

ASTRO-PHYSICS GTO KEYPAD

Version v5.xxx

Please read the manual even if you are familiar with previous keypad versions



Flash RAM Updates

Keypad Java updates can be accomplished through the Internet.
Check our web site www.astro-physics.com/software-updates/

November 11, 2020

ASTRO-PHYSICS

KEYPAD MANUAL FOR MACH2GTO

Version 5.xxx

November 11, 2020

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ABOUT THIS MANUAL

The keypad is a multi-function, portable, hand-held computer which gives you total freedom to set up in the field or at star parties without being tethered to the extra bulk of power-hungry computers. Since our keypad can be used during cold winter nights, it is especially handy and useful. It is very powerful, yet easy-to-use whether you are a visual observer or dedicated imager!

Version 5 of the software was introduced in November 2020 and is available as an upgrade for older keypads. Refer to "Requirements" on page 5 for more information.

The keypad features that are available in version 5 will depend on the software of your control box. These are some differences:

- The GTOCP5 and Mach2GTO have a different startup routine due to the construction of the mount.
- The pointing, tracking and drift modeling features are available to all GTOCP5 control boxes (available to Mach2 only) and only those GTOCP4 control boxes that have this feature enabled by Astro-Physics.

This manual provides instructions to guide you when using version 5 of the keypad software. Over time, we will update the manual in order to improve presentation of the information or to describe new features. We highly recommend the [Technical Support](#) section of our web site for the latest information and for future updated versions of this and other manuals.

For clarity and smoother reading, we will refer to the control boxes as CP4 and CP5 rather than GTOCP4 and GTOCP5, respectively. When referring to both control boxes, we will abbreviate CP4/5.

A final note and an apology to our friends in the southern hemisphere. Many of the instructions in this manual are written entirely from the point of view of those of us in the northern hemisphere. Since descriptive terms like left and right are meaningless without a defined point of reference, we tend to use east and west to avoid ambiguity. The east and west sides of a German equatorial mount are, of course, reversed in the southern hemisphere. At one point, our thought was to always use phrases like the following: ... on the east side (west side in the southern hemisphere) ... This quickly became cumbersome and made the text more difficult to read. For simplicity, we decided to leave many of the explanations in their northern hemisphere framework. To our southern hemisphere friends: We appreciate you no less and apologize for this unintended slight. We know, however, that you are all smart enough to make the necessary translation to down under appropriate instructions. Thank you for your understanding.

PLEASE RECORD THE FOLLOWING INFORMATION FOR FUTURE REFERENCE

Keypad Serial Number: _____

Purchase Date: _____

User Name _____ Password _____

REQUIREMENTS

It is important to understand that your control box and keypad both have software that enable them to function and to communicate. Each time you upgrade your keypad, you will also need to ensure that your control box has the appropriate version so that all of the necessary commands are available.

The upgrade instructions will specify the minimum required control box software version. The Keypad Loader Utility will also query the control box to be sure that correct version is present. before you begin the load.

New control box and keypad software versions can be downloaded from this link:
<https://www.astro-physics.com/software-updates/>

What Mount Control Box Do I Need?

- The GTOCP4 and GTOCP5 control boxes have the computing power and required commands to use version 5 of the keypad. Regrettably, the older control boxes (GTOCP1, GTOCP2 and GTOCP3) will not be able to use keypad with upgraded v5.xxx software. Version 4.19.3. is recommended for these older units.
- Your GTOCP4 or GTOCP5 must be upgraded to the software version specified in the download instructions.

Can I Upgrade My Present Keypad?

- Keypads with serial number 1565GTO or earlier that have the original 256K circuit board cannot be used with the v5.xxx firmware, as they lack the memory capacity. If you have a keypad with a lower serial number that has been repaired, it may have the required memory.
- Two of the buttons in the lower row of the newer keypads have different lettering on them. The FOCUS button has been changed to the RECAL button. The button labeled RA DEC REV will actually function as an ENTER button. The RA DEC REV function will now be accessed through the +/- button. The MENU button has been relabeled to include ESC.

If you load v5.xxx onto an older keypad, you can continue to use your original buttons and simply memorize the new function. Alternatively, you may send your keypad to Astro-Physics to be upgraded the button pad. Contact Astro-Physics for additional information.



Older Button Labels



Newer Button Labels

GTO KEYPAD

The GTO keypad is the communication center for the operation of your GTO mount. We have designed this unit to be as intuitive and easy to use as possible while filling it with terrific features to make your observing session productive and pleasurable. With a few keystrokes, you can slew to objects by their common name or catalog number, set up search parameters to find all the open clusters (in the Messier catalog) that are visible on a given night, focus your telescope for astrophotography, set the countdown timer for the exposure, enter RA and Dec coordinates to find the newest super nova, and much more.

Note: Please understand that the keypad is NOT the brain of the mount. The real control is in the CP4/5 Control Box. The keypad simply provides data for the CP4/5 to do its job. Likewise, a computer with software can also duplicate everything that the keypad does. The mount can be operated using only the keypad, using only a computer, or using both.

The heart of the controller is the 4-line display window that will guide you through all operations. The alphanumeric keypad itself is translucent and backlit with red LEDs for easy visibility at night. The buttons are also made with a phosphoresce material that will glow in the dark for a brief time. Shine an LED on them to extend their luminescence.

Button functions are clearly defined on the button itself or as an instruction on the display window. You do not have to remember shift key patterns or complex keystroke sequences. The directional buttons are shaped like arrows to help you find them in the dark without looking at your keypad. The stop button is readily accessible if you need to cancel any slewing request immediately.

The menu system is very easy to navigate. Each window will display several choices, which correspond to a number button. Simply press the number button to initiate the command, e.g. 1=M, 2=NGC. When you press 1 the Messier entry window will display and you can enter the number of the object that you wish to see. Press GOTO, which will cause the mount to slew. The <PREV and NEXT> buttons will allow you to scroll quickly through the lists of common names or to find more data about the object you are viewing. To adjust most settings, you will press the number indicated on the window several times to scroll (toggle) through your choices and stop at the one you want.



Layout and Buttons of the Keypad

Vacuum Fluorescent Display

The keypad features a four-line, 20-character alphanumeric display. The brightness of the display is adjustable with dim and bright settings. Please refer to the section entitled "Brightness of the Display Window" on page 23. If you are using the keypad in the daylight, you will need to shade the window from the direct light with your hand in order to see it more clearly or drape a dark cloth over your head.

N-S-E-W Directional Buttons

These four buttons are arranged so that the E and W buttons control the movement in right ascension and the N and S buttons control the declination. Depending on which side of mount the telescope is on and if you are using a star diagonal, when you press the N button, the star should move in an upward direction toward the top of your eyepiece field. If the movement does not match the direction shown in the eyepiece, you may wish to use our RA/Dec reverse feature as described in "RA/Dec Reverse" on page 39,

In addition, you can press two buttons simultaneously for diagonal movement, e.g. the N and W buttons will cause a Northwest movement. Note: north and south buttons can be misleading concepts in movement of the Dec axis. The reality is that N moves the Dec axis counterclockwise and S moves the Dec axis clockwise.

STOP Button

Press the STOP button to cancel a slewing command and stop the movement of the telescope immediately. The mount will know where it is, so you can proceed to your next command.

<PREV and NEXT> Buttons

These buttons are used for the following functions depending on the commands you are entering: move from one menu level to another, backspace to make corrections to number entry, or scroll through lists of objects. The < and > symbols appear on many window displays. They signify that you can press the <PREV and NEXT> buttons for more choices or additional information.

When you are in the Main Menu, these buttons toggle the display window brightness. Pressing the <PREV button will dim the window and pressing the NEXT> button will brighten it. There are two brightness levels: dim and bright.

The NEXT> button can also be used in conjunction with the RECAL button to recalibrate on a position.

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 window. 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 Midwestern winter months, we opted for performance.

Number Buttons

The buttons labeled 1–9 and 0 are used to enter numerical data and to make menu choices.

GOTO Button

Press the GOTO button after you have selected the object that you want to view. The mount will slew to the object. This button is also used for other functions, i.e. saving location data.

± Button

This button has different functions:

- Use it to quick-access a menu that includes: Button Rate (for N-S-E-W directional buttons), Slew to Home and Recal, Park Controls and RA/Dec Controls (for Meridian Delay and Scope Flip).
- Use it when editing location, time and date.
- Use it to toggle between + and - when entering RA and Dec coordinates.

MENU / ESC Button

Press this button to move to a previous menu level or to cancel a prompt.

RECAL and NEXT> Buttons Pressed Simultaneously

This button combination is most commonly used following a GoTo slew. The N-S-E-W buttons are toggled to precisely center the object. Once the object has been centered, the RECAL button and NEXT> buttons can be pressed simultaneously to update the coordinates. The keypad will beep to confirm recalibration. We require two buttons so that you do not recalibrate by accident.

ENT Button

This button serves the common function of saving entered data. It will also display Tracking Status of the active modeling routine if it is pressed while in the Main Menu.

Retractable Hanger

On the back of the controller, look for a slot with a thumb rest area. Push up to extend the hanger. A lanyard can be attached here to allow you to hang your keypad on one of the lanyard posts or base knobs of the mount when it is not in use.

Keypad Protector

The keypad protector is a heavy-duty molded rubber casing with a full 1/4 thickness on all impact surfaces. If you accidentally drop your keypad, the rubber casing will absorb much of the blow. Your display, keypad, electronics and the case itself will be protected from damage. In addition, the rubber prevents the keypad from sliding when placed on a table or other flat surface and the keypad will feel secure in your hands as you observe. The KEYPRO also offers protection during transport and storage.

Refer to the [Keypad Maintenance Instructions](#) on the Technical Support page of our website for the KEYPRO's removal and installation. This must be done with care to prevent tearing the material.

Keypad Care and Warranty

Warranty

Keypad: Three (3) years parts and labor.

Battery: 90 days.

The keypad manufacturer warrants that the product is free of defects in materials and/or workmanship from the date of shipment for a period of three years. This warranty does not apply to any products which have been subject to misuse, accident, alteration or if the unit has been serviced by anyone other than an authorized representative. During the warranty period, the manufacturer will, at its discretion, (1) repair the product to full working order or (2) replace the product with a comparable product. Replacement products will be new or serviceably used, comparable in function and performance to the original product. The product will be warranted for the remainder of the original warranty or ninety (90) days from the date of shipment of the product, whichever is longer. **DO NOT open a keypad that is within its warranty period or you will void the warranty!**

Keypad Battery for 512K Memory Boards

This includes keypads with serial number 1568GTO or later (and some earlier keypads that have been repaired or upgraded with a new 512K memory board). These keypads also have a 3V Lithium battery with an estimated life of 5 years at room temperature. This battery has been wired into a special assembly, so the replacement battery must be purchased from Astro-Physics (part # E0334 or E0338), but it can be installed by the customer. If the battery fails within the 3-year warranty period, it is best to have the manufacturer replace it. Opening the unit to replace the battery within the first three years will void the warranty.

Cleaning Red Keypad Display

The red display window is made with a Mylar material. It is recommended to use a commercial glass cleaner to wipe down the display. Spray the cleaner on a cloth and rub the display lightly. Do not use solvents of any kind. **Note: It is a good idea to leave in place the clear protective plastic cover that ships with the keypad, it will extend the display window's lifespan. However, it can be removed if you prefer.**

Temperature Ratings

The real time clock, battery-backed RAM, Extended Temperature Vacuum Fluorescent display, and backlit panel are all rated to -40 degrees F (-40 degrees C).

Environmental Recommendation

Your keypad is rugged and dew resistant, but it is not waterproof. Please take care to hang it vertically by the provided lanyard or to place it face down when operating in damp conditions. Storing it indoors when not in use for extended times is also a good precaution.

GETTING STARTED – DO THIS AT HOME, IF POSSIBLE

Set Up your Mount and Cable Connections

Refer to the instructions in the mount assembly manual to set up your mount. The following cables must be connected: RA and Dec cables, keypad controller cable and power cable. You do not need the mounting plate or telescope tube assembly for these setup procedures.

Gather Basic Information

You need to enter your local parameters to ensure that the mount functions properly. The mount needs to know the local time (and whether you are on daylight savings) and the latitude and longitude of your observing site. You can enter up to nine observing sites to be stored in memory.

To determine your latitude and longitude, do an internet Google search or use a GPS unit. The closer you can get the better, however, it is not necessary to be exact to the seconds (last two number entry fields) since the purpose of these entries is to calculate which objects are above your local horizon. Please make sure that your location information is in **Degrees: Minutes: Seconds** format (i.e.: 42:22:00 Lat. 89:01:07 Long.), rather than decimal format (i.e. 42.3667° Lat. 89.0186° Long.). Also note if you are west or east of the Greenwich meridian. Information on converting the format is on page 26 of the Setup section.

The time zone is determined from the Greenwich meridian. The keypad will automatically determine if you are east or west of the Greenwich meridian based on your entered longitude, so entering a positive or negative number is not needed. For your reference, these are the US time zones.

| | |
|---------------------------|----|
| US Eastern standard time | 05 |
| US Central standard time | 06 |
| US Mountain standard time | 07 |
| US Pacific standard time | 08 |
| US Hawaii standard time | 10 |

Most of this information will be entered only once and will be remembered by the keypad. We recommend that you make these entries at home before you go to your observing session to ensure that you have the information that you need. If you have a GPS (Global Positioning System) device, you may want to enter the coordinates once you reach your site and have the proper numbers. Latitude and Longitude **MUST** be in degrees, minutes and seconds format. Decimal values must be converted. We also recommend keeping a cheat sheet with each location's relevant data.

Enter Your Location, Time and Date

Refer to the section entitled page 11. Once you have entered this data, you can explore the keypad menus and functions with the information in this manual.

Set Up Your Mount in the Field

This manual assumes that your mount is already set up and ready to go. Please refer to the manual for your mount and the manual for either the GTOCP4 or GTOCP5 for more details.

Polar Alignment

The mount manual discusses the importance of polar alignment and various methods to achieve it with a polar alignment scope or various software solutions. One of our favorite methods utilizes the keypad and can be accomplished during daylight hours. It is quick and easy and only requires only a carpenter's level.

Mach2GTO Daytime Alignment Routine

Being able to polar align your mount during the daytime is a great way to prepare for solar observing or events. It is also a way to get a jump on your evening observing, especially if you are hosting a public event where people are clamoring to view while you are trying to polar align!

1. Roughly aim the mount using a compass (or phone app) toward the pole in azimuth.
2. Approximately level the mount with the bubble level (or phone app).
3. Set up your scope and equipment on the mount, balance, and tighten clutches.
4. Power up the mount and unpark. This will initialize the Mach2GTO.
5. Command the mount to go to Park 5 (see Park position at right).
6. Use a carpenter's level and turn the altitude knob until the scope is level.
7. Tell the mount to GoTo a visible object: the sun (with solar filter protection), the moon, bright planets or stars.
8. Use the azimuth adjuster until the object is centered in the field.
9. You are polar aligned and ready to start observing!

You can repeat this process (#5 to #8) to gain accuracy. This may be sufficient for visual observing. For more precise alignment, follow it with your favorite routine after dark.

PARK 5



Northern Hemisphere

The scope is level on the east side of the mount, facing the northern horizon. The counterweight shaft is also level and pointing due west.

*Both Hemispheres: RA is horizontal,
North: Dec = (90-Latitude) South: Dec = (-90-Latitude)*

The southern hemisphere is mirror reversed. The scope is still level on the east side of the mount, but is facing the southern horizon. The counterweight shaft is also level and pointing due west.

Southern Hemisphere



KEYPAD START UP SEQUENCE FOR NEW SETUPS OR SETUP IN NEW LOCATION

Set your keypad to AutoConnect: **NO** if your mount is used under the following circumstances:

- Your initial setup and when travelling to different locations. This is the default setting when you receive your new keypad.
- You are not using an external computer to control your mount.

Background Information: In order for your mount to operate properly, it must have basic information: location, date, time, time zone and daylight savings. This information must come from an external computer source, in this case, the keypad. You will have to enter (or confirm) this information each time you start up when you are set to AutoConnect:NO.

This feature can be activated or de-activated by pressing 2=Setup > 4=Kpd,Mt,Park Opt. Press button 7 to toggle between YES, NO and EXT. Information regarding Auto-Connect: YES provided on page 13 and Auto-Connect: EXT on page 14.

Assemble Your Mount

Refer to the instruction manual for your mount to set up at your observing site. Be sure that you connect your RA and Dec cables, keypad cable and power cable, preferably in that order.

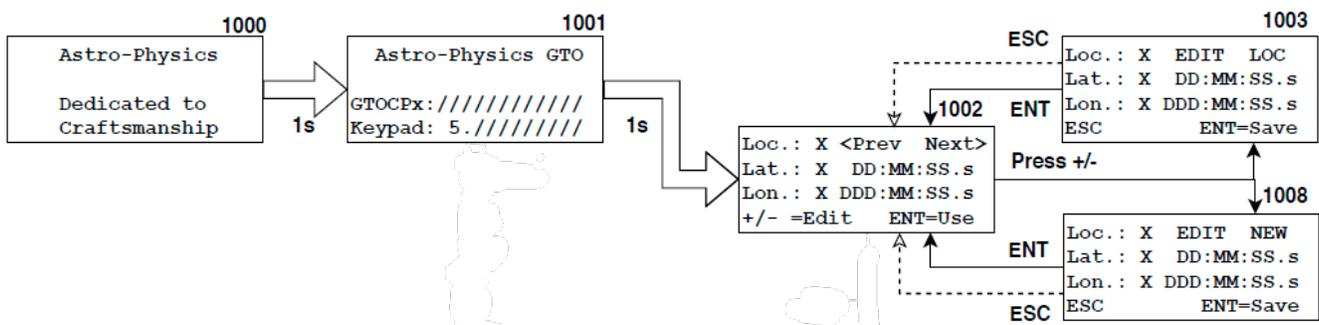
Refer to your mount manual for polar alignment recommendations. The more accurately you polar align, the more accurate will be the centering of objects in a high-power field-of-view.

