ASTRO-PHYSICS

GTO KEYPAD

GTO Keypad with Keypad Protector

Version v4.07
BETA Information

Brief Instructions on the new features of the 4.07 Keypad control software.

Use in conjunction with the Keypad Manual for versions 3.0X or 3.2

November 19, 2003

NEW FEATURES OF VERSION 4.X

Version 4.x of the keypad is a major upgrade from v2.6 and v3.x, incorporating the suggestions offered by our customers. The following is a brief summary. Please refer to the appropriate sections of this manual for detailed information. More information about the features and revisions done to each version of the keypad can be found at www.astro-physics.com in the technical support section.

The ROM chip in your GTO servo control box must be dated later than January 22, 2001 to enable and to utilize all the features in version 4.x of the keypad. You can check this by removing the cover of the GTO control box and checking the date written on a label attached to the ROM chip. Please contact Astro-Physics if you need to order a new chip.

Some of the Major Features

- **Re-designed menu system** Startup and setup displays have been re-designed for easier use and access. Other displays are totally new. Please look through all of the menus to make note of the changes before you go out observing.
- **Full cursor control in all entry areas** The keypad's cursor can be moved backwards and forwards with the PREV< and NEXT> in all of the areas where data is entered. Great for fixing any mistakes you make without having to start from the beginning again. This feature will be especially handy for time and location settings. When you hit the last column of entry data the cursor will move back to the start. You must press GOTO to save or to run your entry or MENU to exit from the screen.
- **All entry screens will only enter when GOTO is pressed**. Pressing MENU will exit you from any screen with the entered data being lost. Adds built in confirmation of all entries.
- **Saved variables** The keypad will now store the important user variables, tracking, slewing and guiding rates and other settings, after it is shut down or unplugged.
- **Four button (N-S-E-W) + Stop** Now available throughout the keypad, in all menus, object screens and most input areas.
- **Guide speed / Button speed settings** Separate settings for external auto-guider operation and button speeds. Auto-guider settings of .25, .5, 1x are now independent of the button speed settings.
- **New +/- routine/display to change button speed** Now permits auto-guide value to be changed on this menu as well.
- **Start From Reference Park** This allows you to start the mount in the field by placing the telescope in Park1 position for quick daytime polar alignment.
- **External Auto Connect** Now you can start the servo from an external computer and send time, date and location from that source at startup without having to unplug the keypad each time. This insures that the keypad, mount and computer will all be in sync with each other automatically. The keypad will go directly to the Main Menu as soon as the external program initializes the mount. All values of time, date and location will be transferred to the keypad. The keypad can then be used in the normal manner at any time.
- **SmartGuide control** Adds variable speed capability to both axes. Designed to null out drift during unguided exposures. Great for tracking slow-moving, non-sidereal objects such as lunar craters, comets and asteroids.
- **Get time and location from mount** You can now ask the mount for the time and location and set that value to the keypad. This value could be sent to the mount via your external computer program. This allows the mount, the keypad and external computer to all be in sync.
- **9 Locations** Longitude, Latitude and time zone now can be set to 9 different places. We suggest noting them on a piece of paper on the back of your keypad so that you can keep track of them all.
- **Altitude/Azimuth display** Added to real-time RA/DEC display. ALT/AZ values change as mount is moved in RA/DEC directions. With tracking rate set to zero, mount can be positioned for fixed targets to any Alt / Az point.
- **Altitude/Azimuth input** this new option allows you to slew to any position in the sky as long as you know it Altitude and Azimuth angles.
- **New local horizon limit setting** Useful for keeping your telescope from slewing to objects below your observing site's horizon.
- **Audio feedback with Recalibration command.** You will now hear a beep when you re-calibrate the mount to let you know that it has done it. Re-Calibrate has also been removed from the objects menu. It is located in the RA/DEC/REV screen 9=Re-Calibrate.

- **What's Up Now** Tied to horizon limit as well using the M, NGC, and IC databases of objects in the keypad. What's up Now function will suggest objects to view based on what is actually above the horizon at the time 'What's Up' is requested.
- **Auto initialization routine** Detects when new firmware is loaded to the keypad and if saved values need to be re-initialized. This new 'power on' routine will now auto-decide if the keypad needs to be re-set to factory defaults when new saved values are added. When a new future release of the code is loaded into the keypad, the user will no longer have to manually reset all his/her custom keypad settings, i.e. locations and daylight savings.
- **Full error checking** added to Location, Date/Time, RA/DEC, Alt/Az entry - with notification if entry is not valid. Will not allow impossible settings.

Features from Version 3.2 (3.2 was only shipped with new mounts or repairs):

- **Sun warning** A warning display shows when you request an object or RA/Dec position that is within 15 degrees of the sun. The warning will not display during the park function.
- **Database level and program code level display** This feature allows you to check your database and code version number. In order to update or download the database from the Internet (feature available soon). Only version numbers 3.2 or higher will display.

GETTING STARTED - DO THIS AT HOME, IF POSSIBLE

Set Up your Mount and Cable Connections

Refer to the instructions in the GTO Keypad manual provided with your mount. The following cables must be connected and power applied: RA and Dec cables, and keypad controller cable and power cable, preferably in that order. You do not need the mounting plate or telescope tube assembly for these setup procedures.

