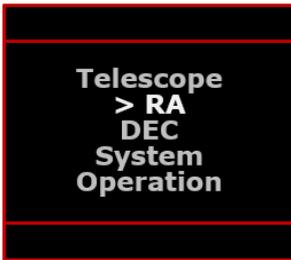
Top / Telescope



Center Key
-> Save & Apply date
Return to "Telescope"

Menu Operation / Save Settings (1/2)

Top Menu



Up/Down Key
-> Highlight menu item

Menu Mode



Up/Down Key
-> Highlight menu item

Save Settings



Up Key or Rotate Wheel CCW
-> Select upper menu

Save & Apply Settings



Up/Down Key
-> Select action item

Yes
-> Save new settings &
apply new settings.
But, some setting need
reboot

Cancel
-> Exit this menu

Factory
-> Factory Reset
This is used for technician.
Never use it if you are not
expert.

Top / Telescope



Center Key
-> Save & Apply date
Return to "Telescope"

Menu Operation / Date & Time (2/2)

Save & Apply Settings



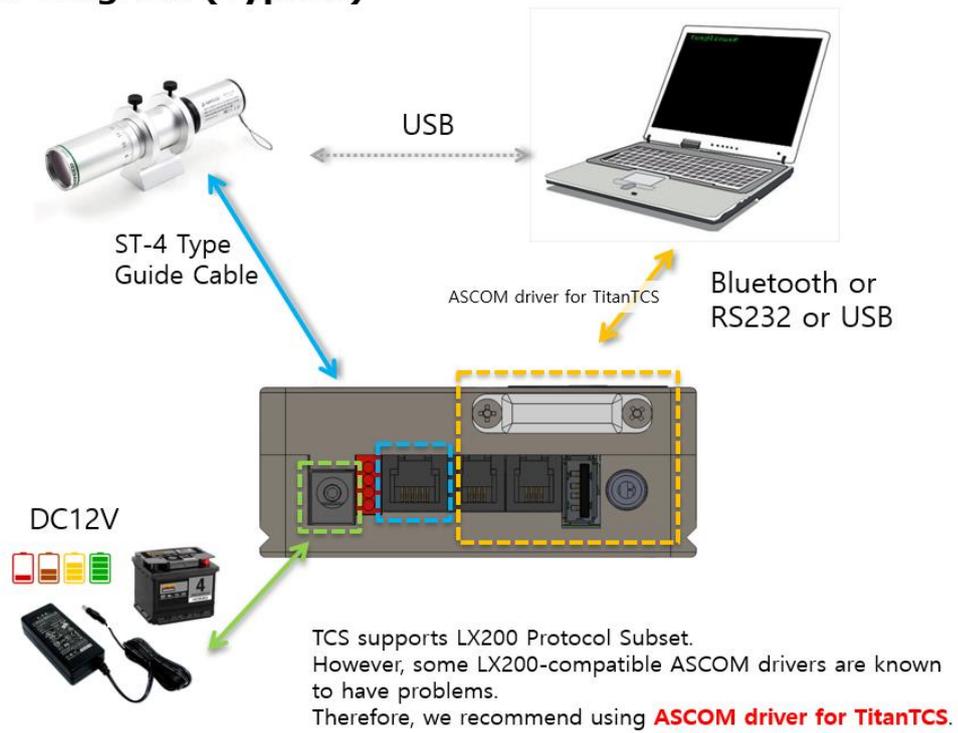
Up/Down Key
-> Select action item

Top / Telescope

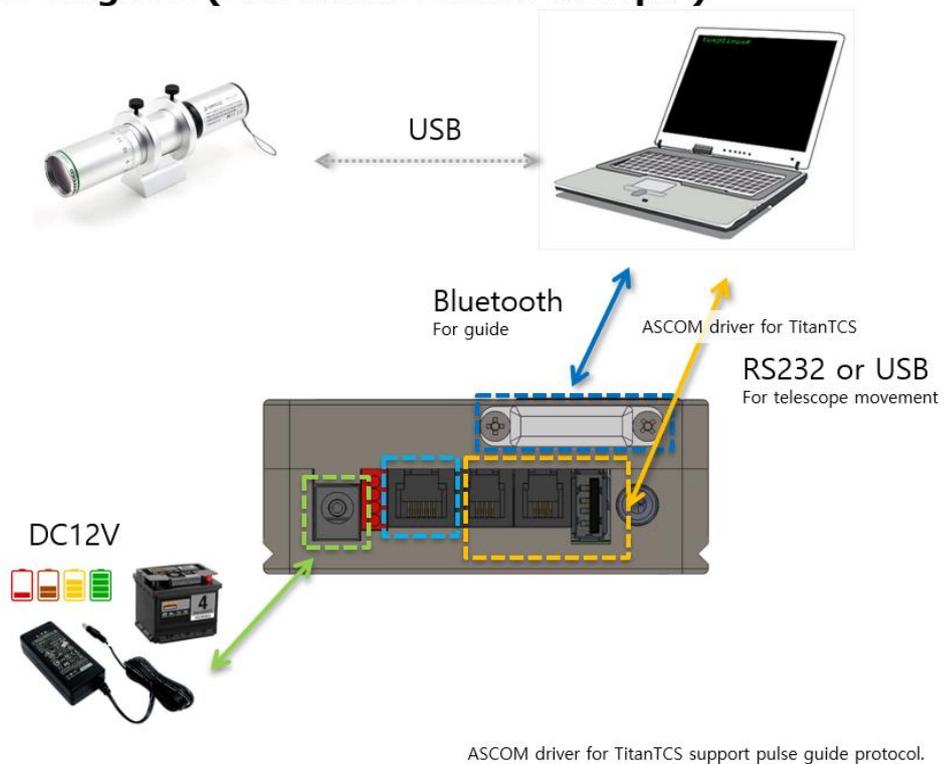


Center Key
-> Save & Apply date
Return to "Telescope"

System Diagram (Typical)



System Diagram (Bluetooth Guide Example)



System Diagram (Camera shutter release)

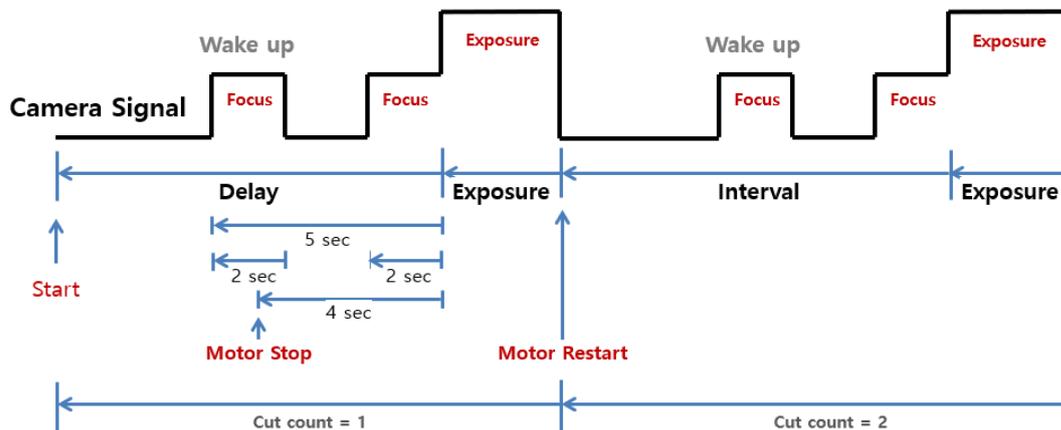


The shutter release cable that is connected to the camera can use the accessories of "Pixel TW-283 Shutter Release".