Startup Sequence

When you turn on the power, the first display of the keypad will briefly read “Astro-Physics Dedicated to Craftsmanship” and then the window changes to display the firmware version number of your CP4/5 and keypad version number for a few seconds. The location selection/setup window will follow automatically.

Note: If the Main Menu window appears, that means that the Auto-Connect feature is set to YES. If you wish to set the Auto-Connect feature to NO, select 2=Setup > 4=Kpd,Mnt,Park Opt. Press 7 to toggle Auto-Connect to NO. This setting will be remembered for your next session.

Location



Select Existing Location

The <PREV NEXT> buttons allows you to scroll between the location numbers in order to select a location that you entered previously or advance to the next blank entry window.

- Select +/- button to modify the data for the chosen location number. You will be given the choice to save it or not.
- Select ENT button to use the selected location in your session.

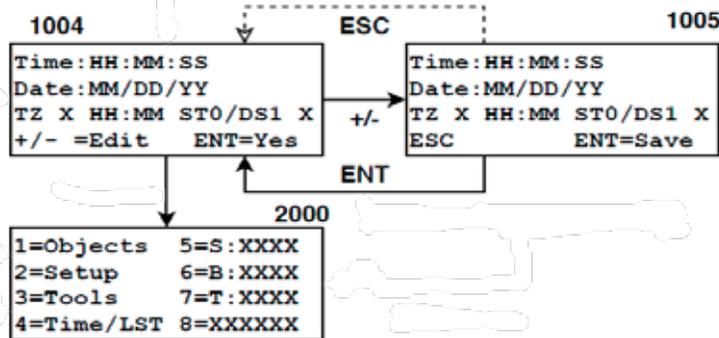
Set Up New Location

- Scroll <PREV OR NEXT> until you find a location with no values or edit an existing location.
- The Lat and Lon values will be zeros for new location windows.

- Be sure to enter N or S with latitude and W or E with longitude.
- Your longitude and latitude must be entered using the degrees: minutes: seconds format. For help converting decimal values to this format, refer to page 46.
- Select ENT button to save.
- Once saved, select ENT button to use in your session. The Date & Time screen will appear.

Date and Time

Carefully review all of the information that is on this screen. If correct, press ENT. Otherwise, push the +/- button to enter new data or correct the existing data. An information screen will display regarding time zones and Daylight Saving abbreviations. Press ENT to proceed.



1. Press the +/- button to modify the information.
 - Time is in hours, minutes and seconds. **You MUST enter the time in 24 hour format!**
 - Date is in month, day and year. Use a leading zero if there is only one digit...example: 07 instead of 7.
 - Enter Time Zone as W or E indicate on which side of the Prime Meridian you are located. Enter the time zone in the first two number fields using a leading zero, if appropriate. The minutes fields are for 1/2 and 1/4 hour time zones as found in parts of Australia, the Pacific and Asia. Time zone information is used to calculate the zenith and LST of the object that you are viewing.

Like longitude, time zones are measured from the Prime Meridian. Time zones are entered into the keypad as positive numbers. The keypad knows the difference because you have entered E or W. .
 - Set Daylight Saving/Standard Time using the W or S buttons on your keypad..
 - W= Standard Time, set to W in Winter or if you observe standard time year around.
 - S= Daylight Saving Time, set to S in summer.
2. Press ENT=Save, double check your information. Pay particular attention to the time zone since this is often overlooked. The keypad will beep.
3. Press ENT=Yes to confirm

For a more detailed discussion of date and time, refer to “Set Date and Time” on page 26, which discusses time zones and daylight savings in greater detail and makes a case for setting your keypad to UTC.

Additional Information

Mach2GTO and 1100 or 1600 Mounts with absolute encoders: After you have started the mount and are not sure if it is pointing correctly, send the mount HOME . You can locate this function in most menus by pressing the +/- button and then press 1=Slew Home. The encoders will send your mount to the home position and recalibrate. This can also be used if you inadvertently do a false recal or sync on an incorrect object that was commanded from any source. You do not need to unplug and start the mount over again. Refer to “Slew Home & Recal” on page 38 for additional information.

KEYPAD START UP SEQUENCE FOR MOUNTS USED AT THE SAME LOCATION WITHOUT A COMPUTER

Auto-connect: YES is a simplified startup sequence appropriate for mounts that meet the following requirements:

- Mounts in a permanent location or portable mounts that are used in the same general location, e.g. in your backyard or nearby star party.
- You are not using an external computer to control your mount.

Please remember that you must follow the procedures as described in the "Auto-Connect: No" on page 11 during your first session at this location before setting Auto-Connect to YES.

This feature can be activated or de-activated by pressing 2=Setup > 4=Kpd,Mt,Park Opt. Press button 7 to toggle between YES, NO and EXT.

When the keypad is in the Auto-connect:YES mode, all you need to do is connect power and the system will remember the location, date, time, time zone and daylight savings. The Main Menu will appear on the window so that you can go directly to the Objects Menu and enter the desired objects to be viewed.

Mach2GTO and 1100 or 1600 Mounts with absolute encoders: After you have started the mount and are not sure if it is pointing correctly, send the mount HOME . You can locate this function in most menus by pressing the +- button and then press 1=Slew Home. The encoders will send your mount to the home position and recalibrate. This can also be used if you inadvertently do a false recal or sync on an incorrect object that was commanded from any source. You do not need to unplug and start the mount over again. Refer to "Slew Home & Recal" on page 38 for additional information.

Important Point

Meridian Delay

The Meridian Delay is remembered or not from your last session depending if you removed power.

- If you removed power, during the last session, the meridian delay is NOT remembered. When you apply power again, the meridian delay resets to zero. This forces you to set up the meridian delay for each session to prevent unintended consequences.
- If you parked the mount, but did not remove power, the meridian delay setting will still be active when you unpark. Be very careful to remember your settings.

KEYPAD START UP SEQUENCE FOR COMPUTER CONTROLLED MOUNTS

Auto-Connect: EXT is a simplified startup sequence appropriate for mounts that are connected to a computer with telescope control software, which has initialization capability.

Please remember that you must follow the procedures as described in the “Auto-Connect: No” on page 11 during your first session at this location before setting Auto-Connect to EXT.

This feature can be activated or de-activated by pressing 2=Setup > 4=Kpd,Mt,Park Opt. Press button 7 to toggle between YES, NO and EXT. Once Auto-Connect is set to EXT, power cycle the mount (power off, wait 10–15 seconds, then power on) in order to activate this feature.

- 1. Prepare your computer and software.** Ensure that your computer is connected to the mount. The CP4/5 has multiple connection options from which to choose. These choices are detailed in the appropriate manual for your control box. Check your computer’s Device Manager to see which COM port number to choose for the software connection.
- 2. Power up your Mount and the External Startup Window will appear on the keypad.** This window 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 (initialization) process. It will patiently wait for the software connection.
- 3. Connect to your mount in the computer software.** Once you make the software connection to the mount, initialization via the computer will take place and the display on the keypad will change to the Main Menu.

Mach2GTO and 1100 or 1600 Mounts with absolute encoders: After you have started the mount and are not sure if it is pointing correctly, send the mount HOME . You can locate this function in most menus by pressing the +/- button and then press 1=Slew Home. The encoders will send your mount to the home position and recalibrate. This can also be used if you inadvertently do a false recal or sync on an incorrect object that was commanded from any source. You do not need to unplug and start the mount over again. Refer to “Slew Home & Recal” on page 38 for additional information.

Important Points

The Computer Controls the Time.

If you have used the External Startup Sequence, do not attempt to change the time on your keypad. Use the computer program to control the time.

Meridian Delay

The Meridian Delay is remembered or not from your last session depending if you removed power.

- If you removed power, during the last session, the meridian delay is NOT remembered. When you apply power again, the meridian delay resets to zero. This forces you to set up the meridian delay for each session to prevent unintended consequences.
- If you parked the mount, but did not remove power, the meridian delay setting will still be active when you unpark. Be very careful to remember your settings.

OBJECTS MENU – HAVE SOME FUN!

Objects Menu

- **<=Object will display current object.** Press <PREV button. The object data for the last object that was selected for a slew will display.
- **RA/DEC=>** will display actual current RA/Dec and Alt/Az coordinates. When you are in Objects menu, press NEXT>. The RA/Dec coordinates of the exact position of your mount will display. These may be slightly different from the above display since the calculations that compensate for atmospheric refraction and precession will change the coordinates slightly. Also, if you move the mount with the N-S-E-W directional buttons or with a software program such as *TheSky*™, this display window will be updated.
- The remaining selections will guide you as you tour the universe. Many of the selections are described below.

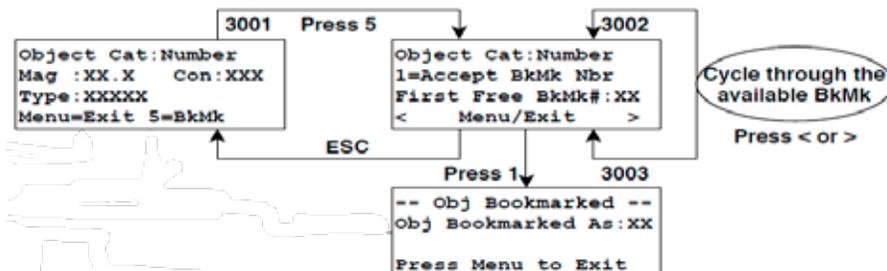
| | |
|------------|----------|
| 1=Objects | 5=S:XXXX |
| 2=Setup | 6=B:XXXX |
| 3=Tools | 7=T:XXXX |
| 4=Time/LST | 8=XXXXXX |

Tips for Using the Buttons and Menus

- **Correcting data entries.** When entering catalog numbers into the keypad, you can use <PREV button to delete the last digit entered. Enter the correct digit. Use NEXT> button to advance forward.
- **Scrolling object lists.** Some of the object selection windows will display < and/or >, usually in the corners. These symbols indicate that you can scroll a list of objects using the <PREV or NEXT> buttons. If you hold these buttons, the object names will scroll quickly in some windows (e.g. stars, common objects).
- **Object Below Horizon.** If the object that you wish to view is not visible, the window will display: Object Below Horizon Altitude -xx. Note that this object might be visible at another time of the night or it may be in the opposite hemisphere. The message does not differentiate.
- **N-S-E-W directional buttons.** The N-S-E-W directional buttons can be used to center your object when you are in the Main Menu, Objects Menu, modeling routines and when the object data windows are displayed. They are not active when you are in object selection windows, e.g. when entering a Messier number or the photographic timer and some setup windows. Remember that you can change your button rate easily by pressing the +- button and pressing <PREV or NEXT> to scroll through the rates.
- **Review object data of catalog items prior to slew.** Enter the number of the object that you are considering, then press NEXT>. The magnitude, object type (galaxy, globular cluster, etc.) and constellation will display. You can press GoTo in this window to initiate a slew, if you wish, or press MENU to exit to make an alternate selection.
- **Display coordinates of catalog object after a slew.** Press <PREV button. The catalog RA and Dec coordinates will display. Press <PREV button again to toggle back to object data. Note that the coordinates of the solar system objects display on the selection window before you slew.
- **Recalibration.** You can recalibrate on current object at any time to fine-tune your calibration. Simply center the object in your eyepiece with the N-S-E-W directional buttons and press the RECAL and NEXT> buttons simultaneously. Listen for the beep to confirm recalibration.
- **Cancel slewing at any time.** Press STOP to cancel a slewing operation. Your telescope will stop immediately. The mount will know where it is, so proceed to the next object using the N-S-E-W buttons or catalog requests described below.

Object Bookmark Tool/Utility

Creating Bookmarks - Adding an Object to the List

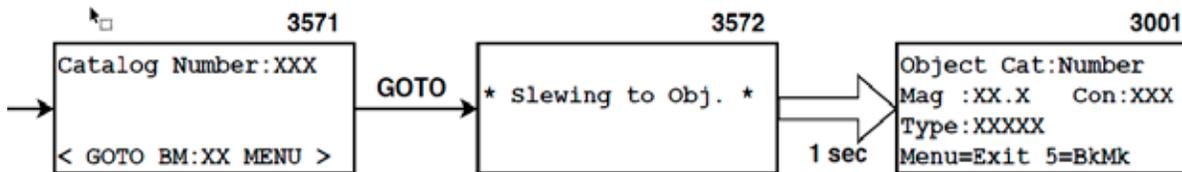


To add an object to the bookmark list, simply GOTO any object. When the mount has successfully slewed to the object,

you can add it to the bookmark list by pressing the BkMk option from the object detail window. The bookmark utility will auto-determine the first FREE bookmark space inside the bookmark list. You can also override this selection by pressing the <PREV' and NEXT> buttons to select the bookmark number you would like to place this object into within the bookmark list.

Most of the object windows will offer this option. You may add up to 50 bookmarks.

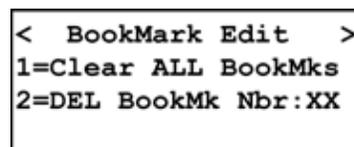
Viewing Your Bookmarked Objects



1. From Objects Menu, choose: 6=More. This will bring you to the More Objects Menu.
2. Choose: 7=Objects Bookmark.
3. The first (or last viewed) object of the bookmark list will display with the catalog name and number.
4. Choices:
 - a) Pressing GOTO will initiate slewing of that object.
 - b) Press NEXT> to view the next object in the bookmark list. You may also press < PREV to see the previous object in the bookmark list.
5. Press MENU to return to More Objects Menu to make an alternate choice.

Delete Bookmarks

1. To Remove/Delete an object from the bookmark list, simply select the tools menu option from the Main Menu.
2. Select 4=BookMark Edit.
3. Selecting desired option:
 - a) 1=Clear all BookMks. This will reset the entire 50 object list to FREE.
 - b) 2=DEL BookMk Nbr:xx where 'xx' equals the last added bookmark used value. Press the '<' or '>' buttons to scroll through the 50 object book mark values which will permit you to delete the object bookmark you specifically wish to delete. When you delete an object's bookmark by pressing 2, the screen will display a single line confirming that the bookmark has been deleted.
4. Press MENU to continue.
5. The numerical position of your remaining bookmarks will remain the same. They will not shift to fill the empty position. When you create your next new bookmark, you will be offered the first available position as shown in screen 3002 above, which may be the one that was just deleted.



M, NGC, IC

These are the most common catalogs used in astronomy and include the brightest and most famous objects including galaxies, diffuse (bright) nebulae, planetary nebulae, globular clusters and open clusters. Many faint objects visible only in larger instruments are included also. A few objects are listed in more than one catalog, so there is some overlap. M (Messier) = 110 objects, NGC (New General Catalog) = 7,840 objects, IC (Index Catalog) = 5,386 objects.

1. Go to Objects menu.
2. Choose M, NGC or IC – press the number that corresponds to your choice (e.g. 1=M).

3. **Enter the catalog number with your keypad.** Look carefully to be sure that the numbers register as you press them.
4. **Choices:** Press GOTO to initiate slewing, NEXT to review object data or MENU to exit.
 - a) After you press NEXT> for object data, you can press <PREV for RA/Dec coordinates. You may also GOTO from that window.
5. **Once you reach the target object, press <PREV to view the RA/Dec coordinates. Press <PREV again to return to the object data.**
6. **Press MENU to return to Objects menu. or 5=BkMk to bookmark for later use.**

```
Messier Number: XXX
Press GOTO for Obj
Press > for Obj-Data
Press Menu for EXIT
```

Common Object Names

This is one of our favorite features. Many of us can't remember the catalog number of an object; however we remember the common name. Use this procedure to view 100 of your favorites.

1. **From Objects menu, select 8=Tour.**
2. **Select 3=Common Obj. Names.** Use <PREV and NEXT> to scroll through list of names that are arranged alphabetically. You may use the <PREV button to scroll backwards through the objects that are at the end of the list first.
3. **Select object.** The window will display the magnitude, type of object and the constellation where it is found.
4. **Choices:** Press GOTO to initiate slewing, <PREV to review RA/Dec coordinates or MENU to exit.
5. **Once you reach the target object, press <PREV to view the RA/Dec coordinates.** Press <PREV again to return to the object data.
6. **Press MENU to return to Objects menu or 5=BkMk to bookmark for future reference.** The catalog number of the object will be remembered, not the common name.

```
Common Names
1=XXXXXXXXXXXX <
2=XXXXXXXXXXXX
3=XXXXXXXXXXXX >
```

Solar System Objects (Sol)

WARNING - Observing during the daytime can be dangerous. Refer to the section entitled "Slewing During the Day" on page 43 for precautions.

All the planets, Pluto, the Moon and the Sun.

1. From Objects menu, select 4=Sol (Solar System).
2. Press the number that corresponds to your choice. The RA/Dec coordinates of the object will display.
3. Press GOTO to initiate slewing or Menu=Exit. If you select GOTO, the mount will slew to the object. If you select the sun or the moon, the tracking rate will automatically change to the solar or lunar rate. Note that the displayed rate in the Main Menu will not indicate these tracking rates.

```
Solar Menu    7=Satn
1=Sun   4=Ven  8=Uran
2=Moon  5=Mars  9=Nept
3=Merc  6=Jupt  0=Plu
```

Common Star Names - Non-scientific

Many of these names are of Arabic origin. Refer to "Appendix C: Alphabetical Star List" on page 53 for the list of stars that we have included. The appendix also shows the Flamsteed-Bayer names and the approximate magnitude of each star.