Your First Session After a Keypad Upgrade to 4.x

1. The Location Selection Screen will appear the first time you start up your mount if you have just upgraded the keypad yourself. If this is a new mount or your keypad was upgraded or repaired by Astro-physics, please skip ahead to step 3.
2. Press GOTO to by-pass this screen then select option 3=Resume From Park
3. Main Menu should now be on the display. All of your Location, Time, Daylight savings and Date settings will have been erased due to the complete re-organization of the Keypad for version 4.x. We recommend that you find your location, date, time, and daylight savings settings that you recorded on paper before you loaded 4.x and make sure that they are correct. You will need this information to get your mount up and running again.
4. DO NOT ATTEMPT TO SLEW TO ANY OBJECTS AT THIS POINT. You must first setup your location and time as described below.
5. Go to Keypad Options selection screen (Main Menu → Setup → Keypad Options). The top line displays 1=Auto-Connect. Press "1" to toggle to "no" if it is not set to "no" already.
6. Press Menu to go back to the Setup Menu.
7. Press 1=Locations & Time. Then, select 1=Set Site Location
8. You will now be presented with the new Location Selection screen with locations 1-9 available.
9. Choose location 1 by entering #1 and pressing GOTO. We recommend that you set location 1 to the site you observe from the most. Enter your Longitude, Latitude and Time Zone settings. If you do not wish to change the settings that are already entered, press the GOTO button to return to the Locations & Time menu. After you have entered the information, you **MUST** press GOTO to save your data and return to the Locations & Time menu. If you made a mistake just use the <> keys to move back to it and fix it.
10. If you wish to enter more locations (up to 9 different sites are available), please do the previous step again; changing the number for each location you enter. We suggest that you write the location number and a brief description on a piece of paper and tape it to the back of the keypad to aid your memory.
11. After you are happy with your location site settings, you need to enter your time, date and daylight savings settings.
12. Press 2=Set Date & Time on the Locations & Time menu. Enter the correct time, date, and current daylight savings settings, for your current location. If you made a mistake just use the <> keys to move back to it and fix it If the settings are already correct, press the GOTO button to return to the Locations & Time menu. To save your changes you **MUST** press GOTO to return to the Locations & Time menu, Pressing MENU will exit the screen with the changes unsaved.
13. After you have competed ALL of the above entries, press Menu twice to go back to the Main Menu.
14. **Turn off the power to your mount for 10-15 seconds.**
15. When you re-apply the power, the keypad should display the Location Selection screen. Please select your location by entering the desired number and press GOTO.
16. You will now be presented with the Sync, Align and Resume Menu (see example screen). You will use this menu to tell your telescope where it is in relation to the sky.

Location Selection Screen

```
Location Selection
Enter number, then
Press GOTO to select
Location <1-9>:
```

Sync, Align, and Resume Menu

```
1=Star-Sync
2=Polar Alignment
3=Resume from Park
4=Resume Ref-Park 1
```

Main Menu

```
1=Object      5=S:1200
2=Setup       6=B:600
3=Tools       7=A:1
4=Time/LST 8=T:Side
```

Setup Menu

```
1=Locations & Time
2=Mount Move Limits
3=Keypad Options
4=Park / Mount Opt.
```

Locations & Time Menu

```
1=Set Site Location
2=Set Date & Time
3=Get Time/Loc FrMnt
4=Load / Initialize
```

Location Input Screen

```
Long: W  000:00:00
Lat  : N   00:00:00
Time Zone          :00
```

Time & Date Input Screen

```
TIME:  21:12:38
DATE:  05/15/2003
Daylight Saving: 0
1=Summer 0=Winter
```

Star Selection Menu

```
Choose Star   Z=05:54
1=Polaris             <
2=Acamar
3=Achernar            >
```

Very Important: You must point to stars in the west when your telescope is on the east side of the mount and stars in the east when your scope is on the west side. When the stars are high and close to the zenith, this can be tricky. However, you can tell which side the star is on by looking at the "Z" number (Zenith R.A. number) in the upper right corner of the Choose Star screen, then comparing that number with the RA number of the star you choose. If the star's RA number is larger, the star is in the east. If your scope is not on the correct side, the mount will not slew properly and the telescope could strike the pier/tripod.

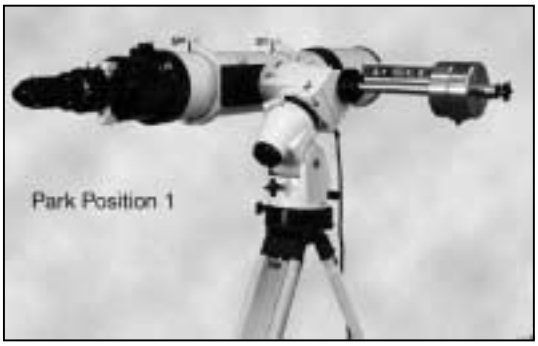
These are your choices:

a) **Star-Sync**. If you are properly polar-aligned (polar scope, drift method), choose Star Sync. Aim the scope at a known object on the star list, which also includes solar system objects (at the end of the star list). Press the + - key to change your button rate, if needed. Scroll through the list to find the object, enter the object number, press the GOTO button (the mount will not actually go anywhere) and you are synchronized. The Main Menu will appear. You are now ready to enter any object from the Object Menu or go to the Setup Menu to make changes, as needed.

b) **Polar Alignment**. If you are not fully polar-aligned yet, choose Polar Alignment, and then choose N Polar Calibrate or 2 Star Calibrate. These routines function the same as version 2.3 or above. Please refer to your original GTO Keypad Manual (also available on the website) for specific instructions. Note, although the solar system objects display in the star list, you cannot use them in these calibration routines. Since the RA/Dec positions of these objects change with time, they are not suitable for slewing back and forth in multiple iterations. Do not use the solar system objects. When you have completed the routine, the Main Menu will appear and you can proceed as usual.

c) **Resume from Park.** Do not select this item for the first session unless you are entering your location data. Your telescope may slew to a dangerous position if you try this one.

d) **Resume Ref-Park 1.** For this start position you will need to have a bubble level. Physically move your mount to the park 1 position by setting both axes to be level with the ground with the telescope on the west side of the mount. Use the bubble level to assist you. When the mount is in position, select this menu option. The Main Menu will display on the keypad so that you can proceed with your session.



