

PANTHER |

Telescope Mount *TTS-160*



User manual

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Introduction

TTS-160 Panther is an advanced computer controlled telescope mounting with many installed features. It is not necessary to know all features in detail to start using the mounting. We have chosen to divide this user manual into two sections: A “quick start” section to get you started observing with the mounting and a more detailed section describing all functions thoroughly.

The quick start section should be read completely. The other section can be used as a look up Manuel.



NOTICE:

The use of the optional Telescope rOTAtor is described in its own user manual.

Product safety



WARNING:

Never point a telescope towards the sun without proper full aperture solar filter. Do never look in the eyepiece when the mounting is slewing during daytime as the telescope might pass the sun.

Always setup the mounting on a level surface so that it cannot fall over. The mounting consists of heavy parts – be careful not to drop these. Always keep a hand on the telescope when the dovetail adapter is not tightened (for balancing etc.). All dovetails must have a security stop in each end securing the dovetail can't slide out of the dovetail saddle.

Electrical safety:

The mounting must be powered from a 12V battery with a 3 Amp fuse. Always connect all cables to the mount and peripherals before connecting the battery. Disconnect the battery power when the mounting is not in use.



WARNING:

Never use mains power and a 12V power supply for outdoor use.

Receiving the mounting

The mounting is unpacked from the shipping boxes and is immediately ready for use.

Quick start

This section describes how to get started using the mounting quickly.

It is described how to:

- Setup the mounting
- Perform the first alignment
- Perform the first GOTO's

Setting up the pier

1. Unfold legs and place on ground.

Take the pier from the transport bag and place with the red handle upwards. Remove the pier base from the pier tube lifting in the red handle. Unfold the legs and place the pier base on the ground. The ground must be approximately horizontal.



2. Setup the pier tube

The pier is placed on the pier base. Position the slots above the legs.

Raise and extend the three tension rods.

Tilt the pier tube a little and insert two of the hooks in the slots in the pier tube.

Extend the third tension rod by turning the hook until it can be inserted into the slot. If needed extend the other tension rods.

Now tighten the tension rods by turning the black cylindrical handles. See to that the tension rods are kept the same length (watch how much of the thread that is visible on the hook).



NOTICE:

Tighten until the pier feels stable but do NOT over tighten the handles.



Installation of the mounting head



NOTICE

The Pier Adapter must be installed on the Mounting head before installing the mounting head on the pier. See Appendix B.

3. Place the mounting head on the pier

When the mounting head is placed on the top of the pier the locking screw of the pier adapter automatically catch the threaded hole in the top of the pier.



WARNING: Be careful not to tilt the mounting head before the locking screw is tightened

The mounting head and the pier are locked together by tightening the locking screw with the handle inside the pier adapter. Do not over tighten the screw.



4. Installation of counterweights

Lock the counter weight arms pointing downwards by tightening the two hand

screws. Note that the right-hand screw is tightened in counterclockwise direction.

Mount a counter weight on each arm. Ensure the handle on the counterweight is loosened. Insert the locking screw head in the keyhole at the top end of the slot in the counterweight arm. Slide the counterweight gently to the bottom of the slot and lock it there with the handle.



Mounting the telescope

5. Mount the telescope

Loosen the two bat screws at the dovetail saddle until the two brass pins can be pushed all the way in. The dovetail on the telescope is inserted into the saddle in the side opposite to the locking screws. Tilt the dovetail into the bottom of the saddle and lock the two locking screws.



NOTICE: Before letting go, try to lift the telescope out of the saddle to ensure that it is locked correctly



WARNING: Do only use dovetail plates with security pins to avoid the dovetail from sliding out of the saddle.





6. Balancing telescope and mounting

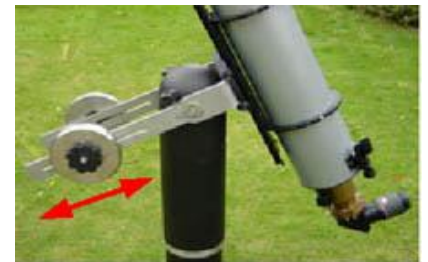
Start by balancing the telescope lengthwise. Leave the counterweights in the lowest position and the telescope HORIZONTAL.

The two altitude hand screws are loosened and the telescope is tilted up and down to feel the balance. Release the dovetail locking screws and slide the telescope in the dovetail saddle until the balance is right. Lock the dovetail locking screws again.



WARNING: Ensure that the dovetail locking screws are tightened before letting go of the telescope

Now the counterweights are balanced. Loosen the altitude hand screws and point the telescope 60-80 degrees upwards. Now the counterweights can be positioned where the balance is right. Place the two counterweights in approximately the same height.



Set the telescope approximately horizontal and lock the altitude hand screws. The setup is now completed.

Powering up the mounting

7. Connection of hand pad and power cable.

Start by connecting the hand pad to the connector marked HP. Afterwards connect the supplied power cable to the connector marked 12V. As soon as the power is connected the mount starts up.

The battery used must deliver 12V, 3 Amps.