1. From Objects menu, choose 5=Strs (Stars).
2. Note that the Zenith hour displays in the upper right corner for your reference.
3. Select a star. Scroll the stars list by pressing the <PREV or NEXT> buttons. Hold button down for a more rapid scroll rate. Press the number that corresponds to your choice. Magnitude, constellation and type will display.

4. Choices: Press GOTO to initiate slewing, <PREV to review RA/Dec coordinates or MENU to exit.
5. Once you reach the target object, press <PREV to view the RA/Dec coordinates. Press <PREV again to return to the object data.
6. Once you reach the target star, press <PREV to view the RA/Dec coordinates. Press <PREV again to return to the object data.
7. Press MENU to return to Stars selection window.

```

Choose Star  Z=HH:MM
1=XXXXXXXXXX  <
2=XXXXXXXXXX
3=XXXXXXXXXX  >

```

Greek Star Names, Organized by Constellation

This menu showcases the brightest stars in each constellation.

1. From Objects menu, select 8=Tour.
2. Select 1=Stars/Constell. The display will identify the constellation to which your telescope is pointing and offer choices of stars with Greek names within that constellation. Refer to "Appendix B: Common Stars - By Constellation" on page 49 and "Appendix D: Constellation Abbreviations" on page 58 for the full names of the constellation
 - a) Press 6=Prev Stars or Next=0 to scroll through the list of stars available within the current constellation.
 - b) Use <PREV and NEXT> buttons to scroll through constellation lists. Choose a constellation that is visible.
3. Select a star. Window will display the magnitude of the star.
4. Choices: Press GOTO to initiate the slew, <PREV for RA/Dec coordinates or MENU to exit to the Stars/Constellation menu to make your next selection.

```

< - Const: XXX + >
1=XXXXX  3=XXXXXX
2=XXXXX  4=XXXXXX
6=Prev Stars Next=0

```

Abell Galaxy Clusters

We have included 2,712 of the approximately 4,000 Abell Galaxy Clusters (ACO).

1. From Objects menu, choose 6=More. This will bring you to the More Objects menu.
2. Choose 1=Abell Galaxies.
3. Enter Abell Number. Note that not all Abell Galaxies are in the database.
4. Choices: Press GOTO to initiate slewing, NEXT> to review object data or MENU to exit.
5. Press <PREV for RA/Dec coordinates. You may also GOTO from that window.
6. When you reach the target object, press <PREV to toggle between RA/Dec coordinates and object data.
7. Press MENU to return to More Objects menu to make an alternate choice.

```

1=Abell 2=ADS 3=PAL
4=UGC  5=LBN 6=LDN
7=Object Bookmarks
8=What's Up Now

```

Aitken Double Star Catalog (ADS)

We have included 215 of the most popular double stars in this catalog. Please refer to "Appendix F: Aitken's Double Star (ADS) List" on page 60 for the ADS numbers that we have included and the corresponding Greek star name.

1. From Objects menu, choose 6=More. This will bring you to the More Objects menu.
2. Choose 2=ADS Double Stars. The window will display the name of the constellation to which your telescope is pointed and a list of ADS objects within that constellation.
 - a) Press 6=Prev ADS or Next=0 to scroll through the list of double stars available within the current constellation.
 - b) Use <PREV and NEXT> buttons to scroll through constellation lists. Choose a constellation that is visible.

3. Select a double star. The window will display the approximate separation of the stars, constellation and object type. Select a double star. The window will display the approximate separation of the stars, constellation and object type (Dbl. Star). Remember that apparent separation may vary from year to year. Consult an ephemeris for the most accurate data.
4. Choices: Press GOTO to initiate slewing, <PREV to view RA/Dec coordinates or MENU to exit.
5. When you reach the target object, press <PREV to toggle between RA/Dec coordinates and object data.
6. Press MENU to return to ADS selection window to make additional choices.

Palomar Globular Clusters (PAL)

We have included all 15 of the PAL (Palomer) Globular Clusters.

1. From Objects Menu, choose 6=More. This will bring you to the More Objects Menu.
2. Select 3=PAL.
3. Enter a PAL Number from 1-15.
4. Choices:
 - a) Press GOTO to initiate slewing. .
 - b) Press NEXT> to view the object data, then press GOTO to slew.
 - c) Press <PREV to toggle between RA / Dec. data and object data.
5. Press MENU to return to More Objects Menu to make an alternate choice.

Uppsalla Galaxy Catalog (UGC)

We have included 2,904 of the 12,921 galaxies in the Uppsalla Galaxies catalog. This catalog features galaxies visible from the northern hemisphere .

1. From Objects Menu, choose 6=More. This will bring you to the More Objects Menu.
2. Choose 4=UGC.
3. Enter UGC Number. Note that not all UGC Galaxies are in the database
4. Choices:
 - a) Press GOTO to initiate slewing.
 - b) Press NEXT> to view the object data, then press GOTO to slew.
5. Press <PREV to toggle between RA / Dec. data and object data.
6. Press MENU to return to More Objects Menu to make an alternate choice.

Lynds' Catalog of Bright Nebula (LBN)

We have included all 1,125 of the HII emission nebulae in Beverly Lynds' Bright Nebula catalog. Note that instead of magnitudes, the Keypad will display Lynds' relative brightness scale ranging in whole integer values from 1 (brightest) to 6 (dimmet).

1. From Objects Menu, choose 6=More. This will bring you to the More Objects Menu.
2. Press 5=LBN.
3. Enter LBN Number.

4. Choices:
 - a) Press GOTO to initiate slewing.
 - b) Press NEXT> to view the object data, then press GOTO to slew.
5. Press <PREV to toggle between RA / Dec. data and object data.
6. Press MENU to return to More Objects Menu to make an alternate selection.

Lynds' Catalog of Dark Nebula (LND)

We have included all 1,791 of the dark nebulae in Beverly Lynds' Dark Nebula catalog. Note that instead of magnitudes, the Keypad will display Lynds' relative opacity scale ranging in whole integer values from 1 (lightest / most transparent) to 6 (darkest / most opaque).

1. From Objects Menu, choose 6=More. This will bring you to the More Objects Menu.
2. Choose 6=LDN.
3. Enter LDN Number.
4. Choices:
 - a) Press GOTO to initiate slewing.
 - b) Press NEXT> to view the object data, then press GOTO to slew.
5. Press <PREV to toggle between RA / Dec. data and object data.
6. Press MENU to return to More Objects Menu to make an alternate choice.

What's Up Now?

The What's Up Now feature is great fun when you are out under the stars with no real plan other than exploring at whim. It's also very handy when entertaining others at a star party or at home. You might discover new objects that you would not have thought to view. Follow the instructions below to narrow your search according to the capabilities of your telescope or preferences.

1. From Objects Menu, choose 6=More. This will bring you to the More Objects Menu.
1. Choose 8=What's Up Now
2. Use the keypad to make selections to narrow the range of your search, if you wish.

a) DB (database or catalog) – The default is All Catalogs. Press 1 to toggle between these choices: All Catalogs, Messier, NGC, IC, Abell Gx (Abell Galaxy), ADS Dbl Str (ADS Double Star), PAL Glob. (PAL globular clusters), LBN Diff Neb (LBN Diffuse Nebula) and UGC Gx (UGC Galaxies).

```

What's Up Now?
1=DB   : XXXXXXXXX
2=Type: XXXXXXXXX
3=Mag  : XX  Start=>
  
```

b) Type of object - The default is All. Press 2 to toggle between these options: All, Galaxy, Opn Cluster (Open Cluster), Glob Cluster (Globular Cluster), Planetary (Planetary Nebula), Nebula, Dbl. Star (Double Star). Note that if you select a specific database, the corresponding type will automatically be selected and you will be prevented from selecting an incorrect object type.

c) Magnitude - The default is 18. Press 3 to toggle between 01 to 20 to designate the maximum magnitude that you wish to include in your search. Select this number based on the capability of your telescope to avoid selecting objects that are too dim to view.

3. Press the NEXT> button to initiate the search. The screen will display What's Up? as the keypad searches the database for suitable objects that are above the horizon. The selection will be random and not based on where your telescope is pointing. As a result, you may slew to the other side even though you know there are suitable objects nearby. Just go with the flow and enjoy the surprises that are offered. You might discover something new.

```

What's Up?
Press MENU to Exit
  
```

- a) When an object is found in the database, the object data screen will display indicating the catalog number, magnitude, constellation and type of object. Your choices:

```
Object Cat: Number
Mag :XX.X   Con:XXX
Type: XXXXXXXX
GOTO / Menu=Exit
```

- i) Press GOTO to slew to the object if it interests you.
- ii) Press NEXT> to search for another object.
- iii) Press the PREV< button to display the RA and Dec coordinates.
- iv) Press MENU to Exit to the What's Up Now Menu. Your previous settings will display.

- b) If the keypad search does not find a match, the screen will display Continue Search.. >. Note that this screen may display after only a few searches even when you know there are other objects that meet your criteria. Your choices::

```
Continue Search.. >
Press MENU to Exit
```

- i) Press NEXT> to request another search of the database.
- ii) Press MENU to exit back to the What's Up Now menu screen.

4. Once you have gone to an object and enjoyed the view, press NEXT> again to initiate the next search.
5. You have the option to discontinue this routine throughout the process. When you have finished, press MENU once or twice to exit back to the More Objects menu.

Tour Objects within Constellations

If you are observing within a constellation and want to know what other Messier, NGC or IC objects are nearby, this tour will provide you with lots of observing ideas.

1. From Objects menu, select 8=Tour.
2. Select 2=Objects/Constell. The display will identify the constellation to which your telescope is pointing and offer choices of objects within that constellation.
 - a) Use <PREV and NEXT> buttons to scroll through the alphabetical constellation lists. Choose a constellation that is visible.
 - b) Press 6=Prev or Next=0 to scroll through the list of objects available within the current constellation.
3. Choose an object. Window will display object data including magnitude, object type and the constellation.
4. Press GOTO to to initiate slewing or <PREV to display RA and Dec coordinates.
5. When you reach the target object, press <PREV to toggle between RA/Dec coordinates and object data.
6. When you have finished, press MENU to exit back to the object selection window for the current constellation.

Custom RA and Dec Coordinates

This menu option allows you to slew to any position in the sky as long as you know the RA and Dec coordinates. This feature is particularly handy if you wish to locate comets, super novas, asteroids or any object that is not included in our catalogs.

1. From Objects menu, select 7=R/D. The Custom RA/Dec entry window will appear.
2. Enter RA and Dec coordinates. Press NEXT> to bypass any numbers that you do not wish to change. Press <PREV if you want to back up to correct an error. To change the + or - press the ± button.
3. Press GOTO to initiate slew or Menu=Exit.
4. When the slew is complete, the window will display zero magnitude and state that constellation and type of object is not available. This is to be expected because you are not accessing a catalog. Press <PREV to display the RA/Dec coordinates again.
5. Press MENU to return to the Objects menu.

Important Note: When you enter custom RA and Dec coordinates they should preferably be entered as precessed coordinates (JNow or Topocentric coordinates). The keypad automatically precesses objects in its database, and any prior RECALLS will have been done on precessed coordinates. However, the keypad cannot know the epoch of the coordinates that you are entering, so it only applies the small refraction transformations. Therefore, for accurate pointing, you will want to maintain consistency and enter precessed coordinates.

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 take your dark frame for CCD imaging or observe terrestrial objects with the tracking turned off.

1. From Objects menu, select 9=AlAz. The Custom Alt/Az Entry will appear.
2. Enter Altitude and Azimuth coordinates.
3. Press GOTO to initiate a slew or MENU=Exit. Use <PREV to make corrections. You will now return to the Objects menu.

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 warning will display.

| |
|---|
| <p>WARNING: Looking at or near the SUN can DAMAGE your eyes. GOTO / Menu to Exit</p> |
|---|

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 and Mylar).

MAIN MENU FUNCTIONS

| | |
|------------|----------|
| 1=Objects | 5=S:XXXX |
| 2=Setup | 6=B:XXXX |
| 3=Tools | 7=T:XXXX |
| 4=Time/LST | 8=XXXXXX |

Brightness of the Display Window

Use the <PREV and NEXT> buttons to adjust the brightness of the display to a bright or dim setting.

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 or drape a dark cloth over your head. This is an unfortunate drawback of the vacuum-fluorescent window. 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 Midwestern winter months, we opted for performance.

1=Objects

This is your gateway to all object databases, tour functions and the RA/Dec coordinate entry window. Refer to the Objects Menu section beginning "Objects Menu - Have some Fun!" on page 15 for a complete discussion of the options available.

2=Setup

Refer to the Setup Menu section on page 25 for a complete discussion of the available options.

3=Tools

Tools Menu offers a variety of handy routines to make your observing or imaging session easier and more pleasurable. Refer to page 9 for a complete discussion.

4=Time/LST

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

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 window only. You must go into the Location and Time menu to change the data, time and location.

5=Slew Rate for GoTo Slew Commands

Press 5 on your keypad to change the slew rate that will be used when issuing a GoTo command. Note that the selection changes (toggles) each time you press the button. We recommend that you use slower rates in cold weather.

GTOCP5: 600x, 1000x or 1800x; when using 12V. The maximum rate will be 1200x (but display as 1800x)
GTOCP4 : 600x, 900x or 1200x.

6=Button Rate

Press 6 on your keypad to change the rate that will be used when you press the N-S-E-W buttons. Available rates include: 0.25x, 0.5x, 1x, 12x, 64x, 200x, 600x, or 1200x. Press the 6 button to toggle between these rates. The displayed rate will be active. This rate can also be changed on a display window accessed by the ± button. The keypad buttons are useful for centering an object, cruising over the lunar surface or moving to another part of the sky.

7=Tracking Rate

Press 7 on your keypad to change the tracking rate: Side (Sidereal), King, Cstm (Custom) and Stop. There is no Solar or Lunar rate setting since these will be set automatically when the user slews to the Sun or Moon.

T:Side Brings up the default sidereal tracking rate.

T:King Brings up the variable King rate that compensates the RA tracking for atmospheric refraction.

T:Cstm Brings up the custom rate calculated from Pointing Model data, previously measured by the user and stored in the GTOCP5 control box. Both RA and Dec axes will be driven at the calculated rates. If no data is present then the custom rate will equal the Sidereal rate.

T:Stop Turns RA tracking off.

8=Model Status

Press 8 to toggle through and set the 3 modeling options.

ModOFF Turns off the Pointing, Ortho and Drift models. It does not affect the custom tracking rate.

PntON Turns on the Pointing model and the Ortho model and uses whatever data was measured and stored by the user. It does not affect the Custom Tracking Rate.

DrftOn Replaces the Custom Tracking Rate with the Drift Rate that was measured by the user with the alternate Drift Model routine. It does not turn on the Pointing or Ortho models.

SETUP MENU

```

1=Locations & Time
2=Future Features
3=Set Limits, Power
4=Kpd,Mnt,Park Opt.
    
```

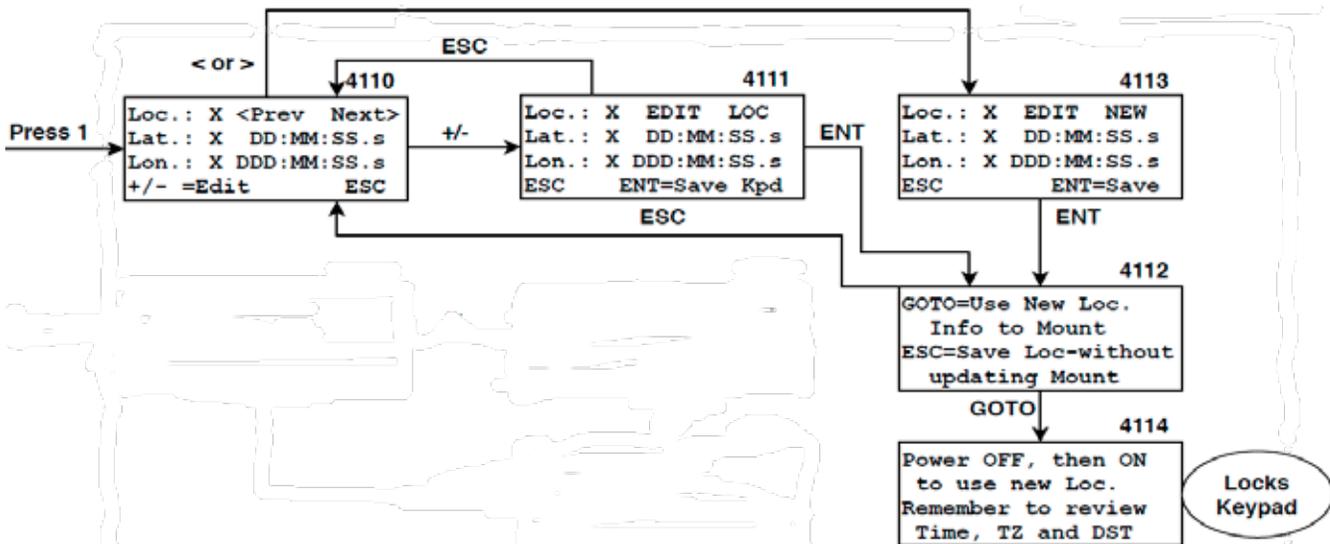
Locations & Time

Press 1 in the Setup Menu to bring up location and time data that can be edited or updated as required. Up to 9 locations can be saved. Time data can be edited or updated from data stored in the mount from an external precise time source such as a computer.

```

1=Site Location Data
2=Set Date & Time
3=Get Loc. frm Mount
4=Get Time frm Mnt
    
```

Site Location Data



Location data must be entered in degrees, minutes and seconds. If your data is in decimal format, refer to the formula on page 26 or, if you have the internet handy, Google it for the conversion. Enter your location as follows:

1. Path: Main Menu > Setup Menu > Locations & Time > 1=Site Location Data.
2. Current location data will display.
3. Either edit this information by pressing the +/- button or use <PREV or NEXT> buttons to scroll to other locations or find an empty location entry field.
4. To edit a location or enter a new location, enter E or W longitude and N or S latitude by pressing the direction buttons. If you make a mistake while entering the data, use the <PREV and NEXT> buttons to move back and fix it. Watch your entry carefully to be sure that all intended numbers are entered in the correct sequence. Note that leading zeros are required. i.e. W 089:08:03.0. Note also that entries have one decimal place that must be filled
5. Press ENT to save the new location or ESC.
 - a) Choose ESC. The values will NOT be saved.
 - b) Choose ENT=Save Keypad. Screen 4112 will appear.
6. Screen 4112 offers two choices .