Practice Using your Keypad

You may want to try out your keypad while the mount is set up at home. We suggest that you don't put the mounting plate, counter weights, counterweight shaft or telescope on the mount since you cannot actually calibrate on a real star. If you guess the location of your calibration stars incorrectly, you may cause the telescope to hit the pier or the plate to strike the mount. Read the following instructions as you use your keypad to simulate an observing session.

When you plug in the cable of your keypad and the power cable, the words Astro-Physics and the version number of the firmware will appear briefly.

- If Auto-Connect is set to "NO", the Location Selection screen will appear. Refer to the section entitled: "Normal Startup Sequence – For Mounts that are Set Up in the Field." in your keypad manual.
- If Auto-Connect is set to "YES", the Main Menu will appear. You can then access the Objects Menu to get a feel of how easy it is to use the new menus on the keypad.
- If Auto-Connect is set to "EXT", the keypad will wait until location and time data is sent to the mount through the serial port. Pressing Menu will cancel this wait (if you are not using external software today). The Location Selection screen will appear so that you can initialize the mount with the keypad. Refer to the section below entitled: "External Startup Sequence – For Mounts that are controlled by an external computer" for instructions regarding this new feature.

STARTUP OPTIONS – NEW OR REVISED

External Startup Sequence – For Mounts that are Controlled by an External Computer.

Keypad Options Menu

1=Auto-Connect:	**NO**
2/3=Reticle	**:0**
4=Focus	**:High**

Auto-Connect: EXT is a simplified startup sequence appropriate for mounts that meet both of these requirements:

- Precisely polar-aligned
- Your mount is connected to a computer with telescope control software

This feature can be activated or de-activated in the Auto-Connect settings in the Keypad Options Menu. You can access this menu by pressing Setup, then pressing #3 to enter into the Keypad Options Menu. Press #1 to toggle between: YES, NO, and EXT.

Once Auto-Connect is set to EXT, press the Menu button until you get to the Main Menu, then power the mount down in order to activate this feature.

1. **Prepare your computer and software**. Have your computer on with your telescope control software running and connected to the mount via the serial port.
2. **Power up your Mount and the External Startup Screen will appear on the keypad**. This screen will check the mount every few seconds to see if the computer has sent it the location and time data it needs to complete the startup process.
3. **Connect to your mount in the computer software.** The display on the keypad should now change to the Main Menu. If it does not, slew to an object close to where the telescope is pointing. Some software only sends the time and location data to the mount after a slew, not at connection.
4. **The Mount should now show the Main Menu and you are ready to use the keypad.** If your telescope was moved since last time you used it, you may need to recalibrate on a star. Refer to "Auto-Start Sequence – For Permanent, Polar-Aligned Mounts" in your GTO Keypad manual for this procedure.

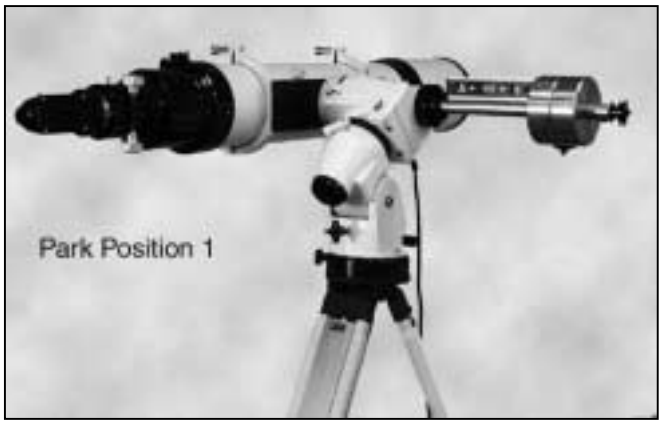
Polar Aligning in the Daytime

Using the Park 1 position to polar align your telescope in the daytime or when Polaris is not visible.

CALIBRATING IN THE DAYTIME
Before calibrating on the sun, you MUST install a safe, quality solar filter. Do not use eyepiece solar filters as they may break in the intense heat of the sun. When you are slewing to any object in the daytime, the telescope may slew across or very near the sun. DO NOT look into the eyepiece as the telescope slews. DO NOT attempt to view any object, e.g. Venus, when it is near the sun. Permanent damage to your eye may result if you look directly at the sun with your telescope. Refer to the section on "Slewing During the Day" for further information and warnings.

This procedure replaces the section of the original keypad manual.

1. Set Park 1 position.



a. Set up mount WITHOUT telescope and counterweights. Don't try this step with the telescope or you may hit your pier/tripod. The photo shows the telescope, but please do not attach at this stage.

b. Point the mount roughly north; a compass would be handy. Remember, magnetic north is not true north.

c. If your keypad is set to auto-connect "no," proceed to step number 2.

d. If your keypad is set to auto-connect "yes, go through the start-up routine.

i. Turn power on, the Main Menu will appear right away.

ii. Enter Setup and select 4=Park/Mount Opt.

iii. Select Park 1. The mount will slew. Ignore the direction the mount is moving. When it is finished slewing, it will put Park 1 into memory. You will need this later.

e. Turn off the power.