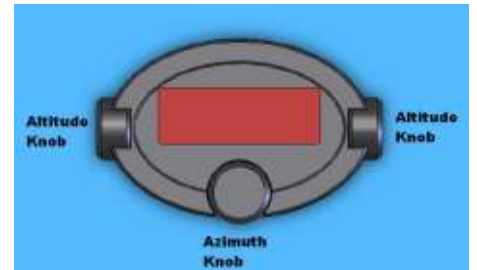




WARNING: All cables for the mount must be connected before the power is switched on/battery

8. Using the hand pad

The hand pad contains a display and 3 knobs. Each knob can be used as both rotational encoder and pushbutton.



The functionality of the knobs are:

Altitude knobs:

Rotating any of the two knobs adjusts movement in altitude direction or scrolls in the menus. Pushing the left knob toggles between the operation screen and the menu system. Pushing the right knob stops both motors (except tracking).

Azimuth knob:

Rotating the knob adjust movement in azimuth direction. Pushing the knob switches between two movement principles when in the operation screen or works as ENTER when in the menu system.

Set the internal clock

(necessary to do first time only)

The handpad starts up with the text: **Track The Stars.**

Press ENTER to go to the Align menu

```
Align mount
Load last Align
Alignment info
Main menu
```

Select line: Main menu

```
Align menu
Setup menu
Operation menu
Park Mount
```

Select line: Setup menu

```
Show/set date & time
Choose location
Edit location
```

Select line: Show/set time & date


```
Date: 10-06-2014
Time: 22:13:50

ENTER    ESC
```

Scroll to set each digit. Press ENTER to step to next digit. Date format: DD-MM-YYYY.

The entered time is activated when ENTER is pressed for the input seconds. TTS-160 Panther stores the time in a Real Time Clock with battery backup. This means that time is kept also when the mounting is switched off.

Setup observation location

(necessary to do first time only)

In the setup menu select line: Edit location.

```
Name: Ganlose
Timezone: 2:00
Longitude: -12:31:24
Latitude: +55:42:14
Horizon: 20°
NEXT    ENTER    ESC
```

Edit location

Use this function to setup your observation locations. Pick the location to be edited. The following information must be input:

- **Name:** Spell the location name by scrolling the alphabet and select the letter by pressing ENTER. When the name is completed press NEXT (left knob) to leave the field.
- **Latitude:** Enter latitude in degrees, arcminutes and arcseconds. Northern latitudes are positive.
- **Longitude:** Enter longitude in degrees, arcminutes and arcseconds. Western longitudes are positive.
- **Time zone:** Enter the local time zone. The time zone is the difference between local time and UT. Note that it is necessary to handle daylight saving time when entering the time zone. The time zone is positive east of Greenwich. Examples on time zones:
 - Berlin, København, Paris: 1
(2 if daylight saving time)
 - London: 0
 - Moscow: 3
 - New York: -5
(-4 if daylight saving time)
 - Los Angeles: -8

- Sydney 11
- Tokyo 9

- **Local horizon:** Enter the wanted local horizon. This is the lowest altitude the mount will go to automatically. Can be left unchanged at 0°

Stellar Alignment / Solar Alignment – “Instant Tracking”

9. Aligning the mounting - using just one object – “Instant Tracking”
The hand pad starts up with the text : **Track The Stars**.
Press *ENTER* to go to the Align menu

```
Align mount
Load last Align
Alignment info
Main Menu
```

Select line: **Align mount**

```
1* Not aligned
2* Not aligned
3* Not aligned
Align menu
```

Select line: **1* Not aligned**

```
Bright Stars cat.
Enter Coordinates
Planets
Back
```

Select line: **Bright Stars (or Planets)**

```
Named stars
Andromeda - Bootes
Canis Ma -Canis Mi.
Carina-Cassiopeia
```

Look at the sky and select a bright star approx. 30 degrees up. Select the constellation of the star in the menu. (select the sun, the moon or a planet if planets was selected)

```
A-And, Alphera
B-And, Mirach
G-And, Alamach
A-Aql, Altair
```

Select the actual star:
(this screen is not shown if Planets was selected)

This opens the operation screen

```
Align * 1
Center and press ok
01:23:45 45:10:12
OK ENTER STOP
```

Point the telescope at the selected star (or sun/moon/planet) using the hand pad knobs.

When the star is exactly centered in the eyepiece press the OK knob (left knob). Best results are achieved by using a cross hair eyepiece.

```
Aligment Successful
Resulting latitude
55.703 deg.
Press any key
```

Alignment star 1 is now completed. The resulting latitude is based on the latitude of the selected location (in the setup menu).

The mount will immediately start to track the selected object. The tracking is based on that the mount is setup vertically. For visual observations and for imaging the sun, the moon or the planets alignment on one object is normally enough (jump to point 11).

10. Aligning the mount on a second star – for high precision goto and for Deep Sky Astrophotography

When Alignment on the first star is completed this screen is showed:

```
1 Aligned
2* Not aligned
3* Not aligned
Align menu
```

Select line: **2* Not aligned**

```
Bright Stars cat.
Enter Coordinates
Planets
Back
```

Select line: **Bright Stars**

Look at the sky and select a bright star approx. 30 degrees up and 45 – 90 degrees away from the first alignment star.