- a) Choose GOTO. A new window will provide instructions to turn the power off. When you turn the power back on, your session will restart with the Auto-Connect:No routine in order to properly initialize your mount. Remember to review and adjust your time, time zone and daylight savings as required for your new location.
- b) Choose ESC. This selection will save the data for future sessions. It will not be active now. This is handy when you prepare for an upcoming star party.

Convert Your Location Data That is in Decimal Format to Hours, Minutes and Seconds

Many websites and GPS units return your location in a decimal number of Lat and Long.
i.e. 42.3589 Latitude 89.0409 Longitude.

The Keypad's input is in Degrees, Minutes, Seconds.
i.e. 42° 21' 32" Latitude 89° 02' 27" Longitude.

If you were to type the decimal data into your Keypad it would give you an error message. This happens because the decimal number is not equivalent to the Degrees, Minutes, Seconds format. The 5.x Keypad has error checking that will not allow more than 60 minutes or 60 seconds to be entered. It is possible to have inaccurate location data in your mount if none of the minute or second values you entered were over 60.

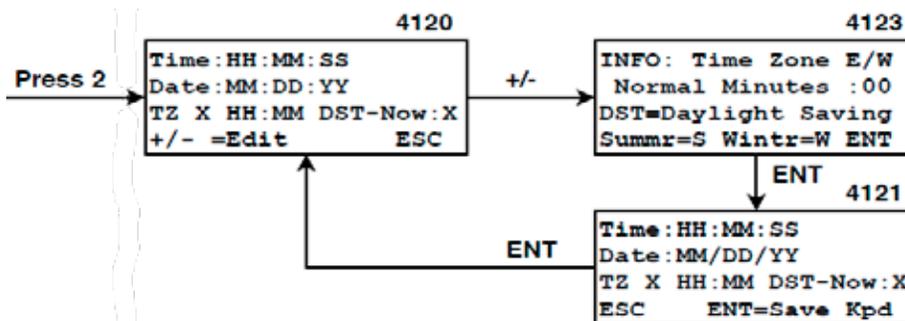
Please double check your location data to make sure you entered it in the correct format.

If you have access to the internet, download the Default IP Address Calculator and Latitude/Longitude Coordinate Converter from our website: https://astro-physics.info/tech_support/mounts/servo/latlong-ip-calculator.html

It is also relatively easy to calculate the conversion. Using the example above:

1. Separate whole degrees from decimal portion: 42° + 0.3589° Lat. and 89° + 0.0409° Long.
2. Multiply the decimal portion times 60. This will give you the minutes:
3. 0.3589 x 60 = 21.534 Minutes Latitude – DO NOT round – use 21'.
4. 0.0409 x 60 = 2.454 Minutes Longitude – DO NOT round – use 02'.
5. Repeat the multiplication with the decimal portion of the minutes calculated in step 2. This will give the seconds:
6. 0.534 x 60 = 32.04 Seconds Latitude – round to 32".
7. 0.454 x 60 = 27.24 Seconds Longitude – round to 27".
8. Combine: Latitude: 42° + 21' + 32" and Longitude: 89° + 02' + 27".

Set Date and Time



1. Path: Main Menu > 2=Setup Menu > 1=Locations & Time > 2=Date & Time. If you only need to make adjustments for Daylight Saving, there is a quick and easy automatic process outlined in the Qwik Daylight Saving Time section on page 27.
2. Date and time information from the mount will display. Consider setting your time to UTC (GMT). Refer to "Setting Keypad to UTC (aka GMT)" on page 28.

Press the +/- button to modify the information. An information screen will display regarding time zones and Daylight Saving abbreviations. Make sure you note the definitions and abbreviations. Press ENT to proceed.

3. **You MUST enter time in 24 hour format.** If you make a mistake while entering the data, use the <PREV and NEXT> keys to move back and fix it. Watch your entry carefully to be sure that all intended numbers are entered.

Please note: Incorrect time settings are a common operator error, particularly when setting up in the evening. You MUST enter the time in 24 hour format! Use the correct local time AND be sure you have the correct time zone and daylight savings setting. Time zone is always standard time and does not change with daylight savings. Daylight savings adjusts the time zone's value by one hour to create the net UTC offset, but it doesn't change the actual time zone..

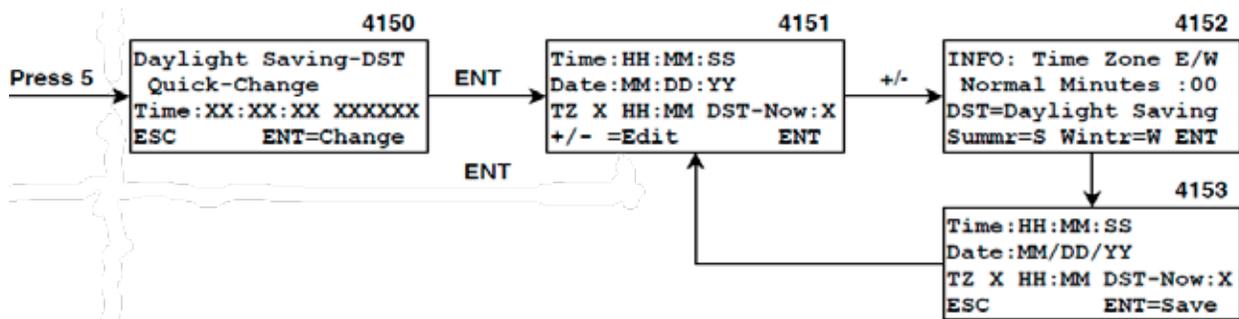
4. Set Time Zone (TZ). Use your actual time zone setting as described above. Do NOT try to fool the keypad by adjusting for Daylight Saving time. Enter E or W to indicate on which side of the Prime Meridian you are located. Enter the time zone in the first two number fields using a leading zero, if appropriate. The minutes fields are for 1/2 and 1/4 hour time zones as found in parts of Australia, the Pacific and Asia. Unless you live in one of those areas, the minutes value should be 00. Time zone information is used to calculate UTC from local time. **UTC is vitally important** because it is used to calculate the meridian as well as altitude and azimuth. Verify UTC from the Main Menu with 4=Time/LST.

Like longitude, time zones are measured from the Prime Meridian. Time zones are entered into the keypad as positive numbers, even though time zone 01 for central Europe is certainly different from time zone 01 for Iceland (2 hours different). The keypad knows the difference because you have entered E or W. Daylight Saving settings allow you to keep the keypad's clock correct with respect to both your current local time and UTC without having to use a fake time zone setting.

5. Set Daylight Saving/Standard Time using the W or S buttons on your keypad..
 - o W= Standard Time, set to W in Winter or if you observe standard time year around.
 - o S= Daylight Saving Time, set to S in summer.
6. Daylight Saving settings allow you to keep the keypad's clock correct with respect to both your current local time and UTC without having to use a fake time zone setting. A good check is to look at the 4=Time/LST window from the main menu.
 - o During normal time (winter) the difference between UTC and your local time should equal your time zone.
 - o During daylight saving time (summer) the difference will be your time zone MINUS 1 hour for western longitudes, and your time zone PLUS 1 hour for eastern time zones.
7. Save new data by pressing the ENT button or revert to the original data with the ESC button (screen 4121).
8. The time has now been updated in the keypad and sent to the mount. Proceed with your session.

Qwik Daylight Saving Time

Version 5 of the keypad features an easy-peezy automated process for the time changes between Daylight Saving Time (DST) and Standard Time (ST). Just a few button presses and you are done.



1. Path: Main Menu > 2=Setup Menu > 1=Locations & Time > 5=QwkDST. The present time and DST setting will display. These characters will flicker since they are continually updating. This is normal.
2. Press ENT=Change. The DST setting will automatically change to the opposite season and the hour will either "Fall back" or "Spring forward" as appropriate.
3. Review the settings and press ENT=Yes to confirm and return to the Locations & Time menu. That's all there is to it.

Setting Keypad to UTC (aka GMT)

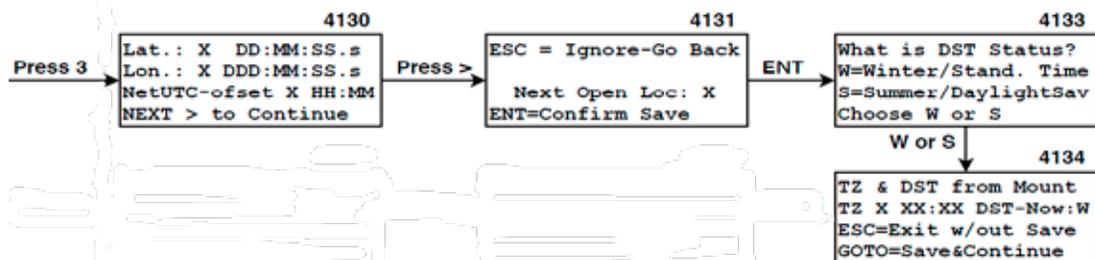
Running everything on UTC is a great way to do things if the laptop is completely dedicated to astronomy endeavors. Professional astronomers all generally set everything including their lives to UTC. **The main thing to remember is that EVERYTHING needs to be set to UTC.** Normal commercial software intended for amateurs will often want to default you to a time zone. Once you have everything set up though, it's awesome.

1. Go to the Date & Time entry window (Main menu > Setup > 1=Locations & Time > 2=Date & Time > +/-=Edit). An information screen will display regarding time zones and Daylight Saving abbreviations. Press ENT to proceed.
2. Set the time to the current UTC time and Time Zone = 00. Daylight Savings must also be set to W=Winter and it will stay W all year round. If you do not know the UTC time, simply search the internet: UTC time.
3. Press ENT to save. The keypad will beep when the values are saved and you will return to the Setup Menu.
4. Press Menu/ESC to go back to the Main Menu
5. Press 4=Time/LST and verify that Local time = UTC
6. DONE!! Don't forget to set your astronomy computer to UTC.

Get Location From Mount

If you are using an external computer to control your telescope, the mount and the keypad could be using different location settings. This command will update the keypad with the last location that was sent to the mount from your computer. This feature is extremely handy for computers synced with GPS units.

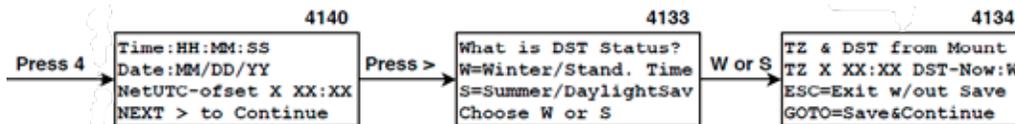
When this feature is selected, a display will appear with the information the keypad has obtained from the mount. If you are using a computer, compare this screen to your computer's settings to be sure they match. If they do not match closely you may need to initialize the mount again from the computer.



1. Go to the Date & Time entry window (Main menu > 2=Setup > 1=Locations & Time > 3=Get Loc. frm Mount). The keypad will query the mount and display the current location data in the CP4/CP5 memory.
2. Review the data and press NEXT> to continue.
3. The next open location slot will display. If you already have location data in 9 slots, the new data will overwrite the data in the 9th slot.
 - a) Press ESC to cancel out of the routine
 - b) Press ENT to confirm saving in the next open slot and proceed to the DST status screen.
4. Enter Your Daylight Saving (DST) status using either the W or S button.
5. Review the Time Zone (TZ) and Daylight Saving (DST) data from the mount to be sure that they are accurate for your present location.
 - a) Press ESC to ignore and cancel out of the change and go back to the Setup Menu.
 - b) Press GOTO to save the location to memory in the designated slot.
6. If you use 3=Get Loc. frm Mount, it is strongly advised that you then use 4=Get Time frm Mnt.

Get Time From Mount

If you are using an external computer to control your telescope, the mount and the keypad could be using different time settings. This command is extremely handy for computers synced with atomic clocks and will sync the keypad with the time that was sent to your mount by the computer. 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's settings to be sure they match.



1. Go to the Date & Time entry window (Main menu > 2=Setup > 1=Locations & Time > 4=Get Time. frm Mnt). The keypad will query the mount and display the current time and date and NetUTC offset that is in the CP4/CP5 memory.
2. Press NEXT > to continue.
3. Enter Your Daylight Saving (DST) status using either the W or S button.
4. Review the Time Zone (TZ) and Daylight Saving (DST) data from the mount to be sure that they are accurate for your present location.
 - a) Press ESC to exit without saving.
 - b) Press GOTO to save and continue.

Future Features

Reserved for future feature updates.

Set Limits, Power

Press 3 in the Setup Menu to bring up mount tracking limits and power settings.

```
1=Limits: XX
2=Power : X
ESC
```

Limits On/Off

Limits can be toggled ON or OFF by pressing 1.

Limits OFF allows the mount to track past the meridian with the scope underneath the mount until the safety hard stop is reached in the Mach2. It also allows the scope to be sent manually under the mount on the east side. Running the mount with limits off must be used with caution, and the user should be monitoring the scope to prevent collision.

With limits ON, the mount stops at counterweight up position. It stops tracking at the meridian. You have several options to track past the meridian:

- Meridian Delay can be used to advance the stop point to allow tracking past the meridian by 1 to 6 hours. Care must be taken to assure that the telescope will clear the pier or tripod when tracking past the meridian. Refer to the information regarding meridian delay on page 40.
- Flip the mount to the other side with the following procedure: Press +/- button . 9=RA/DEC Controls > 4=Flip Scope. Refer to additional information on page 40
- Entering an object a second time and pressing GoTo will also flip sides and continue tracking.

Power HI/MED/LOW - GTOCP5 only

Toggle through three power settings: HI, MED, and LOW.

The HI setting is the normal default setting which produces the full torque on the servo motors for tracking the most unbalanced loads and the heaviest telescope setups without possibility of stalling.

The two lower settings can be used for lighter loads that are well balanced. They are useful where the mount is operated with a battery and where low current consumption is needed. Low setting reduces power approximately 40% from 1.35 amps to 0.9 amps at 12.5 volts battery usage. Slewing power and torque are not affected, only the current consumption during tracking is reduced which is 95% of the power normally drawn from a battery. Power settings are remembered in new sessions.

Kpd, Mnt, Park Opt.

Press 4 in the Setup menu (Main Menu > Setup > Kpd, Mnt, Park Opt.) to bring up six mount park positions, the AutoConnect options and the keypad database update routine.

```
0,1,2,3,4,5=Mnt Park
7=Auto-Connect:XXX
8=Keypad Update
```

Park Options

Simply turn power off: The scope can be left in any orientation and power can be turned off without first parking the mount. The position of the mount will be stored in the CP4/5 and remembered when the mount is powered up again.

Defined park positions: Press 1 thru 5 to send the mount to one of the preset park positions which can be used to orient the telescope for a number of alignment options. Parking the mount turns off the motors but keeps the keypad and CP4/5 controller powered on until the power is turned off. Refer to "Appendix F: Pre-Defined Park Positions" on page 66 for photos illustrating each park position and additional information.

Park 0: Park 0 (Park in Place) is not a predefined park position. Rather, it used to put the mount into a parked state at your

current position. The motors are de-energized, but the keypad and CP4/5 remain powered on until the power is turned off.

Impact of Auto-Connect Settings:

- Auto-Connect set to NO: The mount will not start tracking until you complete the startup routine.
- Auto-Connect set to YES: The mount will begin tracking as soon as power is applied.
- Auto-Connect set to EXT: The mount should be parked and unparked only by the computer, not the keypad in order to utilize the most accurate time information from the computer. Do not park with one and then unpark with the other. This is very important to remember.

GTOCP5 Only:

- Positions 1 thru 5 are fixed encoder positions and do not change with time, date, location or ReCal data. Position 0 parks the mount at any location the user chooses. Position 0 is not saved thru a power cycle to be used again to park at a later time.
- The encoders are used to orient the mount automatically when power is turned back on during the next session. No accuracy is lost and no homing is required when starting a new session.

Auto-Connect

Press 7 in the Kpd, Mnt, Park Opt. window to toggle through: NO, YES, EXT.

AutoConnect NO: At power-up, the location and time/date are displayed and can be edited or updated. Options are to accept the data, edit the data or bring up a new location for initializing this session. Tracking will begin as soon as the mount is initialized. AutoConnect NO should be the default setting for mounts that are frequently moved and do not have a permanent setup.

AutoConnect YES: At power-up, the mount will initialize with the saved location data and use the keypad clock time for initialization of the mount GTOCP5 servo. The keypad will go directly to the Main menu without bringing up the time, date, location data. Tracking will begin as soon as the mount is powered up. This is the preferred method for mounts that are in a permanent location and are not being initialized from external software.

AutoConnect EXT: At power-up, the keypad will not initialize the mount with keypad time, date, location data and will wait until the mount is initialized by external data from a computer or other device. This way the mount can be sent more exact time data from a precision time source on your computer via APCC or the ASCOM driver. Initial pointing accuracy in RA is dependent on sub-second time accuracy since the RA axis position will be off by 15 arc seconds for every 1 second time error upon initialization. For the mount to know exactly where it is pointed in the sky it must have accurate time data at startup.