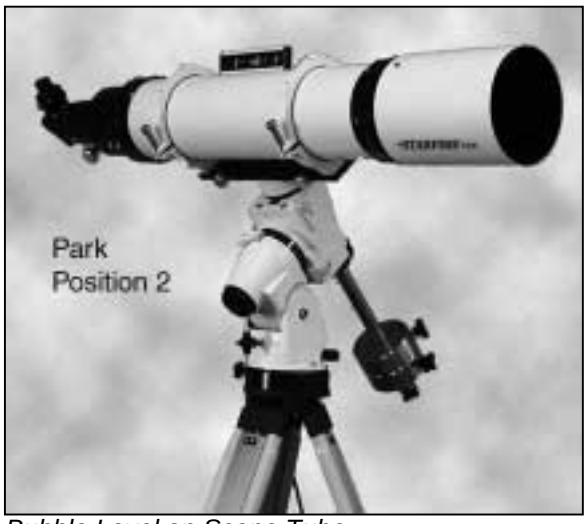
2. Manually move mount to Park 1 position.

a. Assemble the counterweights, and then telescope onto mount. Balance as usual.

b. Point the mount roughly north and approximately level both axes. Refer to the photo for Park 1.

c. Place a carpenter's level on the counterweight shaft and move the RA axis manually until the shaft is precisely level. This will place your mount in the Park 1 position.

d. Tighten the R.A. axis clutches so that the axis cannot be moved accidentally.



Bubble Level on Scope Tube

3. Turn on the power to the mount and go through the startup sequence.

a. If auto-start set to "no", select 4=Resume from Ref-Park 1 from the Start Menu. This will take you to the Main Menu.

b. If auto-start was set to "yes", simply go to next step. It will remember the Park 1 position that you entered previously.

4. **Set Park 2 position**.

a. Enter Setup and select 4=Park/Mount Options.

b. Press Park 2. Wait until the scope has slewed to the Park 2 position.

c. Using the bubble level, level the tube manually by turning the Dec axis only. Do not move the R.A. axis.

d. Tighten the Dec clutches so that it cannot be accidentally moved.

e. Press MENU to resume from park.

5. **Set Park 1 position and make altitude adjustments**.

a. Press Park 1. Wait until the scope slews to the Park 1 position.

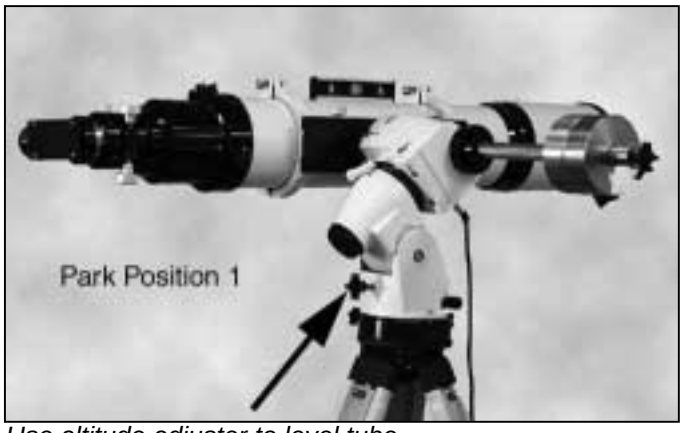
b. With the carpenter's level, level the scope tube using the mount's altitude adjuster. Do not move the axes by hand.

c. Press MENU to resume from park.

6. **Slew to object and make azimuth adjustments if needed**.

a. Scroll back to the Main Menu.

b. Enter Objects Menu and choose the object that you want to slew to. The mount will now slew to where the object is, assuming that the azimuth adjustment is correct (the mount is pointed exactly true north). These are some possible object choices.



Use altitude adjuster to level tube.

i. Sun - The sun is the most visible choice, of course, but you must exercise extreme caution when using this target. You must use a proper solar filter if you wish to image the sun in your eyepiece. Failure to do so may damage your optics and your eyes! If you don't have a filter, you can do this step with the dustcover on your scope (and finderscope) by observing the shadow of the tube on the ground. Another way is to line up the shadow of the front mounting ring on the rear ring. This is easy to do with Astro-Physics rings because the two corners on the top of the ring cast a sharp shadow.

ii. Bright star or planet - You may also choose a bright star or planet if the sun has already set.

iii. Moon

c. Make azimuth adjustments if needed. If the scope is pointed left or right of the object, simply turn the azimuth adjusters until the object is in the field.

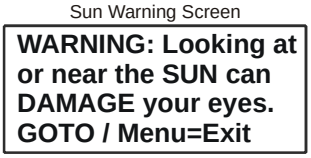
The accuracy of this method depends on how accurate your keypad time and location has been set. Tests completed with an ordinary 7" carpenter's level shows that the mount can be adjusted level to accuracy within 15 arc minutes. We used a Mayes brand "SUPER-CEDE" model that was purchased at a local hardware store. This level has a groove for accurate alignment on curved surfaces. It works well on both the counterweight shaft and the telescope tube.

While this method will get you close, it will not be accurate enough for critical astrophotography. You will have to align more precisely.

SUN WARNING

It is important to remember that slewing to objects near the sun can be quite dangerous to your eyesight. If the sun is above the horizon, the keypad will go through an additional check routine to be sure that the object or position that you select is outside a safe viewing zone. If the object is the sun itself or within 15 degrees of the sun, the following warning will display:

Sun Warning Screen



Please be sure that you have installed a good quality SAFE filter that covers the optics in front of the telescope. Never use eyepiece filters since they may break due to the intense heat of the sun. Do not use solar filters that are cracked (glass), torn (Mylar) or have many pinholes (either glass or Mylar). You may press GOTO to continue your slew to the sun or near-by object if your filter is ready or you may press the Menu button to abort the slew.

MAIN MENU FUNCTIONS

Brightness of the display screen

Use the <PREV and NEXT> buttons to adjust the brightness of the display.

Note: Even when the keypad is set to the bright setting, it will be difficult to see during daylight hours. You will need to shield it with your hands. This is an unfortunate drawback of the vacuum-fluorescent screen. We originally chose this display because of its excellent performance in cold weather down to -40° F (-40°C, yes, the number is the same). Alternative displays scroll very slowly at temperatures below freezing and would not work well at all in extreme temperatures. Since many of our customers (and ourselves) observe during the cold mid-western winter months, we opted for performance.