Repeat procedure used for alignment star 1:
 Select the constellation and the actual star.
 Center the star and press *OK*
 The alignment is now completed and this screen is displayed.

```
Alignment Successful
Calculated Latitude
    55.34
Press any key
```

The calculated latitude should be close to the actual latitude. This latitude is calculated only from the alignment data and takes into account if the mount pier is not vertical.
 The mounting is now tracking alignment star 2.
 (If a wrong alignment star is selected in the sky the mount will show "Alignment failed". In this case restart the alignment process – point 9)

Goto object

11. Goto selected object

```
01:23:45 45:10:12
Menu Speed/Step Stop
```

Ensure the hand pad is in the operation screen by pressing the menu knob (left knob)

```
Goto object
Set distance steps
Synchronize
Corrections
```

Press the menu knob to open the operation menu.
 Select line **Goto Object**

```
Coordinates
Messier Catalog
NGC Catalog
IC Catalog
```

This opens the goto object menu
 Select line **Messier catalog**

```
Messier catalog
    M 031
ENTER CANCEL
```

The input screen for the messier catalog is now displayed.
 Choose an object number by scrolling one digit at a time and step to next digit by pressing the ENTER knob.

```
M 31
Mg 4,5, s. 178, Andr
00:42:42 +41:16:00
      OK  CANCEL
```

Object data is displayed

Press OK to start GOTO.

The mounting centers and tracks the object.

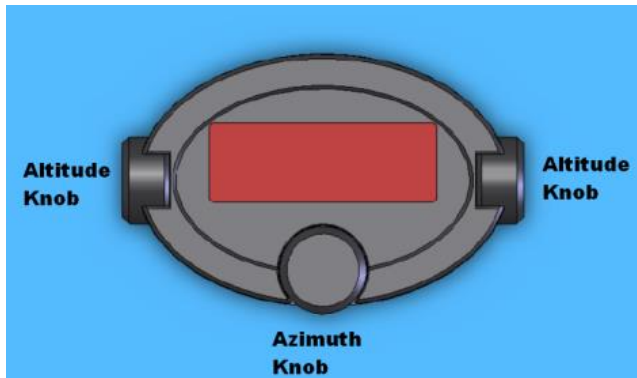
The TTS-160 Panther Mount is constructed to be driven by the internal motors and not pushed by hand. If it is a wish to move the mount manually by hand it is necessary first to loosen the Azimuth friction drive. Please see Appendix A.

You have now completed the “Quick Start” guide and should be able to find and observe objects. More detailed description of the mounts features follows in the next sections.

TTS-160 Hand pad

The hand pad controls all mounting functions – motor movements, menu navigation and data input.

The hand pad contains a display and 3 knobs. Each knob can be used as both rotational encoder and pushbutton. When rotated the knobs moves with small clicks.



The knobs are named

Adjustment of display brightness:

When the mount is powered up the text "Track The Stars" is displayed. At this point the display brightness can be adjusted by turning the Altitude knobs. Press *ENTER* (Azimuth knob) to continue.

Daytime use of Handpad

For daytime use the red glass in front of the display can be removed. It's held by four magnets and can be tilted out by inserting a small lever in the hole at the end of the glass.



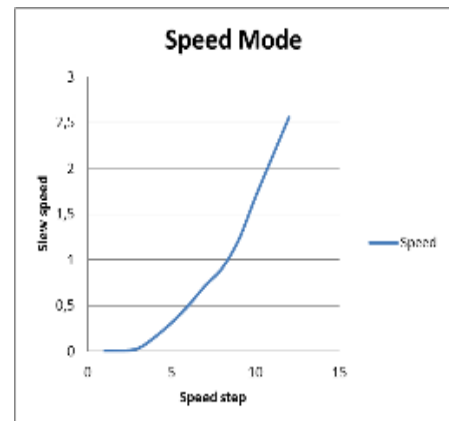
Movement control

When the hand pad is in the operation screen the mount can be moved by turning the knobs. The azimuth knob controls movement in azimuth and both the altitude knobs controls movement in altitude. In this relation the left and right altitude knobs has exactly the same function.

The mount can be set to move in two modes: *Speed Mode* or *Distance Mode*. Pushing the azimuth knob switches between the two modes. An Icon tells the selected mode

Speed Mode

In speed mode the speed is controlled when rotating the knobs. The motor has 12 speed steps. Each click from a rotational knob changes the speed one step up or down. The motor is stopped by turning the knob until speed step zero is reached or easier by turning one click on the knob that controls the other motor

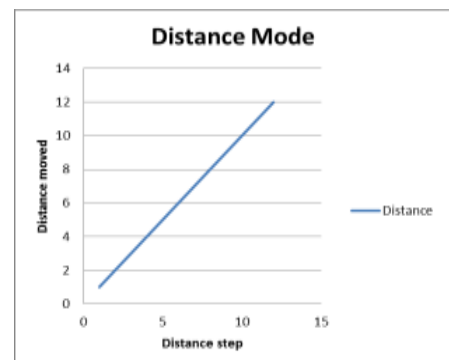


NOTICE:

The mount continues to slew until the motor is stopped. An arrow in the top right corner is shown when the mount is moving.