If super-accurate pointing is required at startup but exact time is not available, then the next best thing is to do a plate solve and ReCal on a known star or star field. APCC Pro has the capability to do plate solves and other pointing functions with available software.

The startup routines for each of these various options were discussed earlier in this manual.

Keypad Database Update

Use this routine only when instructed for a keypad update.

Press 8 in the Kpd, Mnt, Park Opt. window to access the Keypad Upgrade Menu.

Press 1= Load Data Base. Use this to load a new database in the future or reload the database if you replaced your keypad battery. You will not need to go into this menu during the normal use of your mount. If you enter the window by mistake, press the MENU/ESC button to exit.

Press 2=Reset keypad. Use this to reset the location, time, time zone, daylight savings and other user settings to the default zero values. This may be useful if you purchase a used mount and wish to set the parameters yourself. It may also be necessary in certain circumstances for keypad updates.

Refer to "Updating Your Keypad" on page 44 for more information.

TOOLS MENU

```
Tools Menu
2=Modeling
3=Photo Timer
4=Bookmark Tools
```

Modeling

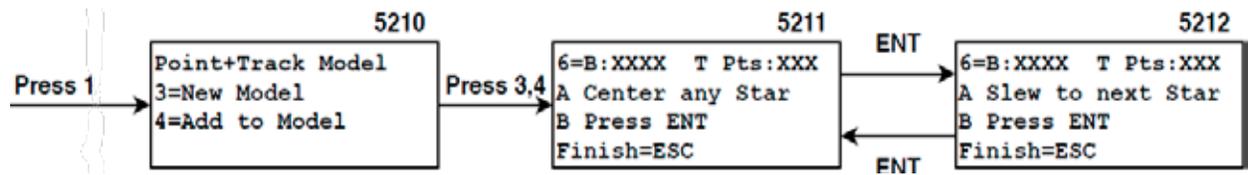
Under Tools Menu there are 3 choices for the GTOCP5: Modeling, PhotoTimer, and Bookmark.

Select 2 = Modeling to bring up 3 modeling choices - Point&Track, Drift and Ortho models. Depending on the setup and software available, the user can employ the Drift and Ortho routines with just the keypad or the full Point + Track model for all-sky modeling.

```
1=Point+Track Model
2=Drift Model
3=Ortho Model
ESC
```

Point + Track Model

Point + Track model can be used for both precision pointing and for precise tracking of an object's path across the sky for unguided imaging. The model can store up to 8 data points along a series of 16 declination lines on both sides of the meridian. It is easiest to do this with an external planetarium program where the user simply slews to any number of stars whose positions are precisely known. Then using a crosshair, the star is simply centered exactly and the data is entered into the control box memory. Once enough data points are stored, the model can be turned on for precise pointing, and the tracking rate can be set to Custom for precise tracking over time. It is not necessary to be precisely polar aligned for the pointing and tracking to be improved with modeling. However, the more precise the polar alignment, the more precise the model will be for long time exposures.



The upper right corner of window 5211 displays the number of data points that have been added for any particular Dec line. A new declination data line is created when a star is entered 10 degrees from the original. Dec lines are created at 10 degree intervals from -90 to +90 degrees. Each Dec line is a corridor that includes any star that is within 5 degrees of the first one. Up to 8 stars can be measured and entered as data points on any one of 16 declination lines in the model. The first declination line will have numbers from 1 to 8. The second Dec line will have numbers from 11 to 18, the third will have numbers from 21 to 28 and so on. As an example, a number 64 means that the 7th Dec line has 4 data points in it, and the user can add 4 more before that line is full.

Pointing Model

The easiest way to do the modeling is to follow one declination line on your planetarium program. For example, you could pick several stars near Declination +30 Deg that are within the +- 5 degree envelope. A star at +26 Dec and a star at +33 Dec would be sorted into the 30 degree corridor. A star at +36 degrees would be sorted into the +40 degree corridor and would therefore be registered as the first star in the second Dec line. All stars' motions and positions would be calculated properly according to their actual RA and Dec coordinates and proper offsets be applied, even if they are not exactly on the actual Dec center line.

The east and west models are independent. All mapped points are remembered through power cycles, available for correction in subsequent sessions, until you create a new model.

Pointing

For good pointing over the entire sky, a minimum of 3 stars are needed for each Dec. line on both sides of the meridian. Start a model run by choosing a reference star near the zenith after centering and doing a Recal (Sync) on it.

Creating a custom tracking model

You can create a tracking model for any object by creating a path that the object will follow across the sky. You only need to model 8 points on the declination line that the object is on. The 8 stars chosen for the model will need to be on the same declination within +/- 20 arc minutes of each other (the closer the better). The stars do not need to be on the exact declination of the object. They can be within +/- 5 degrees of the object, but within +/- 20 arc minutes of each other. The easiest way to create an exact path is to do a plate solve and center for each data point.

The alternative is to measure the exact drift for 8 points along the object's declination line (see Drift Model).

To create a model:

- 1. Open your planetarium program.** Identify a declination line in the area of the sky you wish to model.
- 2. On your keypad, select Point + Track Model (Main Menu > 3=Tools > 2=Modeling).**
- 3. Select 3=New Model if you have not created a model previously.** Window 5211 will appear. The upper right will read "T Pts:000" since you do not have any points in your model when you start.
- 4. In your planetarium program, select a star along your target declination line and slew to it.**
- 5. Image and download for evaluation.**
- 6. Set your button rate by toggling 6 and center your target star.** The lower rates of 1x to 12x can be used to quickly center a star on the crosshair, and the lowest rates of .25x and .5x can be used for very fine adjustment of the centering.

Pro Tip: set your camera on continuous (slow video mode) with your program in order to continuously update 1 per second. This will allow you to see your adjustments quickly.
- 7. Press RECAL or Sync on your planetarium program.**
- 8. Press ENT once the star is centered.**
- 9. Refer to your planetarium program and find another star near the declination line and repeat the process above.** The model can store up to 8 data points along a series of 16 declination lines on both sides of the meridian. The T Pts:xxx display in the upper right corner of your window will help you keep track of the number of points you have acquired as mentioned above.
- 10. If you wish to add points to your model, return to window 5210 and select 4=Add to Model and repeat.**
- 11. Once you have enough points, press MENU/ESC to finish.**
- 12. Return to the Main Menu and select 8=PntON to apply your model and set the tracking rate to 7=T:Cstm.**

Error Codes

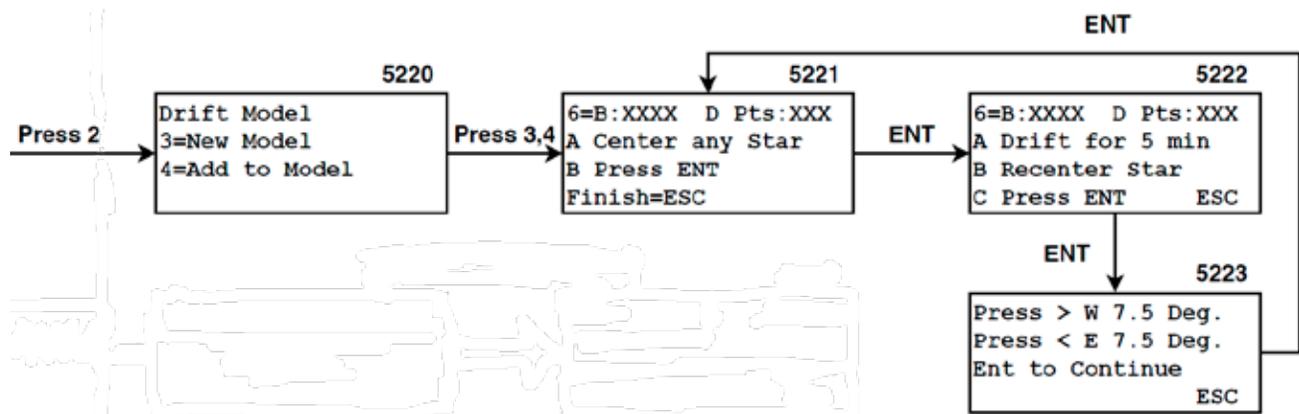
- DEC Line Full: All 8 points of the constant-DEC line have already been mapped.
- No DEC Lines Avail: All constant-DEC lines are already populated.
- Not Tracking: Mount is not in tracking mode and cannot map.
- Sequence Error: Already in mapping mode.
- Model Disabled: Modeling unavailable in this unit.

Drift Model

The Drift model is an alternate way to measure an object's path through the sky and then use it to compensate for drift for unguided imaging. It does not require any external planetarium software - it is a self-contained keypad routine. This model allows the user to build a tracking path for any object as it moves across the sky for a number of hours from East to West. The model measures the drift of stars along the constant declination of the object and applies the proper tracking rate in both RA and Dec axes to keep the object centered and not drifting for typical exposures of between 5 to 20 minutes.

The key is to measure the drift very accurately at several points along the path, starting with the object and moving West at several intervals. One simply does a GoTo slew to the object to be imaged, centers the object and takes a quick image to display some stars. You then pick any star, draw a small focus box around it (with crosshairs enabled) and begin a fast continuous download of the image. Magnify the image on the screen to perhaps 800x and center the star on the crosshair using the N-S-E-W buttons at the appropriate centering rate (.5x or .25x is recommended).

Up to 8 data points on each side of the meridian can be stored at the object's declination. New object paths at different declinations can be measured as desired and simply added to the existing data. As long as the mount is not disturbed or moved, the data will be valid for future imaging sessions.



The upper right corner of window 5221 displays the number of data points that have been added for any particular Dec line. A new declination data line is created when a star is entered 10 degrees from the original. Dec lines are created at 10 degree intervals from -90 to +90 degrees. Each Dec line is a corridor that includes any star that is within 5 degrees of the first one. Up to 8 stars can be measured and entered as data points on any one of 16 declination lines in the model. The first declination line will have numbers from 1 to 8. The second Dec line will have numbers from 11 to 18, the third will have numbers from 21 to 28 and so on. As an example, a number 64 means that the 7th Dec line has 4 data points in it, and the user can add 4 more before that line is full

The east and west models are independent. All mapped points are remembered through power cycles, available for correction in subsequent sessions, until you create a new model.

1. **Go to Drift Model window.** (Main Menu > 3=Tools > 2=Modeling).
2. **Select 3=New Model if you have not created a model previously.** Window 5221 will appear. The upper right will read " D Pts:000" since you do not have any points in your model when you start.
3. **Set your button rate (toggle 6), center a star near the object you wish to image and press ENT.** Window 5222 will display.
4. **Allow some time to pass in order for drift to occur.** The keypad window suggests 5 minutes, but the time can be less - at least 10 seconds.
5. **Check your crosshair and recenter the star with your keypad buttons.** If your camera can be put on video mode, this may facilitate quick centering.
6. **Press ENT.** This will register the drift measurement data at that point. Window 5223 will appear.
7. **Press < or > to command the mount to move E or W in RA by 7.5 degrees (1/2 hour).** Press the West button (> button) to move 1/2 hour, or press it again to move 1 hour. Each press of the button moves the mount by an additional 1/2 hour. It is recommended to move the mount by 1/2 hour if you are below about 45 degrees altitude, where the drift changes quickly. Above that altitude the drift is more regular and you can begin each point at 1 hour intervals. Generally it takes only 3 points above 45 degrees altitude and perhaps 3 - 4 points for locations between 0 and 45 degrees.
8. **Press ENT.** The mount will slew in the commanded direction.

9. **Find another star in the new field, center it and press ENT.** You have just selected your second point.
10. **Allow the mount to drift again and repeat the above procedure for as many points as you wish.** If you plan to image 1/2 to 1 hr, two points may be enough, one point near the object and the 2nd point 1 hr west of the object.
11. **Once you have enough points, select Finish=ESC.**
12. **Return to the Main Menu and select 8=DrftON to apply your model. At that point the mount begins to apply the drift terms and adjusts the RA/Dec rates accordingly. If you want to see what they are, press ENT in the Main Menu and the display will show the RA and Dec drift rates in arc seconds per hour. Now re-enter the object and press GoTo to begin your imaging session.**
13. **If you wish to add points to your model at a later time,** return to window 5220 and select 4=Add to Model. Points can be added at a later date and later session as long as the scope and mount have not been moved.

Pro Tip: Do your modeling before dark using an H-a filter to suppress the sky background and pick a bright star somewhere in the field along the declination of the object. You can generally be done in the hour during twilight before it gets dark enough for imaging. Stars of up to mag 5 can be imaged even before the sun has fully set if the sky is cloud and haze free.

If you don't move the mount and scope between imaging sessions, the model will be accurate for any length of time between sessions. The model will take into account drift due to polar misalignment, atmospheric refraction as well as minor drift due to instrument flexure (if repeatable). If you wish to add another object at a future time, you can use the Add Model routine instead of creating an entire new model. That new object can be anywhere in the sky at any declination.

If you model on a night of very high atmospheric pressure and then image on a night of low pressure, the measured refraction drift rate may be different. The model will not fully apply and you may be limited in exposure time before drift is detected in the image. Typically imaging times of 5 to 10 minutes will not be affected if the object is within +/- 2 hours of the zenith.

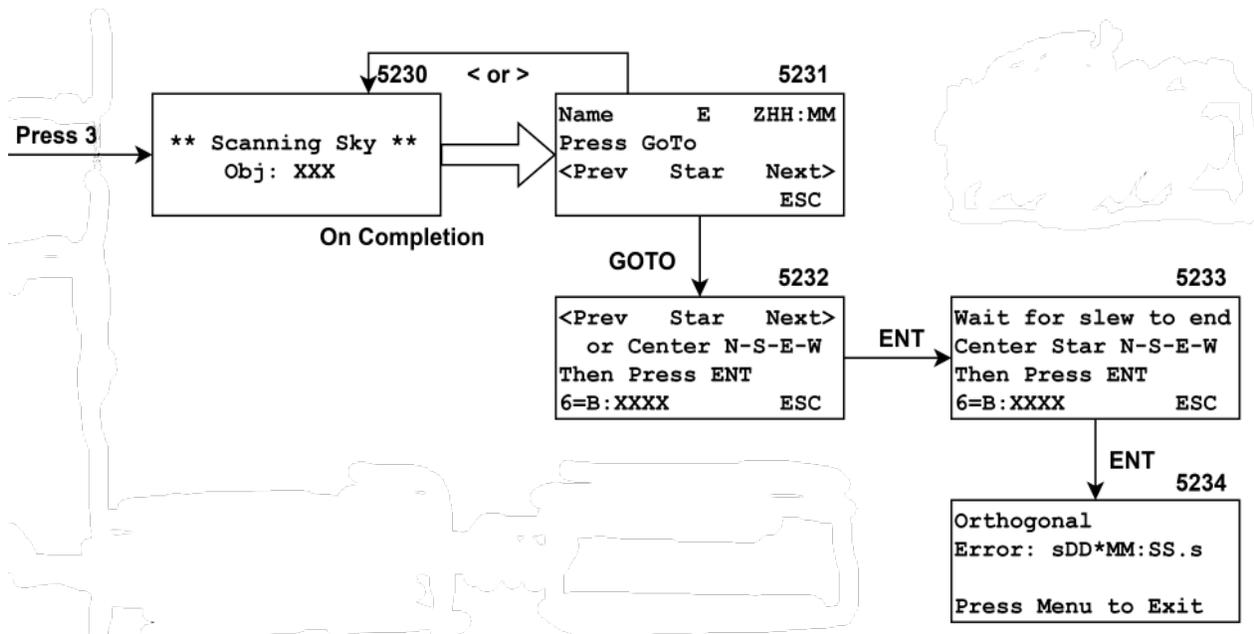
This model is limited in scope, and if longer time exposures are needed or imaging with long focal lengths, we have a very extensive method using APCC-Pro with APPM that can take variable refraction into account as well as other factors.

Error Codes

- DEC Line Full: All 8 points of the constant-DEC line have already been mapped.
- No DEC Lines Avail: All constant-DEC lines are already populated.
- Not Tracking: Mount is not in tracking mode and cannot map.
- Sequence Error: Already in mapping mode.
- Time Too Short: Didn't track long enough to get good data (currently at least 10 seconds is required).
- Excessive Drift: Amount of measured drift is way too large, i.e. did a large slew in the middle of the drift measurement.
- Model Disabled: Modeling unavailable in this unit.

Ortho Model

The Ortho routine uses the stars in the keypad to compensate for telescope non-orthogonality. It is an automatic routine that simply requires the user to start it going and to center the star at the keypad prompt. The Ortho model can be used by itself or in conjunction with the pointing model to form an all-sky model.



1. Go to the Tools Menu window (Main Menu > 3=Tools)
2. Press 3=Ortho Model and the keypad will scan the database and display the name of a star within one hour of the meridian line. You can either press GoTo or send the scope to that star or use < or > buttons to select another star from the keypad database and press GoTo.
3. Once the scope has reached the star's position, center it in your crosshair (eyepiece or digital image on your computer window) and press ENT. Use button 6 to set the appropriate button rate.
4. The mount will flip sides and do a safety slew to pick up the star on the opposite side.
5. Simply center the star again and press ENT.
6. The window will show the orthogonal error and the GTOCP5 will apply this every time you switch sides.
7. To activate, return to the Main Menu and toggle button 8 to read 8=ModOn.:

Track Status

When you are in the main menu, press the ENT button to view the RA and Dec trim rates that are being applied to your track rate based on the model you created. You must have activated the model in order to see the numbers (Main Menu > 8=ModOn.:

```
Track Status
RA Trim = X
DEC Trim = X
Arcsec per hr ESC
```

Photographic Timer

Activate the countdown photographic timer to remind you when your exposure is completed. An audible beep will alert you that the time has expired.