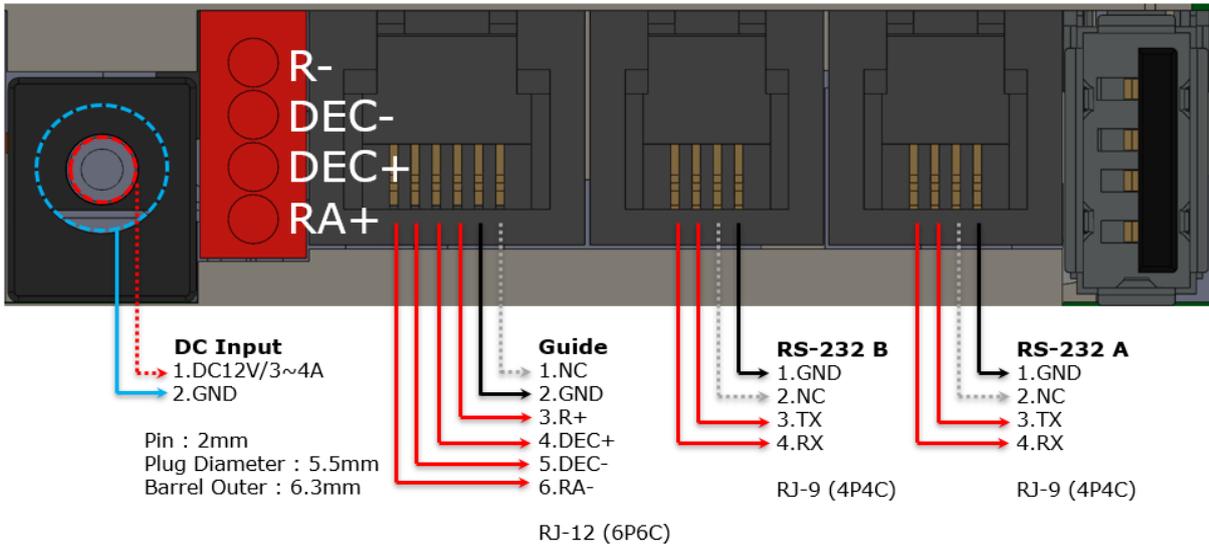
Note: The connector to the TitanTCS is a 3.5 mm stereo jack.

Time chart about interval timer

example case : single set, two cuts, wake up, stop mount



Pin map / Bottom View



13. Frequently Asked Questions

- It does not guide well: There may be several reasons for low guide quality:
 1. The cable of guide CCD is not properly fixed
 2. The guide CCD is not securely fixed
 3. The payload for CRUX is exceeded or counterweight is not properly used
 4. Smoking nearby the mount
 5. There is a source of heat or an entrance where the guide camera is facing.
 6. Seeing is poor
 7. The focus of the guide CCD is not clear
 8. The guide star is too bright
 9. The guide is too dark
 10. The guide star is located at the edge of the guide CCD.
 11. There was too little movement during the guide calibration
 12. There was too much movement during the guide calibration
 13. The guide exposure was too long
 14. The guide exposure was too short
 15. Guiding speed is too fast for the focal length
 16. Guiding speed is too slow for the focal length
 17. The lens or the primary mirror of the guide telescope is not securely fixed
 18. The focal length of the guide telescope is too long
 19. The focal length of the guide telescope is too short

 - What is the safe payload?
 - When the CRUX mount is appropriately loaded, the mount should not be slipped when the telescope is mounted, the declination is completely parallel to the ground, and the power is turned off. In case of the telescope is being slipped, the counterweight may be needed. The safe payload for the mount is the load that does not make it be slipping, even when the power is off.
 - When the power is supplied, the torque generated by the electromagnetic of the motor may allow additional load, but this load should not be considered safe payload. When testing, put your hands under the telescope to prevent any unexpected collision.