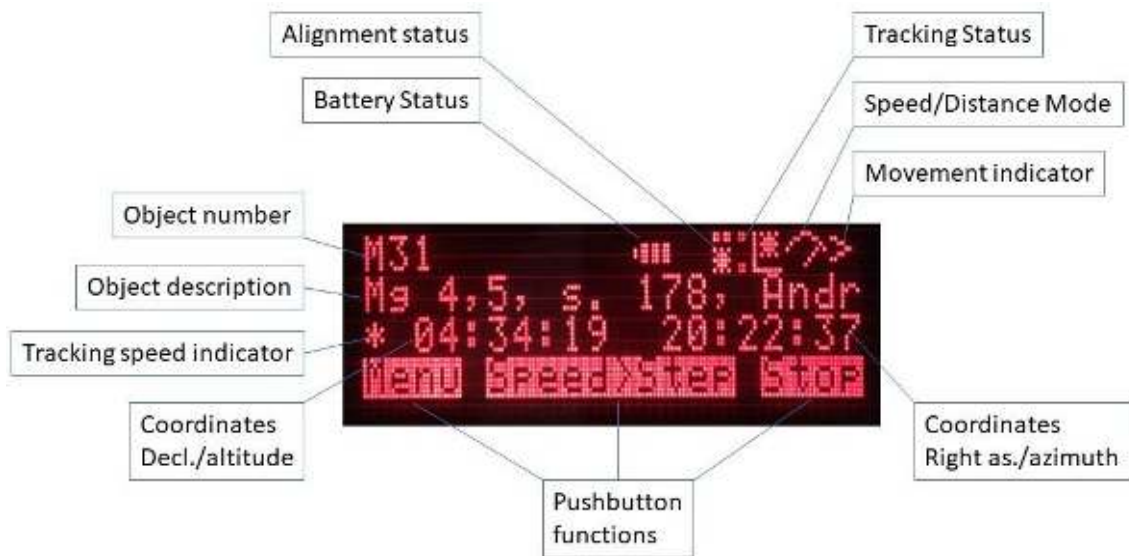
Distance Mode

In distance mode the mount moves a certain distance for each click from a rotational knob. When a click is received the relevant motor speeds up – moves a distance – and slows down again. The distance traveled is set-up in the operation menu.



Operation screen

When the mounting is operating and tracking objects the Operation Screen is displayed. The operation screen shows information concerning object, coordinates and mounting status:



Detailed description of the fields:

- **Object number:**
Displays catalog and object number for the selected object. Otherwise the field is empty.
- **Battery status icon:**
 = 12V, = 11V, = 10V (to low battery voltage)
- **Alignment status icon:**
 Empty field = No alignment
 = 2/3 star alignment completed
- **Tracking status icon:**
 Dot is running when tracking.
- **Speed/distance Mode icon:**
 = Speed Mode chosen
 = Distance Mode chosen
- **Movement indication icon:**
 Arrow indicates that the mounting is moving in the shown direction.
- **Object description:**
 Description of object from the selected object catalog.

- **Tracking speed indicator:**
 - * Sidereal tracking rate manual selected
 - * Sidereal tracking rate automatic selected
 - l Lunar tracking rate manual selected
 - L Lunar tracking rate automatic selected
 - s Solar tracking rate manual selected
 - S Solar tracking rate automatic selected

- **Coordinates:**

Left Coordinate is RA ,AZ or “field rotation angle” depending on what coordinates system is selected.
Right Coordinate is DEC, ALT or “field rotation speed” depending on what coordinate system is selected.

- **Pushbutton function:**
 - Press *MENU* to enter the menu system.
 - Press *ENTER* to change between Speed Mode and Distance Mode.
 - Press *STOP* to stop any movement (besides tracking).

Menu system navigation

To open the menu system (from the operation screen) press the MENU knob.
To leave the menu system press the MENU knob.
The menu system displays one menu item per line. One of the lines is highlighted. Turn the altitude knobs to scroll and select by pressing the *ENTER* knob.

Data input

Data input takes place when:

- an object catalog is used
- a GOTO to a set of coordinates is performed
- editing location information
- setting date and time
- setting up basic mount parameters

When searching for objects in the catalogs it is always the object number that is entered. This is easily done by selecting one digit at a time. The digit is selected by rolling the altitude knobs and selected by pressing *ENTER*.

Entering coordinates is done via the main parts of the coordinates and scrolling through the possible values:

- hours (0-23)
- minutes (0-59)
- seconds (0-59)
- degrees (-89 +89)

Each main part is selected by pressing *ENTER*.