Directional buttons

The N-S-E-W buttons are active at this point.

Objects

This is your gateway to all object databases, tour functions, What's Up and the RA/Dec coordinate entry screen.

Setup

Refer to the next section of this manual for a complete discussion of the new options available here.

Tools

Periodic Error Memory Adjustment (PEM), SmartGuide, Photo Timer, and Status are now all found under this new menu. Please see the SmartGuide section below to learn how to use this new feature.

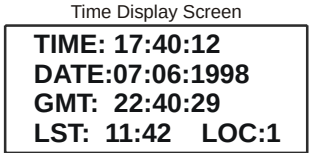
Time/LST

This display screen will show your local time, date, LST (local sidereal time, also known as the zenith hour) and GMT (Greenwich Mean Time, also known as UST – Universal Standard Time).. In addition, the current selected location will appear in the lower right corner. For example, LOC=1 indicates that location 1 is currently selected. Press and hold MENU button a few seconds to exit screen

You will notice that the display will appear to skip a second once in a while. This happens because the display does not update exactly in sync with the clock. As a result, it gets slightly behind and has to skip a second to catch up. This is not a problem.

This is a display screen only. You must go into the Location and Time menu to change the date, time and location.

Time Display Screen



Slew rate

Press “5” on your keypad to change the slew rate: 1200x, 900x, or 600x. Note that the selection changes (toggles) each time you press the button. We recommend that you use slower rates in cold weather.

Button rate

Press “6” on your keypad to change the button rate: 64x, 600x, 1200, .25x, .5x, 1x, or 12x. This determines the rate that the mount will move when the N-S-E-W directional buttons are pushed. The selection changes each time you press the button. This rate will not effect the guide speed of your auto-guider or computer program. Note: in the past, this also set your auto-guider speed, however that is now an independent function.

Guiding rate

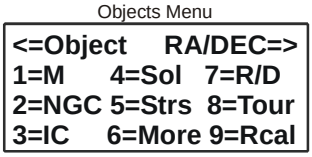
Press “7” on your keypad to change the Guiding rate: .25x, .5x, or 1x. This determines the rate that the mount will move when an auto-guider or computer guiding program moves the mount. The selection changes each time you press the button.

Tracking rate

Press “8” on your keypad to change the tracking rate: Side (Sidereal), Sol (Solar), Lun (Lunar), Stop (no RA movement)

OBJECTS MENU – NEW

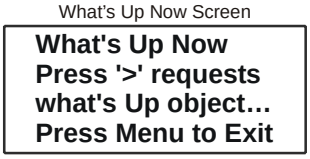
Objects Menu



More Objects Menu

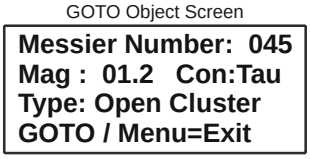
What’s Up Now Function

What’s Up Now Screen



1. **Go to the What’s Up Now screen.**
   (Main Menu→ Objects Menu → 6=More → 4=What’s Up Now)
2. **Press the Next>.** The keypad will search its M, NGC, and IC databases and randomly suggest an object that is above the horizon at your location. Due to the complex calculations that are made to select an object, you may notice a slight pause with a blank screen after pressing the > button. This is normal. The selection is random but based on what is above your current sky horizon and if there is any horizon limit set in the keypad. See “Set Horizon Limits For Your Telescope” for more information about this feature. A typical response from What’s Up is shown in the sample display. You can select this object by pressing the GOTO button or you can press the NEXT> button to have the keypad pick out a different object for you. You may then press GOTO to slew to that object or NEXT> to find a new one.

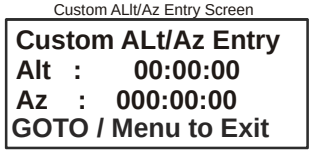
GOTO Object Screen



Custom ALT / AZ Coordinates

This menu option allows you to slew to any position in the sky as long as you know the altitude and azimuth angles. This feature is particularly handy if you wish to observe terrestrial objects with the tracking turned off.

Custom ALlt/Az Entry Screen



1. From Objects Menu, select AlAz. The Custom Alt/Az Entry will appear.
2. Enter Altitude and Azimuth coordinates..
3. Press GOTO to initiate slew or MENU to Exit.

4. You will now return to the Objects Menu.

SETUP MENUS

Setup Menu

```
1=Locations & Time
2=Mount Move Limits
3=Keypad Options
4=Park / Mount Opt.
```

Locations & Time Menu

Set Site Location

Refer to the earlier “Getting Started – Do This at Home” section of the GTO Keypad manual for this information.

Set Date & Time

Refer to the earlier “Getting Started – Do This at Home” section of the GTO Keypad manual for this information.

Get Time/Loc FrMnt

Get Time/Loc FrMnt Screen

```
TIME:21:12:38
LONG:W 089:25:00
LAT    :N 42:38:00
```

If you are using an external computer to initiate and control your telescope, the mount and the keypad could be using different location and time settings. This command will sync the keypad with the last location that was sent to the mount by the computer through the RS-232 serial port. This feature is extremely handy for computers synced with atomic clocks and GPS units. When this feature is selected, a display will appear with the information the keypad has obtained from the mount. Compare this screen to your computer settings to be sure they match. If they do not match closely you may need to send the settings to the mount again by using the initialize command in The Sky or by sending a slew command in other telescope control programs. You will also notice if you have used this feature that your location indicator in the Time/LST menu will show LOC: E. This indicates that you are using the external information in the mount to establish your location and time rather than your preset locations in the keypad’s memory.

Note: Editing the time after getting the information from the mount is disabled. Editing the time in the keypad would cause it to lose sync with your computer and its software. If you need to update your time please enter the Get Time/Location From Mount command again.