1. **Go to Photographic Timer window.** (Main Menu > 3=Tools > 3=Photo Timer). The Photographic Timer window will appear.
2. **Enter hours, minutes and seconds.** The timer will activate and begin recording in 10 seconds..
3. **When the timer reaches 0, a series of audible beeps will sound.** The display will begin to show negative numbers to let you know the time that has elapsed since the timer went off.
4. **Press MENU to cancel timer at any time.**

```
Photographic Timer
Enter hh:mm:ss now
Timer: HH:MM:SS
Menu=EXIT      ENT
```

```
TIMER: HH:MM:SS
```

```
Press MENU to Exit
```

Bookmark Edit

1. Go to the Bookmark Edit window (Main Menu > 3=Tools > 4=Bookmark Edit).
2. You have several options:
 - a) Press 1 to clear all bookmarks.
 - b) Press < or > to scroll through bookmarks until you find the one you want to delete. Note that only the bookmark number will display, so you have to know what object that bookmark represents in order to make your selection.
 - c) Press 2 to clear the chosen bookmark.
 - d) Press MENU/ESC to exit.
 - e) Refer to "Object Bookmark Tool/Utility" on page 15 for a more complete discussion of the Bookmark feature.

```
<  BookMark Edit  >
1=Clear ALL BookMks
2=DEL BookMk Nbr:XX
```

+ - BUTTON, HIDDEN TREASURES



Edit Function

When entering your location and time information, you will be offered the opportunity to edit the existing data or use it to toggle between + and - when entering RA and Dec coordinates. Simply press the button and make your changes.

Button Rate

Press the +- button to adjust the rate when you are in the Main Menu, Objects Menu or object data menus. Scroll through the rates with the <PREV or NEXT> buttons. Other menu locations will lock out the +- button.

Slew Home & Recal

Press 1=Slew Home & Recal and the mount will immediately slew to the home position and recalibrate on that position.

Use this command if you are not sure if your mount is pointing correctly. This can occur if you have inadvertently recalibrated or synced on an incorrect object. The home position was preset at Astro-Physics at the park 3 position. The encoders know that position in all circumstances.

HOME POSITION *(Mach2GTO / GTOCP5)*

Northern Hemisphere & Southern Hemisphere



This is a very special position that is established by Astro-Physics when programming the Absolute Encoders. It is highly precise.

Park Controls

Select 4=Park Controls to reveal the following options that are discussed fully in “Kpd, Mnt, Park Opt.” on page 30:

- Park Controls
- Auto-Connect
- Keypad Update

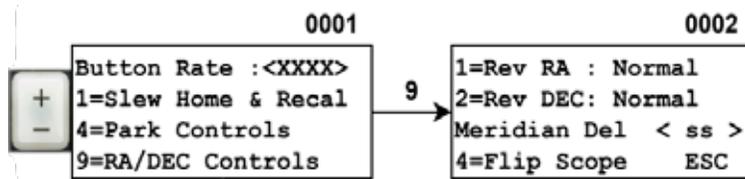
RA/Dec Controls

Select 9=RA/Dec Controls for these options:

- RA/Dec Reverse. The +- button gives quick access to this handy feature. Refer to page 39 to learn why this is so handy.
 - RA: Button 1 toggles between Normal and Reversed
 - Dec: Button 2 toggles between Normal and Reversed
- Meridian Delay. Refer to “Meridian Delay Setting” on page 40 for detailed information.
- Flip Scope. Refer to “Flip Scope” on page 40 to learn about this handy feature.

FEATURE DISCUSSION

RA/Dec Reverse



If your object moves down when you push the “N” button or left when you push the “E” button, press the +- button. Select 1 and/or 2 to correct the apparent motion. If you want to reverse direction of the “N” and “S” button, press 1 and the display will toggle from Normal to Reversed. You can make the same adjustment with the “E” and “W” buttons by toggling number 2. When properly set up, the direction buttons will cause the object to move according to your orientation at the eyepiece.

Tweak Your Pointing Accuracy

If you slew to an object and it is not in the center of your eyepiece, you have several options.

Recalibrate

Recalibrate is used to correct the calibration of the mount if an object that you just slewed to does not appear in the center of the field. Recalibrate can be used even when the object is past the meridian and the telescope is below the mount.

Simply press the RECAL and NEXT> buttons simultaneously to recalibrate on your object. The keypad will beep to confirm that the command has been issued.

In the GTOCP4/5, you can send the mount to an object via a GoTo slew using an external planetarium program, then center and recalibrate using the keypad.

NOTE: You can only use the recalibration option if the keypad has the target object in its memory, i.e. you just gave a slew command via the keypad or external program and the keypad already knows it should be at that object. You CANNOT use this option if you manually move the telescope to another position, since the keypad would have no way of knowing what that object is.

Orthogonality Model

This feature is available for all GTOCP5 control boxes and only those GTOCP4 control boxes that have this feature enabled by Astro-Physics.

If orthogonality issues are affecting your pointing accuracy, use the extremely quick and easy “Ortho Model” on page 36. For a discussion of factors that cause orthogonality issues, see “Orthogonality” on page 42

Alternatively, you can use a smart strategy to compensate. Organize your observing around one or several regions of sky. The regions can be on opposite sides of the meridian, but slews within the region should not require you to cross the meridian. When you finish a region, slew to a bright star in the next region and recalibrate (RECAL + NEXT>). As long as you are not swapping sides by crossing the meridian, you should be able to slew to objects within a reasonable radius of your calibration star with satisfactory accuracy. The useful radius will simply depend on the degree to which your system is not orthogonal, but you should be able to observe in a radius of 20 to 30 degrees before recalibrating.

Pointing Models

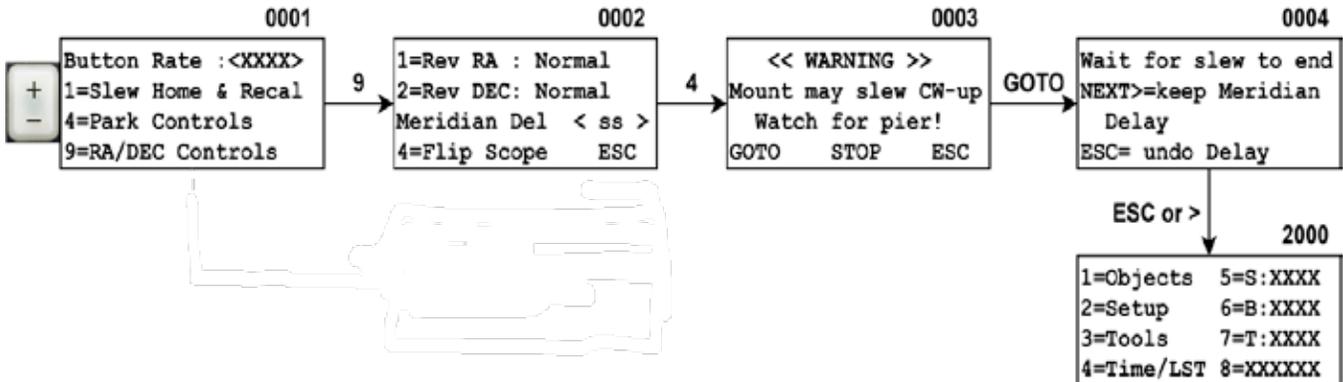
This feature is available for all GTOCP5 control boxes and only those GTOCP4 control boxes that have this feature enabled by Astro-Physics.

There are two pointing model options available in the keypad. The Pointing + Tracking Model can be used if you have a planetarium program available and the Drift Model can be used if you rely solely on the keypad. Check out the information in the corresponding sections beginning on page 32.

Meridian Delay Options

Flip Scope

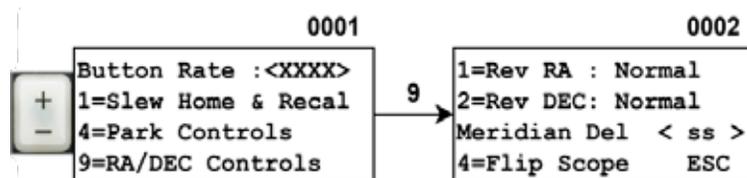
The Flip Scope routine is an alternative way to achieve meridian delay and is easier to accomplish than the Meridian Delay Setting described below.



Path to this function: +- Button > 9=RA/DEC Controls > 4=Flip Scope

1. Press 4= Flip Scope and a warning window will appear as shown in screen 0003 above.
2. Visually check the position of your telescope to determine if there is a chance it could strike the pier when it flips to the other side of the mount. Press ESC if you think there is a chance that the movement will not be successful.
3. Press GOTO to initiate the flip. Keep you finger near the Stop button just in case you need to halt the movement.
4. After the slew is complete, press NEXT> to keep the meridian delay or ESC to undo the delay. The mount will not slew. You must initiate another flip to go back to the other side.

Meridian Delay Setting



Path to this function: +- Button > 9=RA/DEC Controls > Meridian Del

This feature should be used with caution to prevent accidental telescope contact with the pier.

In normal use without any delay, the telescope will track through the meridian when you are following an object. However, when you enter the object again, or if you enter a nearby object that has drifted past the meridian and then slew, the telescope automatically switches sides so that the scope will be right side up instead of diving under the mount. Sometimes, for astro-imaging, you may wish to delay the meridian swap, especially if you are imaging mosaics and the area is beginning to drift across the meridian.

Remember, it is the GoTo slew that will flip the mount...not tracking!

To delay the swap, follow the path above from the +/- button to the Meridian Del setting. Note that this is normally set to zero. Use the <PREV and NEXT> buttons to enter a 1 hour to 6 hour delay or advance of the meridian swap. A setting of 1W means that the scope will continue to slew to objects up to 1 hour past the meridian in the west. It effectively delays the meridian swap by 1 hour. A 6 hour delay means the scope will slew all the way to the horizon on the wrong side of the mount. Entering a 1E means that the scope can be placed on the other side of the mount by 1 hour earlier than normal.

**Mnemonic devices: E will flip the mount early and W will wait to flip! ...or...
E will move the meridian east and W will move the meridian west.**

As a general rule, objects on the pole side of your zenith are poor choices for using the meridian delay. When the telescope is pointed at an object on the pole side, the back of the instrument can hit the pier if you go past the meridian. Objects away from the pole (south if you are in the north and north if you are in the south) are less likely to be a problem. You can see this quite easily by loosening your clutches and swinging your telescope around your mount. Point your scope at various points in the sky along a north / south line and then see how far you can swing the RA past the meridian before striking the pier. In so doing, you can learn a range of safe declination values and meridian delay parameters for your location and particular setup.

When you turn the power off, the meridian hour offset will return to the default setting of 0W. You will have to make a conscious decision to change it during each observing session. If you are permanently mounted and leave your power on after parking, be sure to remember that you have made this setting. We encourage you to return to 0W at the end of your observing session.

Note to programmers: The meridian delay is accomplished by sending a time to the mount that is from 1 to 6 hours different than the clock time. 6 hours plus delays the meridian to the east; 6 hours minus delays the meridian to the west. So, if you want to delay the meridian from your computer terminal, just send the revised time to the servo drive per the AP protocol. **Caution:** If you park the mount with this fake time and turn off the power, then unpark later, the mount will point at the wrong RA. It will be off by the amount you faked. If you are going to send a fake time to the mount with your computer, then make sure you reset to the correct time before you park the mount and turn off the power.

ORTHOGONALITY

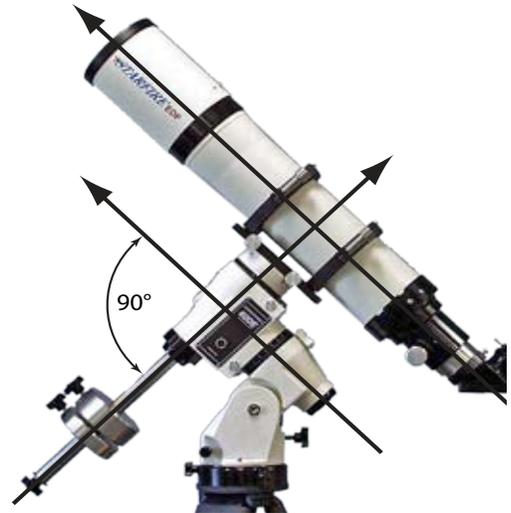
This feature is available for all GTOCP5 control boxes and only those GTOCP4 control boxes that have this feature enabled by Astro-Physics.

Version 5 of the keypad program includes the Ortho Model routine to correct for orthogonal error. This section provides an explanation of orthogonal error and outlines common causes.

A telescope is said to be orthogonal when its optical axis is exactly 90 degrees from the declination axis as shown in the photo. In Alt-Az fork mounts, orthogonality is not an issue. Pointing is straightforward, the scope never has to flip sides and the mount does not need to be polar-aligned. However, in German equatorial mounts, a non-orthogonal telescope will cause errors in any routine that will reduce the pointing accuracy of the system by exactly twice the orthogonal error.

Telescope orthogonality requires that two conditions be met:

1. The RA and Dec axes of the mount are at precise right angles to each other. Astro-Physics mounts are very accurately machined and fulfil this condition.
2. The optical axis of the telescope must be parallel to the RA (polar) axis. Some of the factors which could affect this condition include:
 - a) Improperly machined rings.
 - b) Wedge in the mounting plate or brackets.
 - c) Incorrect position and tilt of a diagonal mirror or diagonal assembly that is not machined square.
 - d) Set screws in focusers, diagonals or adapters which tilt the optical axis.
 - e) Die-cast tube assemblies that lack the precision squareness of a CNC machined part. The tube points in one direction while the optics can point several degrees off in another direction.
 - f) Diagonal displacement or tilt in a Newtonian.
 - g) Mirror shift in a catadioptric. The optics are not tied down to a reference plane, but can move around and point in different directions depending on focus position.
 - h) Collimation adjustment. There is enough freedom in the tilt of a secondary mirror to allow the image to be moved completely out of the eyepiece field. Therefore, collimating the scope may disturb or change orthogonality.



Whatever the reason, the Ortho Model routine will calculate the orthogonal error and compensate for it as you slew from one object to another. Refer to page 36 for more information.

SLEWING DURING THE DAY

You must take extra precautions when observing during the daytime. If not done correctly, you may suffer permanent damage to your eyesight. Be sure to supervise all children and other observers who may not be aware of the dangers.

Observing in the daytime offers many rewards – finding the planets and stars, and observing sunspots and solar prominences of the sun itself.

Potential Dangers

- As the telescope is slewing from one part of the sky to another, it may pass across the face of the sun or near enough so that looking through the telescope would be dangerous unless you have a proper solar filter. **DO NOT LOOK DIRECTLY INTO THE TELESCOPE OR VIEWFINDER WHILE THE TELESCOPE IS SLEWING.**
- The position of the planet or star that you wish to see may be too close to the sun to observe safely. **CHECK THE POSITION OF THE TELESCOPE BEFORE YOU LOOK INTO THE EYEPIECE OR VIEWFINDER. BE SURE THAT IT IS NOT POINTING AT OR ANYWHERE NEAR THE SUN.** Remember that the finder has a wide field of view so you can see a large portion of the sky.
- **PLEASE DO NOT OVERRIDE THE SUN SAFE ZONE DURING THE DAY.** This feature is in the keypad for your safety.
- Observing the sun. Be sure that you have installed a good quality **SAFE** solar 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). If you use a photographic solar filter, be sure to use an additional neutral-density filter when viewing through an eyepiece or the viewfinder of your camera.

How to Observe Safely

1. Place dust cover or proper solar filters on the main objective of the telescope and the finder scope before you slew the telescope, use the N-S-E-W directional buttons or move it manually. Be sure to inspect your solar filter beforehand to be sure that it is not damaged in any way that will allow light through. Use a black marker to cover pinholes that may appear in the coating.
2. Slew or move the telescope.
3. Visually check the position of the telescope to be sure that it is not pointing at or anywhere near the sun.
4. If you are observing planets, the moon or stars – remove the dust cover or filter only when you are sure that it is safe.
5. To observe the sun – **ALWAYS** leave your solar filter in place over the front of the objective and finder.
6. Put the solar filters or dust covers back on the telescope before slewing to the next object.

UPDATING YOUR KEYPAD

Keypad updates will be available periodically through the Software Updates tab on our website. The keypad loader program is Java-based and can be used on Windows, Mac and Linux operating systems. Follow the directions available from the website to complete the load process.

There are two parts of the keypad software.

- Program Load. The software program for the function/features that send the commands to the control box. These new versions will add new features and fix bugs.
- Database Load: The second part controls the object databases (names, RA/Dec coordinates, magnitudes, constellations, etc). New databases may be issued in the future or you may need to reload your database if your keypad battery loses power. When the battery fails (average 5–6 years), then the database will need to be downloaded and reinstalled.

TROUBLESHOOTING

The Keypad displayed the message “motor stall.”

This error message indicates that the Keypad and servo box are unable to communicate with each other and the LED on the control box will also turn yellow indicating that the overload protection feature has been activated. Here are some possible causes to check:

- Your telescope is not balanced properly. Refer to your mount manual for guidance.
- The motors are not connected to the servo box. Be sure all connectors are locked in place.
- A wire connection in one of the mount cables is broken.
- One of the motors is not functioning.
- The mesh of the worm gear and worm wheel is too tight. This will cause the motors to overload, which will cause the overload protection feature of the control box to activate and shut down the signal to the motors.
- The microprocessor chip, which contains the program logic, is missing from the servo box.
- All mounts except the Mach2GTO: One of the small gears in the motor box is jammed.
- Foreign material got into the motor gearbox.

Solution:

Check all possibilities above and correct, if possible. To initiate tracking again, press the N-S-E-W buttons, initiate a slew or go to Main Menu and press “0” Status (if you still get an error message, press the button a second time, just to be sure that the buffer cleared). If you have not moved the telescope while diagnosing the problem, the position will still be in memory and you can continue as if nothing ever happened.

If the “motor stall” message appears again, you have not corrected the cause of the problem. If you are unable to resolve it, check the technical support section of our website before contacting Astro-Physics. Additional troubleshooting and adjustment information will be posted there in the future.