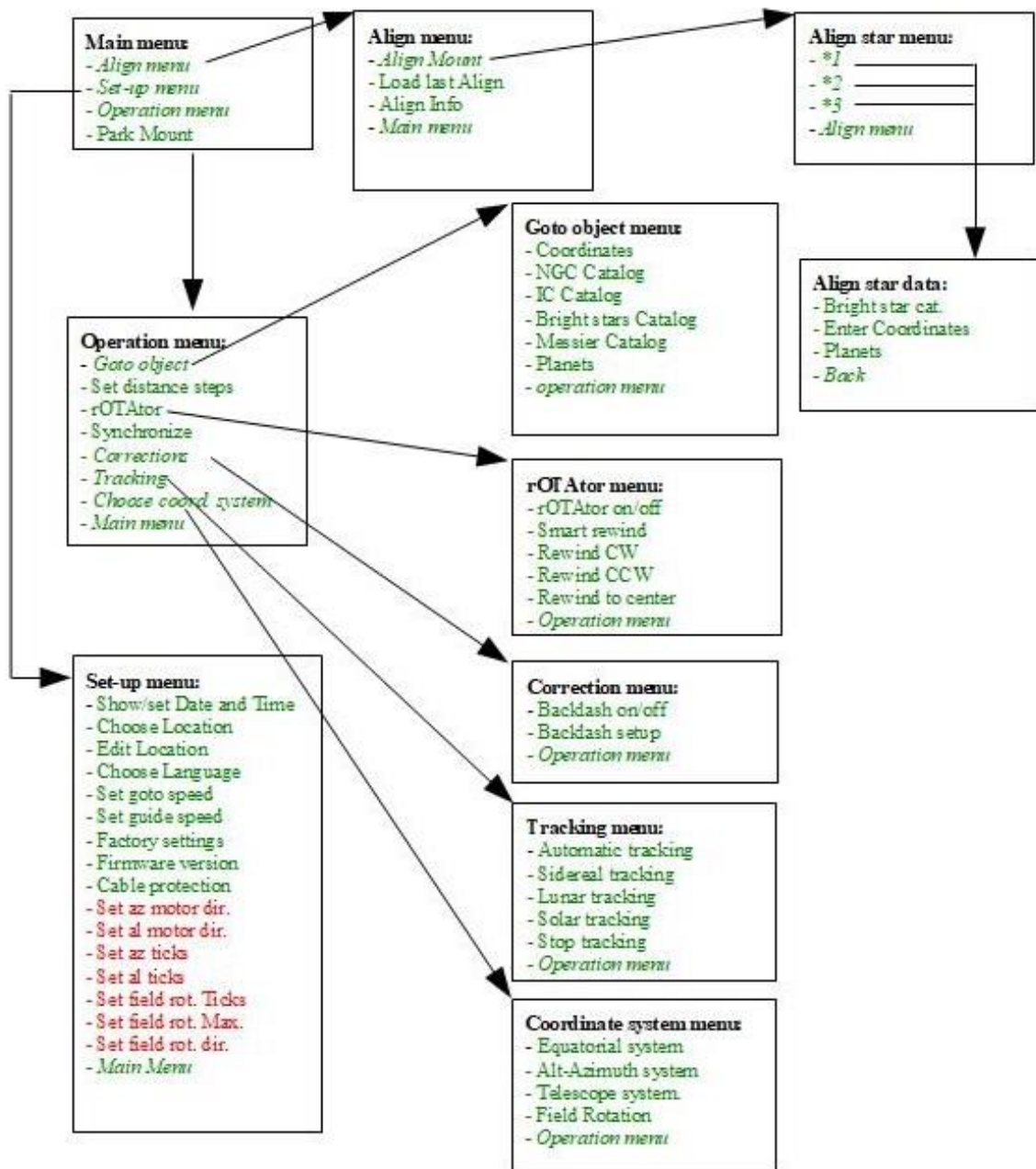
When editing locations, the location name is entered scrolling one letter at a time and confirmed by pressing *ENTER*. When the name is completed the *NEXT* knob (left knob) is pressed. Other location data is input as described above.

TTS-160 control software

This section describes the software in details. It is suited for looking up specific functions.

Menu tree TTS-160

The lines written in *italic* bring you to another menu. The other lines select a function performing an action. Menu points in red are special setup functions not needed/described here.



Main menu

```
Align Menu
Setup Menu
Operation Menu
Park Mount
```

- **Align menu:**
Select this to align the mounting. Start always here.
- **Setup menu:**
Select this to setup the basic parameters.
This menu is not used on every observation session.
- **Operation menu:**
Select this to perform operation commands e.g. Goto.
- **Park Mount (“Quickstart”)**
Select this to save the mounts position before powering down. If the mount is left unmoved the position can be reloaded and the mount can be used right away without any alignment needed. Perfect for observatory use.
See below for load procedure.

Align menu

```
Align mount
Load last Align
Alignment info
Main Menu
```

- **Align mount:**
Select this to align mount on one star/planet/sun or to add a second or third alignment star to a previous completed 1 or 2 star alignment.
- **Load last alignment (“Quickstart”):**
Loads the last parked alignment. If the mount was parked before being powered down it is possible to load the last alignment and continue with that. This demands the mount/telescope has not been moved since it was powered down from the last observation session.
- **Alignment information:**
Shows data for the actual alignment.
When aligning on 2 or 3 stars the mounting calculates the angle between the mountings azimuth-axis and the earth polar axis. This is displayed as *Calculated Latitude*. If the mounting pier is vertical the shown calculated latitude should match the latitude of the observation spot. The calculated latitude is used to evaluate the quality of an alignment.

When aligning on 1 star the alignment information shown is related directly to the latitude of the selected observation location.

Align mount menu

Select this menu to perform a new 1 star alignment or to add a 2nd/3rd star to an already completed 1/2 star alignment.

The menu contains one line per alignment star. When no alignment has been performed all lines says *Not aligned*. When a star (or planet/moon/sun) has been selected and alignment on the star has been made the line shows *Aligned*. Note that the alignment stars must be selected in ascending order.