 - What is the amount of periodic error?
 - The periodic error of the CRUX mount is about ± 20 seconds, the same as that of a harmonic gear. In the case of high magnification observations, the object seen by the eyepiece may be wobbling about the diameter of the Saturn or the Jupiter. This is much larger than the periodic error of EM200, which is about ± 7 seconds. The biggest advantage of the harmonic gear mount is that it has no backlash and a large payload compared to the weight of the mount. In general, photography using the harmonic gear mount presupposes a guided shooting. When taking a guided shot, its advantages are maximized, unlike the usual worm wheel mount. The Titan TCS has a built-in PEC function. The user can take the most advantage of harmonic gear mount using PEC function in that it eliminates the backlash.

 - ASCOM Driver for CRUX series
 - The ASCOM Driver designed for Titan TCS is available. It can be downloaded from the *Download* page of the HOBYM Observatory homepage. Please upgrade the old firmware to the latest version before using it.
-

- On a very cold day, there is a stall or vibrational noise while slewing and does not properly move.
 - If the weather is below -10 °C, it is recommended to attach counterweight or to reduce the maximum motor speed to about 50% level to minimize the mechanical burden to the mount. Please contact HOBYM Observatory if you continue to experience the same problem after trying the above-mentioned suggestion.

- What telescopes can be mounted without counterweights?
 - The Crux140Traveler has a large payload, but it is recommended to use a counterweight or to mount less than the recommended payload when taking photographs. Maintaining a safe payload will ensure the quality of photography. Please refer to “*What is the safe payload?*” section of the FAQ for more details.
 - The example below is the case of observing with an eyepiece.
 - Takahashi: Refractors under FSQ106, Cassegrain telescopes under Mewlon-200, Epsilon-160
 - GSO: 8-inch RC telescope or less, 8-inch reflector or less
 - Celestron, Meade: 8-inch Schmidt Cassegrain Telescope or less
 - Vixen: Visac 8-inch, R200ss, 4-inch Refractor or less
 For astrophotography, use smaller telescope because extra equipment is required.

- The guide graph is poor.
 - There can be two major causes.
 - The first is when the polar alignment is not precisely done. If the tripods are lightweight, the polar alignment can be distorted after you mount the telescope to the tripod. It is recommended to install on a hard floor, set the telescopic cameras, etc. and then proceed to polar alignment.
 - The second case is when the seeing is not good.
 - Since the CRUX mount has no backlash, the seeing has a major influence on the guide quality. Often, when seeing is poor, the guide graph has a high correction level and large peak-to-peak.

- The motor stalls while slewing.
 - There can be two causes.
 - The first is power issues. The problem may occur due to the low voltage because of the insufficient DC adapter capacity or a low battery. In this case, use a DC adapter with a higher capacity or charge the battery.
 - The second is when the payload weight is exceeded. In this case, reduce the load to the mount.
 - Even if the telescope is within the recommended payload, when it has a large aperture, the payload will be lower as it gets farther away from the DEC mounting surface.

- About the holding torque of the motor
 - There may be a possibility that the mount slips when a heavy telescope is mounted, and the mount turns off. Therefore, it is recommended to uninstall the telescope before you turn off the mount. Do not forcibly rotate the axis of the mount, as it generates electrical power and may cause severe damage to the Titan TCS.