The Keypad display says “low battery.”

Your battery output has dropped below 11 volts. If you plug in your Kendrick heater, CCD camera or other power-hungry device into the same battery that operates your mount, your battery voltage will drop momentarily. We recommend that you power your mount from a separate battery. You might consider a large marine battery. If 110V is available, we recommend that you use a power supply (filtered and regulated) with a minimum output of 5 amps at 12V DC. DO NOT use a wall-transformer.

The Keypad locks up on the “Astro-Physics” window and will not advance to the next window.

There are several conditions that may cause this to occur.

- Battery power has dropped. If you measure the output of your battery to be above 11.5V, but the Keypad is locking up, please contact Astro-Physics. If your battery measures below 11.5V, recharge or replace your battery.
- Recent lightning strike or power surge damaged components in the control box. The control box will have to be returned to Astro-Physics. Please call ahead for a return authorization number.
- Other unknown chip failure in the control box. Contact Astro-Physics.
- Keypad locks up in cold weather but works fine when used in warmer temperatures. This is a rare problem caused by a defective real-time clock in the Keypad. Contact Astro-Physics.
- Corroded circuit board in the Keypad.

The Keypad display text blinks on and off, but there is no clicking sound.

- Battery power has dropped below the required threshold. If you measure the output of your battery to be above 11.5V, but the Keypad is still blinking on and off, please contact Astro-Physics. If your battery measures below 11.5V, recharge or replace your battery.

The Keypad is resetting – making a clicking sound as the window display disappears and reappears

- If Auto-Connect had been set to “NO”, the Location Selection menu will appear each time requesting you to startup again.
- If Auto-Connect had been set to “YES” or “EXT”, the display will reappear wherever you left off. The clicking noise will be annoying, but you will not lose functionality.

There are several potential causes and detailed solutions, which are outlined in the [Keypad Resetting Solutions](#) article on our website in the Technical Support section.

The telescope slewed in the wrong direction toward the pier.

As long as you provide the mount with proper information, your telescope will slew safely from one part of the sky to another. These are a few scenarios that can cause a problem:

- You did not start your first session at that location by following the appropriate procedure outlined in the manual.
- Your time or daylight savings is not set correctly (if it applies to your state or country). In the time & date menu, press the “0” number button if daylight savings is not in effect (e.g. winter). Enter “1” if daylight savings is in effect (e.g. summer). Remember to change this when we “spring forward” or “fall back”.
- For the GTOCP4 control box: When you selected your calibration star, the scope was set up on the wrong side of the mount. Or, in conjunction with the daylight savings issue, if the daylight savings is set incorrectly and you choose a star near the meridian, the scope may be on the wrong side of the mount according to the time set on the Keypad.

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 in the upper right corner of the stars, then comparing that number with the RA number of the star you choose. If the 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.

- You identified a star incorrectly when you selected it.
- Your time setting sent to the mount by the computer may be inaccurate.

I pressed the Keypad button and it jumped ahead two steps.

This happens if you hold the button too long. Just give it a short press.

The power light goes out and the motors stop.

The voltage of your battery has probably gone below 10 volts.

The Time/LST Window doesn’t exit right away when I hit the menu button.

Please push and hold the menu button until you are brought back to the main menu. A quick push may not be recognized right away in this menu since time is continually updating.

The Mount will not park correctly, nor will it point properly, it also indicates that an object is below the horizon when I can clearly see it is not.

GTOCP4: This can occur if you did not enter your location, date and time data and follow the Normal Startup Procedure. Every time you start up at a new location or change your time, you must follow the Normal Startup procedure to send vital date, time and location data to your mount. Otherwise, it will be lost.

I am upgrading my Keypad from the website and the loader appears to be working but no data is appearing on the window other than sending page x...

GTOCP4 only with versions prior to P01-01-14. In most cases this is caused by attempting to load the Keypad through the bottom port on the control box. The Keypad MUST be loaded through top COM port on the control box or the load will fail. If you have already attempted to load your Keypad in this manner and are only left with a blinking cursor on the window,

you can start the loading steps from the start and your Keypad will load properly. Please follow all download instructions very carefully.

When I enter an object it slews to the wrong place, tells me that it is below the horizon by several degrees and has completely incorrect object data.

If all 3 of these symptoms are occurring it is likely that your Keypad's database has been corrupted or lost. Many things can cause this to happen, removing the internal Keypad battery improperly, having a dead or dying battery or power surges caused by lightning strikes are all common triggers for this. Follow the directions on the website to reload the database. If the database continues to fail after you have reloaded it, please call Astro-Physics for further instructions.

APPENDIX A: RELEASE NOTES

Version 5.001, 11-10-20

- Improved routine for Get Time from Mount and Get Location from Mount.

Version 5.00.135.2, 11-07-20

- Released for Mach2GTO mounts with GTOCP5.

APPENDIX B: COMMON STARS – BY CONSTELLATION

| Constellation | Star Name | Flamsteed-Bayer Designation | Abbrev | Magnitude(SAO) |
|-----------------------|-------------------|-----------------------------|----------|----------------|
| Andromeda | Alpheratz | 21-Alpha Andromedae | Alf And | 2.1 |
| | Mirach | 43-Beta Andromedae | Bet And | 2.4 |
| | Almach | 57-Gamma1 Andromedae | Gam And | 2.3 |
| Aquarius | Sadalmelik | 34-Alpha Aquarii | Alf Aqr | 3.2 |
| | Sadalsuud | 22-Beta Aquarii | Bet Aqr | 3.1 |
| | Skat | 76-Delta Aquarii | Del Aqr | 3.5 |
| | Albali | 2-Epsilon Aquarii | Eps Aqr | 3.8 |
| Aquila | Altair | 53-Alpha Aquilae | Alf Aql | 0.9 |
| | Alshain | 60-Beta Aquilae | Bet Aql | 3.9 |
| | Tarazed | 50-Gamma Aquilae | Gam Aql | 2.8 |
| Aries | Hamal | 13-Alpha Arietis | Alf Ari | 2.2 |
| | Sheratan | 6-Beta Arietis | Bet Ari | 2.7 |
| | Mesarthim | 5-Gamma2 Arietis | Gam Ari | 4.8 |
| Auriga | Capella | Alpha Aurigae | Alf Aur | 0.1 |
| | Menkalinan | 34-Beta Aurigae | Bet Aur | 2.1 |
| Boötes | Arcturus | 16-Alpha Boötis | Alf Boo | 0.2 |
| | Nekkar | 42-Beta Boötis | Bet Boo | 3.6 |
| | Seginus | 27-Gamma Boötis | Gam Boo | 3.0 |
| | zar | 36-Epsilon Boötis | Eps Boo | 2.7 |
| | Muphrid | 8-Eta Boötis | Eta Boo | 2.8 |
| | Alkalurops | 51-Mu1 Boötis | Mu Boo | 4.5 |
| Cancer | Acubens | 65-Alpha Cancri | Alf Cnc | 4.3 |
| | Asellus Borealis | 43-Gamma Cancri | Gam Cnc | 4.7 |
| | Asellus Australis | 47-Delta Cancri | Del Cnc | 4.2 |
| Canis Major | Sirius | 9-Alpha Canis Majoris | Alf CMa | -1.6 |
| | Mirzam | 2-Beta Canis Majoris | Bet CMa | 2.0 |
| | Wezen | 25-Delta Canis Majoris | Del CMa | 2.0 |
| | Adhara | 21-Epsilon Canis Majoris | Eps CMa | 1.6 |
| | Furud | 1-Zeta Canis Majoris | Zet CMa | 3.1 |
| | Aludra | 31-Eta Canis Majoris | Eta CMa | 2.4 |
| Canis Minor | Procyon | 10-Alpha Canis Minoris | Alf CMi | 0.5 |
| | Gomeisa | 3-Beta Canis Minoris | Bet CMi | 3.1 |
| Canis Venatici | Cor Caroli | 12-Alpha Canum Venaticorum | Alf CVn | 2.9 |
| | Chara | 8-Beta Canum Venaticorum | Bet CVn | 4.3 |
| Capricornus | Algedi | 6-Alpha2 Capricorni | Alf Cap | 3.8 |
| | Dabih | 9-Beta1 Capricorni | Bet Cap | 3.3 |
| | Nashira | 40-Gamma Capricorni | Gam Cap | 3.8 |
| | Deneb Algedi | 49-Delta Capricorni | Del Cap | 3.0 |
| Carina | Canopus | Alpha Carinae | Alf Car | -0.9 |
| | Miaplacidus | Beta Carinae | Bet Car | 1.8 |
| | Avior | Epsilon Carinae | Eps Car | 1.7 |
| | Aspidiske | Iota Carinae | Iota Car | 2.3 |
| Cassiopeia | Schedar | 18-Alpha Cassiopeiae | Alf Cas | 2.5 |
| | Caph | Beta Cassiopeia | Bet Cas | 2.3 |
| | Navi | 27-Gamma Cassiopeiae | Gam Cas | 2.8 |
| | Ruchbah | 37-Delta Cassiopeiae | Del Cas | 2.7 |
| Centaurus | Alpha Centauri | Alpha1 Centauri | Alf Cen | 0.1 |
| | Hadar | Beta Centauri | Bet Cen | 0.9 |

| Constellation | Star Name | Flamsteed-Bayer Designation | Abbrev | Magnitude(SAO) |
|------------------------|--------------|-----------------------------|---------|----------------|
| Cepheus | Menkent | 5-Theta Centauri | Tet Cen | 2.3 |
| | Alderamin | 5-Alpha Cephei | Alf Cep | 2.6 |
| | Alfirk | 8-Beta Cephei | Bet Cep | 3.3 |
| | Erral | 35-Gamma Cephei | Gam Cep | 3.4 |
| | Kurhah | 17-Xi Cephei | Xi Cep | 4.6 |
| Cetus | Menkar | 92-Alpha Ceti | Alf Cet | 2.8 |
| | Diphda | 16-Beta Ceti | Bet Cet | 2.2 |
| | Kaffaljidhma | 86-Gamma Ceti | Gam Cet | 3.6 |
| | Baten Kaitos | 55-Zeta Ceti | Zet Cet | 3.9 |
| | Mira | Omicron Ceti | Omi Cet | 2.1 |
| Columba | Phact | Alpha Columbae | Alf Col | 2.8 |
| | Wazn | Beta Columbae | Bet Col | 3.2 |
| Corona Borealis | Alphecca | 5-Alpha Coronae Borealis | Alf CrB | 2.3 |
| | Nusakan | 3-Beta Coronae Borealis | Bet CrB | 3.7 |
| Corvus | Alchiba | 1-Alpha Corvi | Alf Crv | 4.2 |
| | Gienah | 4-Gamma Corvi | Gam Crv | 2.8 |
| | Algorab | 7-Delta Corvi | Del Crv | 3.1 |
| Crater | Alkes | 7-Alpha Crateris | Alf Crt | 4.2 |
| Crux | Acrux | Alpha2 Crucis | Alf Cru | 1.6 |
| | Mimosa | Beta Crucis | Bet Cru | 1.5 |
| | Gacrux | Gamma Crucis | Gam Cru | 1.6 |
| Cygnus | Deneb | 50-Alpha Cygni | Alf Cyg | 1.3 |
| | Albireo | 6-Beta1 Cygni | Bet Cyg | 3.2 |
| | Sadr | 37-Gamma Cygni | Gam Cyg | 2.3 |
| Draco | Thuban | 11-Alpha Draconis | Alf Dra | 3.6 |
| | Rastaban | 23-Beta Draconis | Bet Dra | 3.0 |
| | Eltanin | 33-Gamma Draconis | Gam Dra | 2.4 |
| | Altais | 57-Delta Draconis | Del Dra | 3.2 |
| | Edasich | 12-Iota Draconis | lot Dra | 3.5 |
| | Giasar | 1-Lambda Draconis | Lam Dra | 4.1 |
| | Alrakis | 21-Mu Draconis | Mu Dra | 5.1 |
| | Grumium | 32-Xi Draconis | Xi Dra | 3.9 |
| Equuleus | Kitelpha | 8-Alpha Equulei | Alf Equ | 4.1 |
| Eridanus | Achernar | Alpha Eridani | Alf Eri | 0.6 |
| | Cursa | 67-Beta Eridani | Bet Eri | 2.9 |
| | Zaurak | 34-Gamma Eridani | Gam Eri | 3.2 |
| | Azha | 3-Eta Eridani | Eta Eri | 4.0 |
| | Acamar | Theta Eridani | Tet Eri | 3.2 |
| | Beid | 38-Omicron Eridani | Omi Eri | 4.1 |
| | Keid | 40-Omicron2 Eridani | Omi Eri | 4.5 |
| Gemini | Castor | 66-Alpha Geminorum | Alf Gem | 1.6 |
| | Pollux | 78-Beta Geminorum | Bet Gem | 1.2 |
| | Alhena | 24-Gamma Geminorum | Gam Gem | 1.9 |
| | Wasat | 55-Delta Geminorum | Del Gem | 3.5 |
| | Mebсутa | 27-Epsilon Geminorum | Eps Gem | 3.2 |
| | Mekbuda | 43-Zeta Geminorum | Zet Gem | 3.9 |
| | Propus | Eta Geminorum | Eta Gem | 3.3 |
| Grus | AlNair | Alpha Gruis | Alf Gru | 2.2 |
| Hercules | Rasalgethi | 64-Alpha Herculis | Alf Her | 3.5 |
| | Kornephoros | 27-Beta Herculis | Bet Her | 2.8 |

| Constellation | Star Name | Flamsteed-Bayer Designation | Abbrev | Magnitude(SAO) |
|-------------------------|----------------|-----------------------------|---------|----------------|
| Hydra | | | | |
| | Alphard | 30-Alpha Hydrae | Alf Hya | 2.2 |
| Leo | | | | |
| | Regulus | 32-Alpha Leonis | Alf Leo | 1.3 |
| | Denebola | 94-Beta Leonis | Bet Leo | 2.2 |
| | Algieba | 41-Gamma2 Leonis | Gam Leo | 2.6 |
| | Zosma | 68-Delta Leonis | Del Leo | 2.6 |
| | Adhafera | 36-Zeta Leonis | Zet Leo | 3.6 |
| | Alterf | 4-Lambda Leonis | Lam Leo | 4.5 |
| | Chertan | 70-Theta Leonis | Tet Leo | 3.4 |
| | Rasalas | 24-Mu Leonis | Mu Leo | 4.1 |
| | Arneb | 11-Alpha Leporis | Alf Lep | 2.7 |
| | Nihal | 9-Beta Leporis | Bet Lep | 3.0 |
| Libra | | | | |
| | Zubenelgenubi | 9-Alpha2 Librae | Alf Lib | 2.9 |
| | Zubeneschamali | 27-Beta Librae | Bet Lib | 2.7 |
| Lyra | | | | |
| | Vega | 3-Alpha Lyrae | Alf Lyr | 0.1 |
| | Sheliak | 10-Beta Lyrae | Bet Lyr | 3.9 |
| | Sulafat | 14-Gamma Lyrae | Gam Lyr | 3.3 |
| Ophiuchus | | | | |
| | Rasalhague | 55-Alpha Ophiuchi | Alf Oph | 2.1 |
| | Cebalrai | 60-Beta Ophiuchi | Bet Oph | 2.9 |
| | Yed Prior | 1-Delta Ophiuchi | Del Oph | 3.0 |
| | Yed Posterior | 2-Epsilon Ophiuchi | Eps Oph | 3.3 |
| | Sabik | 35-Eta Ophiuchi | Eta Oph | 2.6 |
| | Marfik | 10-Lambda Ophiuchi | Lam Oph | 3.9 |
| Orion | | | | |
| | Betelgeuse | 58-Alpha Orionis | Alf Ori | 0.6 |
| | Rigel | 19-Beta Orionis | Bet Ori | 0.3 |
| | Bellatrix | 24-Gamma Orionis | Gam Ori | 1.7 |
| | Alnilam | 46-Epsilon Orionis | Eps Ori | 1.8 |
| | Mintaka | 34-Delta Orionis | Del Ori | 2.5 |
| | Alnitak | 50-Zeta Orionis | Zet Ori | 2.0 |
| | Trapezium | 41-Theta1 Orionis | Tet Ori | 5.4 |
| | Saiph | 53-Kappa Orionis | Kap Ori | 2.2 |
| | Meissa | 39-Lambda Orionis | Lam Ori | 3.7 |
| Pavo | | | | |
| | Peacock | Alpha Pavonis | Alf Pav | 2.1 |
| Pegasus | | | | |
| | Markab | 54-Alpha Pegasi | Alf Peg | 2.6 |
| | Scheat | 53-Beta Pegasi | Bet Peg | 2.6 |
| | Algenib | 88-Gamma Pegasi | Gam Peg | 2.9 |
| | Enif | 8-Epsilon Pegasi | Eps Peg | 2.5 |
| | Homam | 42-Zeta Pegasi | Zet Peg | 3.6 |
| | Matar | 44-Eta Pegasi | Eta Peg | 3.1 |
| | Biham | 26-Theta Pegasi | Tet Peg | 3.7 |
| Perseus | | | | |
| | Mirfak | 33-Alpha Persei | Alf Per | 1.9 |
| | Algol | 26-Beta Persei | Bet Per | 2.9 |
| | Atik | 44-Zeta Persei | Zet Per | 2.9 |
| | Menkib | 46-Xi Persei | Xi Per | 4.0 |
| Phoenix | | | | |
| | Ankaa | Alpha Phoenicis | Alf Phe | 2.4 |
| Pisces | | | | |
| | Alrescha | 113-Alpha Piscium | Alf Psc | 4.3 |
| Piscis Austrinus | | | | |
| | Fomalhaut | 24-Alpha Piscis Austrini | Alf PsA | 1.3 |
| Sagittarius | | | | |
| | Rukbat | Alpha Sagittarii | Alf Sgr | 4.1 |
| | Arkab | Beta1 Sagittarii | Bet Sgr | 4.3 |
| | Alnasi | 10-Gamma2 Sagittarii | Gam Sgr | 3.1 |
| | Kaus Media | 19-Delta Sagittarii | Del Sgr | 2.8 |
| | Kaus Australis | 20-Epsilon Sagittarii | Eps Sgr | 2.0 |
| | Ascella | 38-Zeta Sagittarii | Zet Sgr | 2.7 |