1 star alignment procedure:

```
1* Not aligned
2* Not aligned
3* Not aligned
Align menu
```

Select first alignment star in the menu
1 not aligned*

```
Bright stars cat.
Coordinates
Planets
Back
```

Select *Bright stars* to pick a star from the catalog, *Planets* to pick a planet (including the moon/sun) or *Coordinates* to manually enter the object coordinates.

```
Named stars
Andromeda - Bootes
Canis Ma -Canis Mi.
Carina-Cassiopeia
```

If Bright stars is selected:
Pick the star in the menu by first finding the relevant constellation.

```
A-And, Alphera
B-And, Mirach
G-And, Alamach
A-Aql, Altair
```

```
RA 00:00:00
DEC +00:00:00

OK CANCEL
```

If Coordinates is selected:
Enter object coordinates (Epoch 2000). RA in hour, minutes and seconds. Declination in degrees, arc-minutes and arc-seconds.

```
1 Align *
Center and press ok
01:23:45 +45:10:12
OK      STEP  STOP
```

The operation screen is now displayed. Slew to the selected star and center it using the hand pad. Press OK when the star is exactly centered.

```
Alignment Successful
Calculated Latitude
      45.00
Back
```

First alignment star is now completed and the result of the alignment is shown.

This 1 star alignment – “**Instant Tracking**” uses the location data and the assumption that the pier is precisely vertical.

For most visual observations, daytime solar observations and planetary imaging this simple and fast alignment is completely adequate.

The advantage is that a very fast alignment can be made in daytime on the sun or on a planet.

2 star alignment – higher precision

For higher precision alignment – recommended when doing long exposure astrophotography – a second alignment star must be added. This will take the exact angle of the pier into the equations. So, there is no need to spend time levelling the pier exactly.

Select alignment star 2 and align as alignment star 1.

```
Alignment Successful
Calculated Latitude
      45.34
Back
```

When alignment star 2 is aligned the system calculates the complete alignment data. If the result is OK the resulting *Calculated Latitude* is displayed to let the user estimate the quality of the alignment.

If the alignment fails it is necessary to perform the procedure again and ensure the correct stars are selected in the sky.

Adding alignment star 3

To improve goto accuracy on certain parts of the sky a 2 star alignment can be expanded by adding a 3rd alignment star. This can be done at any time as long as a 2 star alignment is already completed. Adding alignment star 3 is done exactly as alignment star 1 and 2.

Choosing the best alignment stars

Alignment star 1 and 2 should be at 30 – 45 degrees altitude. The horizontal distance between the stars should be between 45 and 120 degrees. A 3rd alignment star should be selected higher in the sky at altitude 50-70 degrees.

Setup menu

```
Set date and time
Select location
Edit location
Select Language
```

The setup menu contains functions to configure the main parameters of the mounting and to select observation location. It is usually not necessary to enter the setup menu during an observation run.

```
Set date and time
24:12:2005
12:21:55
      OK      CANCEL
```

Set date and time.

Use this function to set date and time. The entered time is activated when *OK* is pressed for the input seconds. TTS-160 stores the time in a Real Time Clock with battery backup. This means that time is kept also when the mounting is switched off.

Date and Time must be correct for the mount to work best.

```
My home
Brorfelde (*)
Location3
Location4
```

Select location

This function sets the active location from the already stored locations. There are 5 available locations. Locations that have not been defined by the user is named Location1, Location2A location is selected by pressing ENTER. The asterisk shows which location is active. When a location is selected the geographical coordinates, timezone and user horizon are taken from the location.

```
My home
Longitude:-120:23:12
Latitude:+45:23:46
NEXT      OK      CANCEL
```

Edit location

Use this function to setup your observation locations. Pick the location to be edited. The following information must be input:

- **Name:** Spell the location name by scrolling the alphabet and select the letter by pressing ENTER. When the name is completed press NEXT (left knob) to leave the field.
- **Latitude:** Enter latitude in degrees, arcminutes and arcseconds. Northern

latitudes are positive.

- **Longitude:** Enter longitude in degrees, arcminutes and arcseconds. Western longitudes are positive.
- **Time zone:** Enter the local time zone. The time zone is the difference between local time and UT. Note that it is necessary to handle daylight saving time when entering the time zone. The time zone is positive east of Greenwich. Examples of time zones:
 - Berlin, København, Paris: 1
(2 if daylight saving time)
 - London: 0
 - Moscow 3
 - New York: -5
(-4 if daylight saving time)
 - Los Angeles -8
 - Sydney 11
 - Tokyo 9
- **Local horizon:** Enter the wanted local horizon. This is the lowest altitude the mount will go to automatically.

```
Danish  
English  
German  
Back
```

Select language

Use this function to select displayed language.

```
4 degrees/second  
3 degrees/second  
2 degrees/second  
1 degrees/second
```

Set goto speed

Use this function to select goto speed.

```
1 arcsecond/second  
3 arcsecond/second  
5 arcsecond/second  
10 arcsecond/second
```

Set guide speed

Use this function to select guide speed (when the autoguider interface is used).

Factory Settings

Use this function to restore factory settings. This will clear all user settings.

Firmware Version

Use this function to display the firmware version number

Cable Protection

Use this function to turn cable protection on/off.

When cable protection is **off** the mount will always make the shortest goto an object. This mean the mount can turn unlimited in Azimuth.

When cable protection is **on** the mount will never rotate more than a 200 degrees in either direction from the starting (power up) position. This avoid risk of twisting cables.

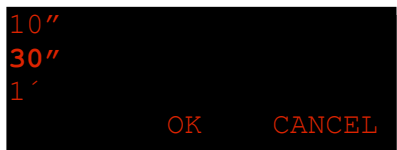
Before reaching the movement limit a warning will be given. When the limit is reached the mount stops and the user must manually slew away from the stop position.