- The mount/tripod falls over due to the unbalance.
 - The problem may be because the center of mass of the total system changes as the mount rotates and cause unbalance in weight distribution. If the center of mass is near the outer edge of the total system, the system may fall over with a very small additional force. Use the tripod that can extend the legs as wide as possible or use a heavier one.
- Can it be used in the southern hemisphere sky?
 - Manu> Observatory> Enter longitude and latitude> Change time> Save, and restart.
- GoTo is not precise
 1. Check whether the target star is precisely synced
 2. Check polar alignment
 3. Check if there is an error message displayed on the TCS.
 4. The gear ratio was incorrectly set at the initial setting
- The telescope moves in the wrong direction when slewing or GoTo.
 1. Check the date/time settings.
 2. Check the observatory location setting in the menu.
 3. The telescope and the target star both must be above the horizon while synchronizing.
 4. Check if there is an error message displayed on the TCS.
 5. If the problem persists, contact HOBYM Observatory.
- When operating at the highest speed, there is a motor sound, but the mount does not move (The motor stalled).
 1. The motor stalled due to the mechanical overload caused by a temperature drop
 2. Low input voltage
 3. There is too much weight unbalance. Maintain the weight balance while operating.
 4. Check the Acceleration setting [Acc. Rate]. When the Acc. Rate is set too high, the operational load increases. Lower the maximum speed and acceleration setting.
- GoTo takes too much time.

For accurate pointing, it slows down near the target point.

 1. Check the current coordinate values from OLED.
 2. Check whether the speed volume is at or near parking.
 3. Check the maximum speed setting.
- Bad connection with the simulation programs.
 - When connecting with a 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.
 1. 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]

2. Check USB, Bluetooth and the COM port number: number of the serial ports of TCS in Device Manager.
 3. When connecting via Bluetooth, a blue color "B/T" indication should appear at the top of TCS.
 4. 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 the software distributor.
- The time and location of the simulation program do not match with the ones of TCS.
 1. 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.
 2. If it is difficult to set the date/time and observatory location by software, use the functions of TCS itself and set it the same as software.
 3. TCS does not allow the user to enter the time before 2017. Therefore, date/time information only after 2017 is available.
 - Poor guide performance
 1. 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.
 2. 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-.
 3. Confirm whether all LEDs respond to the signal or not.
 4. 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.
 5. Try to turn off the PEC function. In rare cases, the guide signal and PEC processing may interfere.
 - Date and time settings are not maintained between power downs.
 - Open the battery cover of the side of the device to replace the battery. Replace with a 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 the 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 the problem persists does not improve, replace the CR2032 button cell. When replacing the battery, please refer to the above for instructions.
 - When the 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.
 - When it automatically stops with a melody sound while tracking.
 - The RA Auto Stop function is activated.
 - 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.
- When TCS receives a command from Object / GOTO, the error message is displayed without moving.
 - Check the time and location setting.
 - The first star has to be synced and Object / GOTO.
 - Do not GOTO near the horizon.
- PEC is turned off but dimmed gray color "PEC" appears in the 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.
- Turning PEC on worsens the guide performance.
 1. In a case the load on the telescope caused a slip after PEC training.
 2. In a case that the position was lost due to the stall of the motor.
 3. In a case that the power was turned off without Parking.
 - Refresh the PEC Training. The PEC function uses newly trained PEC data.
 - If the PEC function is not activated automatically, redo PEC Training and use newly trained data to operate PEC function.