Load / Initialize

This feature allows updates of the keypad database when upgrades are available in the future. It also will set your keypad back to all of the factory default values. When 4.0 was loaded into your keypad either by Astro-Physics or by you downloading it yourself, this command would have been run to clear the keypad of all values in memory i.e. Location, Backlash and so on. If you accidentally press 4=Load / Initialize, a confirmation message will appear. Press Menu=Exit to escape.

Note: There are two parts of the keypad firmware. One controls the actual program function/features and the second controls the object databases (RA/Dec coordinates, magnitudes, constellations). Only the database upgrade or control code initialization uses this load / Initialize feature.

Mount Move Limits Menu

Mount Movement Menu

```
1=RA Backlash   : 0
2=DEC Backlash : 0
3=Safe Zone      : 00
4=Horizon Lim.  : 00
```

As you look at the display, you may notice that the numbers to the right of the colon will appear to shimmer. This is normal since these values are continually scanned by the keypad.

R.A. Backlash Adjustment

Since the R.A. motor is always running, there is no backlash or delay in the R.A. motion in 0.25x, 0.5x, and 1x. Where R.A. backlash becomes noticeable is in the 12x, 64x and higher slew rates. Here, backlash will manifest itself as a delay in the continuation of the R.A. drive. In other words, the star will continue to drift for a number of seconds after letting go of one of the two directional buttons (E or W). This is the time it takes for the motor gear train to completely reverse again in order to begin the normal tracking. For that reason, we added a short pulse of 64x sidereal to get the gearbox to re-engage quickly. There is no drift in the other direction because you are not unwinding the gear train. Adjustment of the backlash is very simple.

1. **At Main Menu, press 6=B.** This controls the speed of your N-S-E-W directional buttons. Continue to press 6 to scroll (toggle) through choices. You can also access a button speed menu by pressing the +/- button. This feature is available from most display screens.
2. **Select 12x or any higher speed.** We recommend 12x since this is the easiest to evaluate.
3. **Choose Setup from the Main Menu**.
4. **Choose Mount Move Limits from the Setup Menu**.
5. **Press 1=RA Backlash**. As you continue to press 1, the number field will scroll 0-9. Zero will have no compensation and 9 will probably be overcompensated.
6. **Stop the selection on 3 (or any other number you choose)**. We recommend that you start with 3 if you are beginning your adjustment.
7. **While viewing a star at high power through an eyepiece, use the E-W buttons to test this setting at 12x**. With the proper backlash setting, the star will appear to stop moving when the button is released. Too high a setting will cause the star to jump back a bit. If this happens, select the previous number. You can now test this without leaving the Mount Move Limits Menu.
8. **Repeat the process, increasing RA Backlash setting by 1 each time to evaluate changes**.
9. **The number will remain in permanent memory and will not need to be set again, however it can be adjusted at any time.**

The RA and Dec backlash settings are retained in the keypad memory. Each time you initialize the mount with the keypad, these values are sent to the ROM chip in the GTO control box. The amount of backlash can vary depending on load and orientation of the telescope. It can never be precisely set, so there will always be a small delay or small overshoot.

Declination Backlash Adjustment

When using the 1x, .5x and .25x guide rates in declination, you may find that there is a delay when attempting to reverse the motion of the star. Normally declination drift is only in one direction and will require correction with only one button. However, occasionally it may be necessary to reverse the motion. The multiple gear trains inside the drive motors take a number of encoder pulses to unwind and rewind in the opposite direction. To compensate for this, we have included a circuit that pulses the motor very rapidly for a moment before continuing at the slower rate. Because the delay varies with each motor, we have programmed a 10-position adjustment, which can be used to dial in the exact amount of compensation.

1. **At Main Menu, press 6=B.** This controls the speed of your N-S-E-W directional buttons. Continue to press 6 to scroll (toggle) through choices. You can also access your button speed anywhere you can use them by pressing the +/- button and using the Button Rate Menu.
2. **Select .25x**.
3. **Choose Setup from the Main Menu**.
4. **Choose Mount Move Limits from the setup menu**.
5. **Press 2=DEC Backlash**. As you continue to press 2, the number field will scroll 0-9.
6. **Stop selection on 3 (or any other number you choose)**. We recommend that you start with 3 if you are beginning your adjustment.
7. **While viewing a star at high power through an eyepiece, use the N-S buttons to test this setting at .25x**. You have set the compensation number correctly when the telescope will move almost instantaneously when reversing the direction in declination. You can now test this without leaving the Mount Move Limits menu.
8. **If needed, repeat the process, increasing the Dec Backlash setting by 1 each time in order to evaluate changes**.
9. **The number will remain in permanent memory and will not need to be set again**.

i) Normally, Dec backlash is adjusted only for manually guided astrophotography where the scope is always in one orientation for a long time. Even here, a different adjustment may be needed in different parts of the sky.

Set Safe Zone Limits for Your Telescope

Astro-Physics mounts are used with a wide variety of telescopes, piers, tripods and accessories. You may determine that if the telescope attempts to point to some areas of the sky, it may hit the pier or tripod. The safe zone function will allow you to control the area in which the scope is allowed to slew. Based on your safe zone setting, the keypad will determine whether the object that you have selected for slewing is within a restricted zone or the safe zone. If the object is in an area of the sky within the restricted zone, your keypad will display “Outside Safe Zone, Slewing canceled…” However, it you are slewing with the N-S-E-W buttons, there are no restrictions, so you must watch carefully.

How to Determine Your Safe Zone

Set up your telescope with all of the accessories you plan to use and balance your load. Move your scope through its range of motion. Can you point the scope straight up without hitting the pier or tripod? If so, leave your safe zone set at 0 degrees. This means that the entire sky can be accessed. The telescope in the photograph does not require a safe zone setting. It will move safely into all positions with the 6x7 camera.