Operation menu

The operation menu is the most used menu. When changing from the operation screen to the menu system the operation menu is always displayed first. The operation menu contains the following functions:

Goto Object Menu

Select this function to perform a GOTO. The Goto Menu is described later.

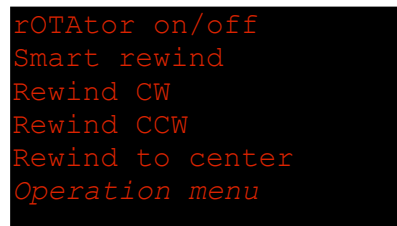


Set Distance Step size

Use this function to set the size of the steps the mounting moves when distance mode is selected.

rOTAtor

This submenu control the optional telescope rOTAtor.



rOTAtor on/off

Toggles the rotator tracking on, off.

Smart rewind

Rewinds the rOTAtor to the best startposition for the target. Use this normally.

Rewind CW, CCW, Center

Rewind the rOTATor to the selected position.

Check rOTAtor user manual for details.

Synchronize

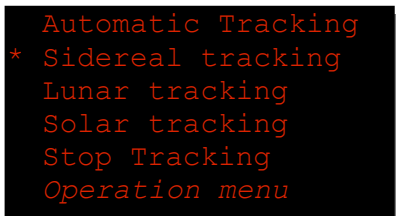
This function synchronizes the mounting coordinates with the coordinates of the last goto-object. The function is used like this:

If an object is not precisely centered after a GOTO - center it manually using the hand pad. When the object is centered select the Synchronize function. Now the mounting coordinates match the sky exactly.

Performing a synchronization will improve GOTO accuracy in the part of the sky where the synchronization is made. It is not certain that GOTO to other far parts of the sky will be improved. The function can be used with advantage to make a very precise GOTO. First make a GOTO to a nearby star. Synchronize on this star and then make the GOTO to the final object.

Tracking

This submenu sets how tracking speed is handled. The selected line is marked with an *:



```
Automatic Tracking
* Sidereal tracking
Lunar tracking
Solar tracking
Stop Tracking
Operation menu
```

Automatic tracking

The tracking rate is automatically set based on latest goto object. Moon gives lunar rate. All other objects sidereal rate.

All commands through ASCOM gives sidereal Rate (Icons: *, L, S)

Sidereal tracking

Sets tracking rate to Sidereal (Icon: *)

Lunar tracking

Sets tracking rate to Lunar (Icon: l)

Solar tracking

Sets tracking rate to Solar (Icon: s)

Stop Tracking

Stops tracking until a new tracking rate is selected



```
RA/DEC
ALT/AZ
Mounting
Field rotation
```

Select displayed coordinates

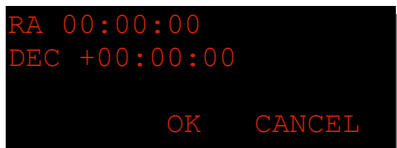
Select this function to choose the coordinates displayed on the operation screen: (and to

start the telescope rOTAtor):

- **Right Ascension, Declination**
Ordinary celestial coordinates
- **Alt./Azimuth**
Azimuth counted from north through east.
- **Mounting coordinates**
Displays the angles for each of the mounting axles. The horizontal coordinate is growing from west towards east. The angles start at zero when the mounting is powered up. Note that the altitude coordinates are changed when an alignment is performed.
- **Field rotation**
Displays the absolute field rotation angle and the rotation speed. The absolute angle is defined to be zero degrees when the object passes the meridian. The right field shows the field rotation speed in degrees/minute. This information can be used to estimate how long photographic exposures that can be made without field rotation being visible in the single exposures.

Goto Object menu

The Goto object menu is used to make a GOTO to an object or a position. The menu contains the following functions:



```
RA 00:00:00
DEC +00:00:00
OK CANCEL
```

Coordinates RA,DEC

Select this function to make a GOTO to a set of celestial coordinates. The coordinates are entered as described earlier concerning the hand pad. When the coordinates has been entered the system checks if the position is above the defined local horizon. If that is the case the mounting will GOTO the position. Otherwise a message is given that the object is below the local horizon. The local horizon is setup under location.

Object catalogs

The following catalogs are installed:

- Messier catalog
- NGC catalog

```
Messier catalog
      031
      OK      Cancel
```

- IC catalog

The use of all catalogs is identical.

When a catalog is selected an input screen is displayed. The object number is entered in this screen. When the object number is entered the system checks if the object is below the defined local horizon. If so a message is given. The local horizon is setup under *Location*.

```
M 31
Mg 4,5, s. 178, Andr
00:42:42 +41:16:00
      OK      CANCEL
```

If the object is above the local horizon the catalog data for the object is displayed. Press ENTER if the object is the wanted and the mounting will GOTO the object.

```
Sun
Moon
Mercury
Venus
```

Planets, Sun & Moon

When this function is selected a list with the sun, moon and planets are displayed. Select an object. When selected it is checked if the object is above the defined local horizon. If so the mounting will GOTO the planet. Otherwise a message is given that the object is below the local horizon. The local horizon is setup under *location*.

Operation menu

Select this function to return to the operation menu.

Control via PC, IPAD, Mobile device

The TTS-160 mounting can be controlled from a connected PC. The interface is based on the LX200¹ protocol that is supported by most planetarium software packages. ASCOM drivers for LX200 can be used.