14. Crux140Traveler Technical Data

Crux140Traveler	ITEM	Specification
MAIN SPEC	Type	German Equatorial Mount
	Azimuth Adjustments	$\pm 10^\circ$
	Elevation Adjustments	5° to 90°
	Weight (without counterweight)	3 kg (without Titan TCS)
	Counterweights	1.8 kg
	Optimal Loading Capacity without Counterweights	8 kg (The position of 50mm from DEC head)
	Maximum Loading Capacity with Counterweights	13 kg (The position of 50mm from DEC head)
	Operating Voltage	12V DC
	Tube mountings	M8 & M6 screws (PCD 35mm)
MECHANICAL SPEC	R.A. Reduction Gear	SSHG-14-100-2A or Equivalent
	DEC. Reduction Gear	SSHG-14-100-2A or Equivalent
	Final Reduction Gear Backlash	Almost zero
	P-motion	$\pm 25''$ w/PEC $\pm 8''$
	High Speed Mode	800x the sidereal rate (12V DC)
		Computerized-GoTo
		Ball Head Base
		Weight shaft (18mm DIA)
1.8 g Counterweight		
TiTaN TCS	Dimension	88mm x 108mm x 35mm
	RA Stepping Motor	50:1 reduction geared PM Stepper motor 48step
	Dec Stepping Motor	50:1 reduction geared PM Stepper motor 48step
	RA total output PPS	355pps
	Dec total output PPS	355pps
	Flexible micro step control	Tracking : 1/128 Microstep Slewing : 1/4
	Maximum Slewing Speed	800x the sidereal rate (12V/3A DC)
	Time-Lapse Mode	0.1x ~
	Az-Alt Mode	Easy to set up and GoTo without polar alignment
	PEC Function	P-motion control under $\pm 8''$
	Object Database	NGC, IC, M, Planet, etc. over 14,000 items
	OLED Color Display	1.69" Diagonal Size, 160X128 Pixels
	Tracking current sinking	12V / 0.5~0.8A
	Max speed Slewing current sinking	12V / 1.5~3A
	Wireless Control	Bluetooth/WiFi module
	Various Port	RS232, USB, Guider port, Camera shutter release

15. Photographs taken using Crux140



Crux140Traveler/WO Redcat51/QHY247/QHY5LII Guiding/Duo band filter/Mongo/Injoon Hwang



Crux140Traveler/WO Redcat51/QHY247/QHY5LII Guiding/Duo band filter/Mongo/Injoon Hwang

Equipment setting reference



16. Online Reference Webpages

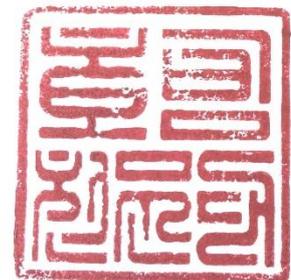
- HOBYM Observatory main homepage : www.HOBYM.net
- HOBYM Observatory Facebook Page : <https://www.facebook.com/HOBYM-Observatory-1414619488756747/>
- Crux140Traveler official webpage : <https://www.HOBYM.net/crux140-tv>
- Titan TCS official webpage : <https://www.HOBYM.net/Titan-tcs>
- Download Manuals : <https://www.HOBYM.net/manual-1>
- HOBYM Blog : <https://www.HOBYM.net/blog>
- International Suppliers : <https://www.HOBYM.net/partner>
- Contact Info : <https://www.HOBYM.net/contact>
- Facebook User Community : <https://www.facebook.com/groups/193879510629347/>
- Facebook Japanese User Community:
<https://www.facebook.com/groups/165687264123804/>

Have a great astronomical life with the Crux140Traveler. HOBYM Observatory will do our best to support the product until its lifetime.

Limited Warranty

CRUX equatorial mounts are warranted by HOBYM Observatory. (HOBYM) to be free of defects in materials and workmanship for a period of 5 Years (Mechanical parts) and 2 Years (Electronical parts) from the date of original purchase. Your official HOBYM dealer or HOBYM will repair or replace (period of 90 days from the date of purchase) a product or part thereof, which upon inspection by HOBYM or official HOBYM dealer, is found defective in materials or workmanship. However, the cosmetic scratches are not subject to this warrant as it is natural to occur in casting production and does not influence the use of the product. Provided the defective part should return to HOBYM observatory, freight-prepaid, with proof of purchase.

This warranty is not valid in cases where the product has been damaged, dropped, abused, mishandled, subjected to temperature or weather extremes, where unauthorized repairs have been attempted or performed, connect to the improper voltage supply, or where depreciation of the product is due to normal wear-and-tear. HOBYM observatory specifically disclaims special, indirect, or consequential damages or lost profit which may result from a breach of this warranty.



Appendix I – Sep. 29th, 2021

[Points to note when guiding using Crux140Tv.]

HOBYM Observatory developed the world's first harmonic gear inspection system. The inspection system is used to test the quality of the harmonic gears used in the equatorial mount and to check the final performance of mount.