If your telescope is in danger of hitting the tripod, you must set your safe zone to some number between 0-20 degrees. To determine this setting, move your counterweight bar to a position parallel with the ground. Take care that the telescope and accessories are moved out of the way of the pier or tripod. Note the position setting of the RA circle when the counterweight shaft is in this parallel position. Now, gradually move your telescope by hand to the limit of the safe zone you wish to set – as close to the pier/tripod that you are comfortable. Note the change in the position of the RA setting circle. You can calculate the safe zone setting based on this difference, knowing that each hour is equal to 15 degrees. For each of these mounts, each tic mark on the RA setting circle is equivalent to these values:

- 1200GTO – 1 degrees
- 900GTO – 1.25 degrees
- 600EGTO - 2.5 degrees
- 400GTO – 2.5 degrees

The safe zone setting may vary depending on what accessories are on your scope, e.g. CCD camera with filter wheel, Daystar H-alpha filter or just an eyepiece.

Remember that if you set your safe zone to a number greater than 0, you will also lose a corresponding amount of the zenith as shown in the photo.

The software that controls the mount sets the safe zone. In this manual, we are discussing keypad control. However, if you are using an external software program, that program controls the safe zone. The keypad settings are not active in that situation. For instance, you can set your "safe zone" in Digital Sky Voice and the "Telescope Limit Line" in The Sky. The programs themselves do the calculations for the target object (is it within the safe zone or out-of-bounds?) to determine whether the mount should slew or not. If it is safe, the RA/Dec numbers are sent to the mount. If not, you are informed that the object is outside the limits. If the software program does not contain some sort of safeguard to assure the safe position of your telescope, you must be very careful and watch the movements during a slew. The mount will slew wherever it is told, even if it is not safe.

Set Your Safe Zone

1. **Go to Mount Move Limits Menu**. (Main Menu → Setup Menu → Mount Move Limits Menu).
2. **Press 3=Safe Zone**. Notice that the number field changes.
3. **Enter number of degrees**. As you continue to hold #3, the number choices increase from 0-20 and back to zero. Release #3 to stop the scroll through the numbers.

Set Horizon Limits for Your Telescope

Astro-Physics mounts are used in wide variety of Locations. You may determine that if the telescope attempts to point to some areas of the sky, that the object will end up behind a wall, a hill or some other obstruction that limits your horizon. The horizon limit function will allow you to control the area in which the scope is allowed to slew.

Based on your horizon limit setting, the keypad will determine whether the object that you have selected for slewing is above the horizon or not. If the object is in an area of the sky that is below the Horizon Limit that was set, your keypad will display “Object Below Horizon Limit. Altitude: [Value]” The value indicates how many degrees the object is above the actual horizon if you were viewing from a perfectly flat location. If the number is within a degree or two of the limit you have set or you know you have a lower horizon in the direction the object is in, you can hit GOTO and mount will slew to the object. Alternatively, you may hit Menu to cancel the slew and choose another object from the Objects Menu.

How to Determine Your Horizon Limit

After you set up your telescope, take note of any area around the horizon that may be obstructed for example trees, houses, observatory walls, mountains, hills and so on. If you are in a valley or an observatory with high walls, your horizon limit setting will be higher than an observer on a hilltop or on an island looking over a large body of water. Move your scope through its range of motion. Notice the areas of the sky that you cannot see through the telescope. If you can see the sky in every direction, then leave your horizon limit set at 0 degrees. This means that the entire sky can be accessed and observed without obstruction. If you have major obstructions, you can consider setting the horizon limit.

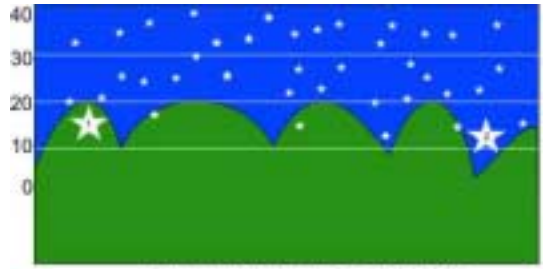
How Horizon Limit Works

Observer A’s site is on a hill with a very long, distant local horizon, whereas Observer B is in a valley with a very close and obstructed horizon. Observer A would set his horizon limit to 0 because they can see the entire sky. Observer B, in the valley, would set his horizon limit to around 20 so that the keypad will prompt him if he attempts to slew to an object that would be below his local horizon.

If Observer B attempted to view Star 1, the object would be below their horizon (hidden by a nearby hill) and the keypad would prompt to tell them this. If Observer B attempted to view Star 2 the keypad would prompt them that the object was below the horizon but Observer B would know they could see Star 2 and would press GOTO to override the horizon limit slew to mount to observe it.

Observer A View Horizon Limit Setting = 0

Remember that if you set your horizon limit to a number greater than 0, you will receive a warning for any object below the limit. If you experience numerous unnecessary prompts, adjust your limit . If you are not being prompted for objects that are below the horizon at your location consider raising the number.



Observer B View Horizon Limit Setting = 20

Note: The software that controls the mount sets the horizon limit. In this manual, we are discussing keypad control. However, if you are using an external software program, that program controls the horizon. The keypad settings are <u>not active</u> in that situation and you might end up slewing to an object below your local horizon.

Set Your Horizon Limit

4. **Go to Mount Move Limits Menu**.
   (Main Menu → 2=Setup → 2=Mount Move Limits Menu).
5. **Press 4=Horizon Lim.:** Notice that the number field changes.
6. **Enter number of degrees**. As you continue to hold #4 button, the number choices increase from 0-50 and back to zero. Release the button to stop scrolling through the numbers.