Connecting the PC

The mounting is connected to a RS/232 port on the PC. A USB to RS/232 adapter can be used if no RS/232 port is available on the PC.

- Connect the included interface cable to the RS/232 port on the PC.
- Connect the cable to the PC interface on the mounting.

¹By Meade Instruments Corporation.

Wifi adapter like SCi-Fi works equally well.

Using the PC control

The LX200 interface is always ready to use. Therefore it is only necessary to open the connection from the PC (Note that the mounting first must be aligned using the hand pad):

- When connected the relevant planetarium program is selected.
- The telescope interface is setup for LX200 protocol and the correct COM port is selected (follow the software manual)

The communication must be setup with the following parameters:

- **Speed:** 9600 baud
- **Data bits:** 8
- **Parity:** N
- **Stop bits:** 1

Open the connection to the telescope.

This completes the setup of the connection. The telescope position can now be shown on the sky map and GOTO's can be made directly by picking objects from the software. The mounting hand pad can be used normally at the same time.

Maintenance

All parts of the mounting is constructed and built to last without any needed regular maintenance. Therefore there is no need to grease gears or adjust worm gear mesh. Both worm gears have spring mounted worm assemblies securing backlash free operation.

Cleaning

The mounting is produced from corrosion resistant materials. To clean the mounting use a moist cloth.

NOTICE:

Do not pour water on the mounting.



Appendix A

Wire connections for the serial interface

The connector for connecting a PC has the following connections:

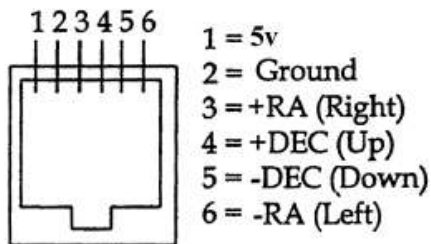
Cable 2 pinout	DB-9 (female) Pin	RJ-10 (4P4C) Pin
	1	
	2	3
	3	4
	4	
	5	1
	6	
	7	
	8	
	9	



Note that a standard PC connection cable is supplied with the mounting. Extra cables can be supplied.

Wire connections for autoguider interface

The connector for autoguider has the following connections:



1 = 5V
2 = Ground
3 = +Az(right)
4 = +Alt
5 = -Alt
6 = -Az(left)

Cables for autoguiders can be supplied.

Updating the firmware

Updating the firmware is done through the PC interface. Updating files and instructions is e-mailed directly to registered users.

Updating software is available for Windows, Mac OS and Linux.

Adjustment of Azimuth friction drive

The Azimuth drive is a 2 stage construction. The first stage is a worm gear with a backlash free spring loaded worm assembly. The second stage is an internal friction drive. The friction of the friction drive can be adjusted.

From the Factory the friction drive is adjusted fairly tight meaning the mount can only be turned by the internal motors. This gives the most precise and stable tracking needed for astro imaging.

If you want to be able to turn the telescope by hand it's necessary to loosen the friction drive:

1. Place the mount head upside down on the telescope dovetail saddle on a solid table.



WARNING:

Be sure to lock the Altitude screws well first.

2. Remove the pier adapter from the mount head (See Appendix B)



3. Remove the two plastic caps. Can be lifted with the sharp edge of a knife.
4. A 2.5mm Allan key is used to adjust the friction. Insert the LONG end of the Allan key in the hex socket found behind the plastic caps.



5. First loosen hexagonal socket screw behind each of the two plastic caps.



WARNING:

Do not loosen the screws more than 2 full turns. Otherwise the screws might will out of the threaded hole.

With both screws loosened its easy to rotate the mount head housing by hand.

6. Now tighten the two screws a little. Tighten the two screws the same amount.
Check if you still can rotate the mount housing by hand. Adjust the screws until the housing feels fairly hard to rotate.
7. Insert the plastic caps and mount the pier adapter
8. Setup the pier and install the mount head, counter weight and telescope
9. Now try gently to rotate the telescope in azimuth by hand feeling the friction drive sliding. If it feels to hard or to loose repeat the adjustment process.
10. If the friction drive is to be locked completely tighten the two screws fairly hard.



WARNING:

Do never over tighten the friction set screws. Only use the long end of the Allan key in the socket.

Appendix B

Mounting the Pier adapter on the Mount Head

1. **Remove bottom adapter base plate**

Place the adapter on a flat table with the magnetic spring loaded threaded rod upwards. Unscrew the 6 screws and remove the base plate and the star shaped handle plate.



2. **Mount Pier Adapter top baseplate on TTS-160 Mounting Head**

The altitude clutches on the Mounting Head is locked firmly. Place the Mounting Head on a stable table upside down on the Telescope Saddle plate.



WARNING: Secure Altitude clutches before placing mount head upside down. Be careful not to knock over the head.

Place the Pier adapter top plate on the mount head and fix with screw (Metric $\varnothing 8\text{mm} \times 20\text{mm}$)



Tighten firmly with enclosed Allan Key - do not over-tighten.

3. Mount Pier Adapter lower baseplate

Mount the lower base plate of the Pier adapter with the 6 screws. Remember to insert the star shaped handle plate as shown



Tighten the screws with the enclosed Allan key.

The mount head with the Pier adapter is now ready for use on the Pier.



NOTICE:
The Pier Adapter stays on the Mounting Head. It will fit in the transport bag.