The contents of this appendix are summarized for reference when taking astrophotography by identifying the characteristics of harmonic equatorial mount using the inspection system. Astrophotography is the product of overcoming numerous obstacles. Therefore, it can be said that it is the product of knowledge accumulated through the experience of the astrophotographer.

1. Characteristics of the Crux14Traveler harmonic equatorial mount.

- "There is no backlash" : The backlash of the final reducer has been an obstacle for all equatorial mount in the past. If there is no backlash of the final reducer, there are many advantages when taking astrophotography. The final reducer of the Crux140 uses a harmonic gear, so there is no backlash.
- "There is backlash": Crux140Traveler uses a motor equipped with a reducer. Therefore, the backlash of the intermediate motor reducer is inevitable. Nevertheless, using a motor reduction gear has the effect of increasing the payload. This is because the equatorial mount is not only used for astrophotography. However, this creates issues that need to be considered or overcome when photographing using a relatively heavy system.
- "Friction of the harmonic gear": Harmonic gear has self-sustaining force. This is different from rigidity that can withstand the weight. This frictional force provides some degree of freedom from balance compared to the worm wheel equatorial.
- "Large periodic error" : In the past, the precision of the worm wheel equatorial mount was determined by the periodic error. The periodic error of harmonic gears is very large. Normally two to three times as large as the precision worm wheel equatorial mount. However, the absence of backlash allows for agile guidance sufficient to overcome periodic errors.

2. Regarding the appropriate payload for astrophotography

- The total reduction gear structure of Crux mount is as follows. :

Ex) Crux140Traveler

Harmonic gear reduction 101:1 (almost no backlash) * Motor reduction gear 50:1 (with backlash) * Motor step 48: 1 * Micro step 128

- When the CRUX mount is appropriately loaded, the mount should not be slipped when the telescope is mounted, the declination is completely parallel to the ground, and the power is turned off. In case of the telescope is being slipped, the counterweight should be needed. However, this does not mean that guiding for photography is perfect.
- You need a more conservative approach for more sophisticated guiding. In most cases, the backlash of the reduction gear of the motor, which is the intermediate reduction stage, is a problem, so the friction force of the harmonic gear does not exceed the weight that it can withstand. To do this, either use a system that the equatorial mount can afford, or make sure the weight difference isn't too large. In other words, breaking the balance within the limits of the frictional force of the harmonic gear does not adversely affect the photo guiding.
- The Crux140Traveler is a versatile and versatile German harmonic equatorial mount that's small and lightweight enough to fit in a camera bag. Therefore, it is recommended to use a small-aperture telescope or camera lens when taking pictures. However, relatively large and heavy telescopes can also be mounted and photographed. In that case this requires a lot of consideration and technical know-how.

3. When do guide jumping symptoms occur?
4. If you start shooting with a relatively heavy telescope without a balance weight, jumping symptoms are likely to occur before and after the point where the friction force and weight of the harmonic gear are balanced after a certain section passes the point where the weight balance changes

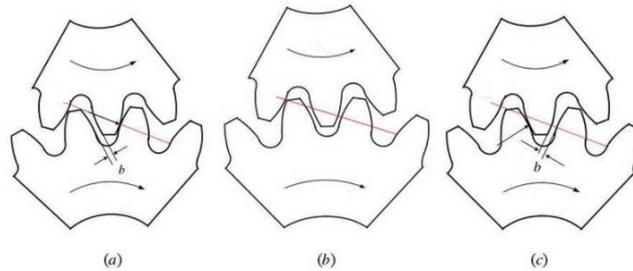


Figure A



Figure B

In other words, as the telescope moves westward, the load exceeds the friction force of the harmonic gear. This will affect the gear reducer and cause a change point as shown in (1) in Fig. C. (1 in Figure C)