Keypad Options

Auto-Connect

Keypad Options Menu

1=Auto-Connect:	**NO**
2/3=Reticle	**:0**
4=Focus	**:High**

Please refer to these sections of your GTO Keypad manual:

- ”Normal Startup Sequence – For Mounts that are Set Up in the Field.”
  For instructions about Auto-Connect : NO
- “Auto-Start Sequence – For Permanent, Polar-Aligned Mounts”
  For instructions about Auto-Connect : YES
- “External Startup Sequence – For Mounts that are controlled by an external computer.”
  For instructions about Auto-Connect : EXT

Reticle Illuminator Adjustment

The brightness of an illuminated reticle can be adjusted with the keypad. Plug the cord of the reticle into the connector on the GTO Control Panel.

1. **Go to the Keypad Options Menu**. (Main Menu →#2 Setup→ #3 Keypad Options).
2. **Press the 2 and 3 buttons to desired brightness level from 0-9**. Button 3 will increase, 2 will decrease.

Focus Adjustment

If you are using an electric focuser such as the ones offered by JMI or Meade, you can control the in and out focus movement with the keypad controller.

1. **Plug the power cord of the focus unit into the GTO Control Panel**.
2. **Hold the focus (FOC) button on the keypad with one finger and press the <PREV or NEXT> buttons to change focus.**
3. **To change the speed, go to Keypad Options Menu**. (#2 Setup→ #3Keypad Options).
4. **Press 4=Focus**. The rate choice will alternate (toggle) between Low and High.
5. **Select rate**

Note: If you are using the keypad and *The Sky* software together, it is best to use either one or the other to control the focus and not try to use both alternately. Use the keypad if you are standing at the eyepiece, use *The Sky* if you are focusing a CCD image from your computer screen.

Both the keypad and *The Sky* default to the slow speed when you begin your session. However, If you change the keypad to the fast setting, then use *The Sky,* you will notice that *The Sky* focus speed will be fast even though "slow" has been selected from the dialog box. To gain control with *The Sky*, simply select "fast", then "slow." The speed will now operate at slow. The same is true if you focus with *The Sky* first, then switch to the keypad. Use the same technique to gain control with the keypad. This occurs because the Servo Drive Box stores the last focus speed information and until you actively change the speed with either device, it will remember the speed last used.

Park / Mount Options

See the GTO Keypad manual that came with your mount for information about this menu.

TOOLS

PEM

Please see the GTO Keypad manual that came with your mount for information

SmartGuide

SmartGuide is a new variable tracking rate tool for your Astro-Physics GTO mount. It can be found in the tools menu (#3).

Why do I need SmartGuide?

Due to atmospheric refraction, the stars in the sky do not move at precisely the same rate of motion everywhere, nor is a perfectly precise polar alignment easy to obtain. Both of these factors can contribute to mount motion that is slightly off the sidereal rate of motion as well as exhibiting declination drift. Also, some objects such as the moon, asteroids, and comets do not move at the sidereal rate. With today's CCD cameras, the challenges for precision are bigger than ever, therefore SmartGuide was developed as a tool to reduce the guiding errors on these objects.

How does SmartGuide work?

SmartGuide compensates for changes in sky motion by introducing small corrections to the two axes to cancel out image drift. These corrections are done in the keypad software by periodically sending

short pulses of movement to the mount in the direction that needs the adjustment. Compensation can be achieved for very small to very large drift in either axis.

How do I use SmartGuide?

To use smart guide you will need either a CCD camera or a crosshair eyepiece.

- Make sure your PEM is recoded and active.
- Select a bright star or object near the area you wish to image.
- Enter the SmartGuide menu by hitting #3 (Tools) on the Main Menu, then select option #2 (SmartGuide), press >NEXT button to move to the More Menu.
- Take note of the button speed setting. We recommend making your adjustments at 1x button speed or slower. Button speed can be adjusted by pressing the +- button to bring up the speed setting.
- Press #1 on the pad to enter Auto SmartGuide setup.
- Center the star on the screen (or crosshair if you are using an eyepiece) and press 1 to activate the SmartGuide recording.
- Let your mount run for 5-10 minutes, then go back and precisely center the object on the screen (or crosshair if you are using an eyepiece).
- Press #1 as soon as you have the object centered again.
- The keypad display will now show 5 significant numbers on it.
    - RM: The amount in Arc seconds the mount has moved in RA
    - DM: The amount in Arc seconds the mount has moved in DEC
    - Time: In seconds that you recorded your measurement.
    - RS: The amount of RA drift per second in arc seconds RM/Time
    - DS: The amount of DEC drift per second in arc seconds DS/Time
- These are the values that SmartGuide will now use to compute the button on-time, in milliseconds, to track the object at the chosen tracking rate.
- Hit GOTO to start SmartGuide running.
- The keypad display will now show the following:
    - R: The movement direction in RA
    - D: The movement direction in DEC
    - S: Speed
    - RM: Length of pulse in milliseconds sent to the RA Axis
    - DM: Length of pulse in milliseconds sent to the DEC Axis
    - PE: Length of wait time between pulses
- Setup your CCD or camera and image away.

Is SmartGuiding better than Auto Guiding?

Auto guiding is always more accurate than matching drift rates with SmartGuide. It would always be the preferred method except in circumstances where a guidestar is not available (filtered shots, star-poor regions, H-alpha imaging etc.). Matching drift rates with SmartGuide is akin to setting your car's speed on cruise control and trying to match exactly the car in front of you who also has his set on cruise. If you don't adjust your speed from time to time (i.e. guiding), eventually you will either hit him, or drift farther apart. It's even more difficult if the car in front is slowly increasing or decreasing his speed.

Photo Timer

Please see the GTO Keypad manual for information.

Status

Please see the GTO Keypad Manual for information.

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