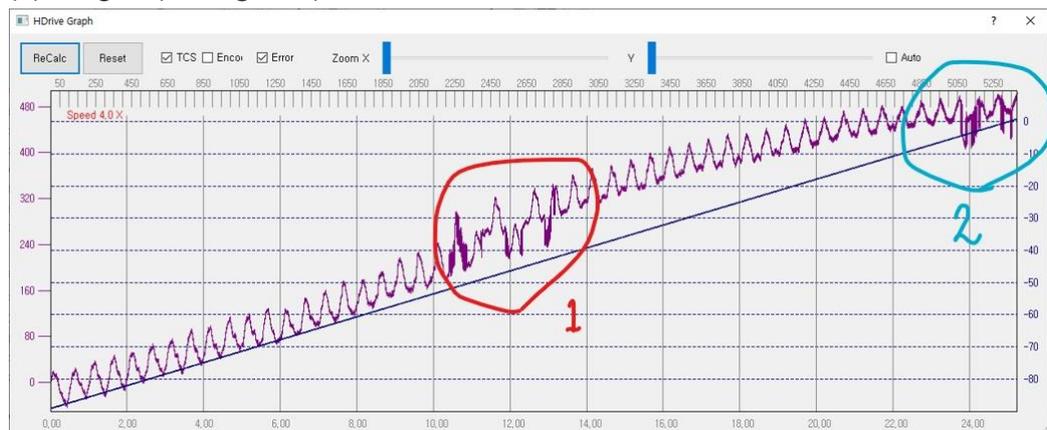


Figure C

- Guide instability can increase near the meridian, where it is most loaded. (2 in Figure C)
5. 4. How to solve it
 - Equip a balance weight to achieve some degree of balance. (Figure D)



Figure D



Figure E

- Always make the east side heavier.
- Start shooting from the east by placing the telescope below the weight. (Figure D)
- Move the center of gravity of the telescope toward the camera. (Figure E)

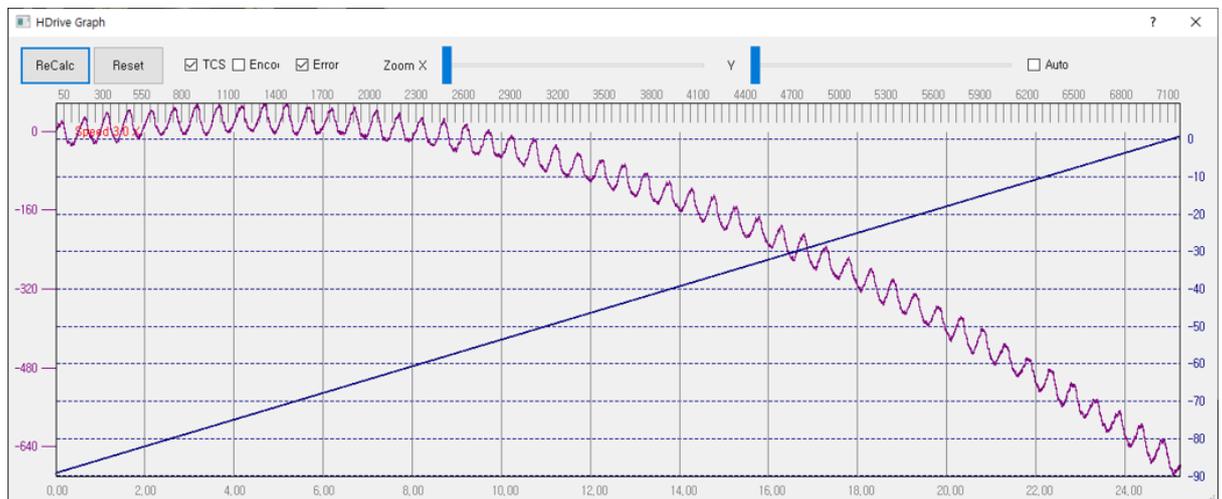


Figure F (Test result in Figure E)