| Constellation | Star Name | Flamsteed-Bayer Designation | Abbrev | Magnitude(SAO) |
|----------------------------|-----------------|-----------------------------|---------|----------------|
| Scorpius | Kaus Borealis | 22-Lambda Sagittarii | Lam Sgr | 2.9 |
| | Nunki | 34-Sigma Sagittarii | Sig Sgr | 2.1 |
| | Antares | 21-Alpha Scorpii | Alf Sco | 1.1 |
| | Graffias | 8-Beta Scorpii | Bet Sco | 2.9 |
| | Shaula | 35-Lambda Scorpii | Lam Sco | 1.7 |
| Serpens | Lesath | 34-Upsilon Scorpii | Ups Sco | 2.8 |
| | Unukalhai | 24-Alpha Serpentis | Alf Ser | 2.8 |
| Taurus | Alya | 63-Theta Serpentis | Tet Ser | 4.5 |
| | Aldebaran | 87-Alpha Tauri | Alf Tau | 1.1 |
| Taurus | Elnath | 112-Beta Tauri | Bet Tau | 1.8 |
| | Alcyone | 25-Eta Tauri | Eta Tau | 3.0 |
| | Celaeno | 16 Tauri | 16 Tau | 5.4 |
| | Electra | 17 Tauri | 17 Tau | 3.8 |
| | Taygeta | 19 Tauri | 19 Tau | 4.4 |
| | Maia | 20 Tauri | 20 Tau | 3.9 |
| | Sterope | 21 Tauri | 21 Tau | 5.9 |
| | Merope | 23 Tauri | 23 Tau | 4.3 |
| | Atlas | 27 Tauri | 27 Tau | 3.8 |
| | Pleione | 28 Tauri | 28 Tau | 5.2 |
| Triangulum Australe | | | | |
| | Atria | Alpha Trianguli Australis | Alf TrA | 1.9 |
| Ursa Major | | | | |
| | Dubhe | 50-Alpha Ursae Majoris | Alf UMa | 2.0 |
| | Merak | 48-Beta Ursae Majoris | Bet UMa | 2.4 |
| | Phecda | 64-Gamma Ursae Majoris | Gam UMa | 2.5 |
| | Alioth | 77-Delta Ursae Majoris | Eps UMa | 1.7 |
| | Megrez | 69-Delta Ursae Majoris | Del UMa | 3.4 |
| | Mizar | 79-Zeta Ursae Majoris | Zet UMa | 2.4 |
| | Alkaid | 85-Eta Ursae Majoris | Eta UMa | 1.9 |
| | Talitha | 9-Iota Ursae Majoris | Iot UMa | 3.0 |
| | Tania Borealis | 33-Lambda Ursae Majoris | Lam UMa | 3.5 |
| | Tania Australis | 34-Mu Ursae Majoris | Mu UMa | 3.2 |
| | Alula Borealis | 54-Nu Ursae Majoris | Nu UMa | 3.7 |
| | Alula Australis | 53-Xi Ursae Majoris | Xi UMa | 3.9 |
| | Muscida | 1-Omicron Ursae Majoris | Omi UMa | 3.5 |
| | Alcor | 80 Ursae Majoris | 80 UMa | 4.0 |
| Ursa Minor | | | | |
| | Polaris | 1-Alpha Ursae Minoris | Alf UMi | 2.1 |
| | Kochab | 7-Beta Ursae Minoris | Bet UMi | 2.2 |
| | Pherkad | 13-Gamma Ursae Minoris | Gam UMi | 3.1 |
| Vela | | | | |
| | Regor | Gamma2 Velorum | Gam Vel | 1.9 |
| | Suhail | Lambda Velorum | Lam Vel | 2.2 |
| Virgo | | | | |
| | Spica | 67-Alpha Virginis | Alf Vir | 1.2 |
| | Zavijava | 5-Beta Virginis | Bet Vir | 3.8 |
| | Porrina | 29-Gamma Virginis | Gam Vir | 2.9 |
| | Vindematrix | 47-Epsilon Virginis | Eps Vir | 3.0 |
| | Zaniah | 15-Eta Virginis | Eta Vir | 4.0 |
| | Syrma | 99-Iota Virginis | Iot Vir | 4.2 |

APPENDIX C: ALPHABETICAL STAR LIST

These stars are listed in the same order as they appear on your display when you are either following the calibration routine or have chosen Stars from the Objects Menu. Note that Polaris appears twice.

| Common Name | Flamsteed-Bayer Designation | Abbrev. | Magnitude (SAO) |
|--------------------|------------------------------------|----------------|------------------------|
| Polaris | Alpha Ursae Minoris | Alf UMi | 2.1 |
| Acamar | Theta Eridani | Tet Eri | 3.2 |
| Achernar | Alpha Eridani | Alf Eri | 0.6 |
| Acrux | Alpha2 Crucis | Alf Cru | 1.6 |
| Acubens | 65-Alpha Cancri | Alf Cnc | 4.3 |
| Adhafera | 36-Zeta Leonis | Zet Leo | 3.6 |
| Adhara | 21-Epsilon Canis Majoris | Eps CMA | 1.6 |
| Albali | 2-Epsilon Aquarii | Eps Aqr | 3.8 |
| Albireo | 6-Beta1 Cygni | Bet Cyg | 3.2 |
| Alchiba | 1-Alpha Corvi | Alf Crv | 4.2 |
| Alcor | 80 Ursae Majoris | 80 UMa | 4.0 |
| Alcyone | 25-Eta Tauri | Eta Tau | 3.0 |
| Aldebaran | 87-Alpha Tauri | Alf Tau | 1.1 |
| Alderamin | 5-Alpha Cephei | Alf Cep | 2.6 |
| Alfirk | 8-Beta Cephei | Bet Cep | 3.3 |
| Algedi | 6-Alpha2 Capricorni | Alf Cap | 3.8 |
| Algenib | 88-Gamma Pegasi | Gam Peg | 2.9 |
| Algieba | 41-Gamma2 Leonis | Gam Leo | 2.6 |
| Algol | 26-Beta Persei | Bet Per | 2.9 |
| Algorab | 7-Delta Corvi | Del Crv | 3.1 |
| Alhena | 24-Gamma Geminorum | Gam Gem | 1.9 |
| Alioth | 77-Epsilon Ursae Majoris | Eps UMa | 1.7 |
| Alkaid | 85-Eta Ursae Majoris | Eta UMa | 1.9 |
| Alkalurops | 51-Mu1 Boötis | Mu Boo | 4.5 |
| Alkes | 7-Alpha Crateris | Alf Crt | 4.2 |
| Almach | 57-Gamma1 Andromedae | Gam And | 2.3 |
| AlNair | Alpha Gruis | Alf Gru | 2.2 |
| Alnasi | 10-Gamma2 Sagittarii | Gam Sgr | 3.1 |
| Alnilam | 46-Epsilon Orionis | Eps Ori | 1.8 |
| Alnitak | 50-Zeta Orionis | Zet Ori | 2.0 |
| Alpha Centauri | Alpha1 Centauri | Alf Cen | 0.1 |
| Alphard | 30-Alpha Hydrae | Alf Hya | 2.2 |
| Alphecca | 5-Alpha Coronae Borealis | Alf CrB | 2.3 |
| Alpheratz | 21-Alpha Andromedae | Alf And | 2.1 |
| Alrakis | 21-Mu Draconis | Mu Dra | 5.1 |
| Alrescha | 113-Alpha Piscium | Alf Psc | 4.3 |
| Alshain | 60-Beta Aquilae | Bet Aql | 3.9 |
| Altair | 53-Alpha Aquilae | Alf Aql | 0.9 |
| Altais | 57-Delta Draconis | Del Dra | 3.2 |
| Alterf | 4-Lambda Leonis | Lam Leo | 4.5 |
| Aludra | 31-Eta Canis Majoris | Eta CMA | 2.4 |
| Alula Australis | 53-Xi Ursae Majoris | Xi UMa | 3.9 |
| Alula Borealis | 54-Nu Ursae Majoris | Nu UMa | 3.7 |

| Common Name | Flamsteed-Bayer Designation | Abbrev. | Magnitude (SAO) |
|--------------------|------------------------------------|----------------|------------------------|
| Alya | 63-Theta Serpentis | Tet Ser | 4.5 |
| Ankaa | Alpha Phoenicis | Alf Phe | 2.4 |
| Antares | 21-Alpha Scorpii | Alf Sco | 1.1 |
| Arcturus | 16-Alpha Boötis | Alf Boo | 0.2 |
| Arkab | Beta1 Sagittarii | Bet Sgr | 4.3 |
| Arneb | 11-Alpha Leporis | Alf Lep | 2.7 |
| Ascella | 38-Zeta Sagittarii | Zet Sgr | 2.7 |
| Asellus Australis | 47-Delta Cancri | Del Cnc | 4.2 |
| Asellus Borealis | 43-Gamma Cancri | Gam Cnc | 4.7 |
| Aspidiske | Iota Carinae | Iot Car | 2.3 |
| Atik | 44-Zeta Persei | Zet Per | 2.9 |
| Atlas | 27 Tauri | 27 Tau | 3.8 |
| Atria | Alpha Trianguli Australis | Alf TrA | 1.9 |
| Avior | Epsilon Carinae | Eps Car | 1.7 |
| Azha | 3-Eta Eridani | Eta Eri | 4.0 |
| Baten Kaitos | 55-Zeta Ceti | Zet Cet | 3.9 |
| Beid | 38-Omicron Eridani | Omi Eri | 4.1 |
| Bellatrix | 24-Gamma Orionis | Gam Ori | 1.7 |
| Betelgeuse | 58-Alpha Orionis | Alf Ori | 0.6 |
| Biham | 26-Theta Pegasi | Tet Peg | 3.7 |
| Canopus | Alpha Carinae | Alf Car | -0.9 |
| Capella | Alpha Aurigae | Alf Aur | 0.1 |
| Caph | Beta Cassiopeiae | Bet Cas | 2.3 |
| Castor | 66-Alpha Geminorum | Alf Gem | 1.6 |
| Cebalrai | 60-Beta Ophiuchi | Bet Oph | 2.9 |
| Celaeno | 16 Tauri | 16 Tau | 5.4 |
| Chara | 8-Beta Canum Venaticorum | Bet CVn | 4.3 |
| Chertan | 70-Theta Leonis | Tet Leo | 3.4 |
| Cor Caroli | 12-Alpha2 Canum Venaticorum | Alf CVn | 2.9 |
| Cursa | 67-Beta Eridani | Bet Eri | 2.9 |
| Dabih | 9-Beta1 Capricorni | Bet Cap | 3.3 |
| Deneb | 50-Alpha Cygni | Alf Cyg | 1.3 |
| Deneb Algedi | 49-Delta Capricorni | Del Cap | 3.0 |
| Denebola | 94-Beta Leonis | Bet Leo | 2.2 |
| Diphda | 16-Beta Ceti | Bet Cet | 2.2 |
| Double Double | | | 6.0 |
| Dubhe | 50-Alpha Ursae Majoris | Alf UMa | 2.0 |
| Edasich | 12-Iota Draconis | Iot Dra | 3.5 |
| Electra | 17 Tauri | 17 Tau | 3.8 |
| Elnath | 112-Beta Tauri | Bet Tau | 1.8 |
| Eltanin | 33-Gamma Draconis | Gam Dra | 2.4 |
| Enif | 8-Epsilon Pegasi | Eps Peg | 2.5 |
| Errai | 35-Gamma Cephei | Gam Cep | 3.4 |
| Fomalhaut | 24-Alpha Piscis Austrini | Alf PsA | 1.3 |
| Furud | 1-Zeta Canis Majoris | Zet CMa | 3.1 |
| Gacrux | Gamma Crucis | Gam Cru | 1.6 |

| Common Name | Flamsteed-Bayer Designation | Abbrev. | Magnitude (SAO) |
|--------------------|------------------------------------|----------------|------------------------|
| Giasar | 1-Lambda Draconis | Lam Dra | 4.1 |
| Gienah | 4-Gamma Corvi | Gam Crv | 2.8 |
| Gomeisa | 3-Beta Canis Minoris | Bet CMi | 3.1 |
| Graffias | 8-Beta Scorpii | Bet Sco | 2.9 |
| Grumium | 32-Xi Draconis | Xi Dra | 3.9 |
| Hadar | Beta Centauri | Bet Cen | 0.9 |
| Hamal | 13-Alpha Arietis | Alf Ari | 2.2 |
| Hinds Crimson Star | | | 6.0 |
| Homam | 42-Zeta Pegasi | Zet Peg | 3.6 |
| Izar | 36-Epsilon Boötis | Eps Boo | 2.7 |
| Kaffaljidhma | 86-Gamma Ceti | Gam Cet | 3.6 |
| Kaus Australis | 20-Epsilon Sagittarii | Eps Sgr | 2.0 |
| Kaus Borealis | 22-Lambda Sagittarii | Lam Sgr | 2.9 |
| Kaus Media | 19-Delta Sagittarii | Del Sgr | 2.8 |
| Keid | 40-Omicron2 Eridani | Omi Eri | 4.5 |
| Kitalpha | 8-Alpha Equulei | Alf Equ | 4.1 |
| Kochab | 7-Beta Ursae Minoris | Bet UMi | 2.2 |
| Kornephoros | 27-Beta Herculis | Bet Her | 2.8 |
| Kurhah | 17-Xi Cephei | Xi Cep | 4.6 |
| Lesath | 34-Upsilon Scorpii | Ups Sco | 2.8 |
| Maia | 20 Tauri | 20 Tau | 3.9 |
| Marfik | 10-Lambda Ophiuchi | Lam Oph | 3.9 |
| Markab | 54-Alpha Pegasi | Alf Peg | 2.6 |
| Matar | 44-Eta Pegasi | Eta Peg | 3.1 |
| Mebсутa | 27-Epsilon Geminorum | Eps Gem | 3.2 |
| Megrez | 69-Delta Ursae Majoris | Del UMa | 3.4 |
| Meissa | 39-Lambda Orionis | Lam Ori | 3.7 |
| Mekbuda | 43-Zeta Geminorum | Zet Gem | 3.9 |
| Menkalinan | 34-Beta Aurigae | Bet Aur | 2.1 |
| Menkar | 92-Alpha Ceti | Alf Cet | 2.8 |
| Menkent | 5-Theta Centauri | Tet Cen | 2.3 |
| Menkib | 46-Xi Persei | Xi Per | 4.0 |
| Merak | 48-Beta Ursae Majoris | Bet UMa | 2.4 |
| Merope | 23 Tauri | 23 Tau | 4.3 |
| Mesarthim | 5-Gamma1 Arietis | Gam Ari | 4.8 |
| Miaplacidus | Beta Carinae | Bet Car | 1.8 |
| Mimosa | Beta Crucis | Bet Cru | 1.5 |
| Mintaka | 34-Delta Orionis | Del Ori | 2.5 |
| Mira | Omicron Ceti | Omi Cet | 2.1 |
| Mirach | 43-Beta Andromedae | Bet And | 2.4 |
| Mirfak | 33-Alpha Persei | Alf Per | 1.9 |
| Mirzam | 2-Beta Canis Majoris | Bet CMa | 2.0 |
| Mizar | 79-Zeta Ursae Majoris | Zet UMa | 2.4 |
| Muphrid | 8-Eta Boötis | Eta Boo | 2.8 |
| Muscida | 1-Omicron Ursae Majoris | Omi UMa | 3.5 |
| Nashira | 40-Gamma Capricorni | Gam Cap | 3.8 |

| Common Name | Flamsteed-Bayer Designation | Abbrev. | Magnitude (SAO) |
|--------------------|------------------------------------|----------------|------------------------|
| Navi | 27-Gamma Cassiopeiae | Gam Cas | 2.8 |
| Nekkar | 42-Beta Boötis | Bet Boo | 3.6 |
| Nihal | 9-Beta Leporis | Bet Lep | 3.0 |
| Nunki | 34-Sigma Sagittarii | Sig Sgr | 2.1 |
| Nusakan | 3-Beta Coronae Borealis | Bet CrB | 3.7 |
| Peacock | Alpha Pavonis | Alf Pav | 2.1 |
| Phact | Alpha Columbae | Alf Col | 2.8 |
| Phecda | 64-Gamma Ursae Majoris | Gam UMa | 2.5 |
| Pherkad | 13-Gamma Ursae Minoris | Gam UMi | 3.1 |
| Pleione | 28 Tauri | 28 Tau | 5.2 |
| Polaris | 1-Alpha Ursae Minoris | Alf UMi | 2.1 |
| Pollux | 78-Beta Geminorum | Bet Gem | 1.2 |
| Porrima | 29-Gamma Virginis | Gam Vir | 2.9 |
| Procyon | 10-Alpha Canis Minoris | Alf CMi | 0.5 |
| Propus | Eta Geminorum | Eta Gem | 3.3 |
| Rasalas | 24-Mu Leonis | Mu Leo | 4.1 |
| Rasalgethi | 64-Alpha Herculis | Alf Her | 3.5 |
| Rasalhague | 55-Alpha Ophiuchi | Alf Oph | 2.1 |
| Rastaban | 23-Beta Draconis | Bet Dra | 3.0 |
| Regor | Gamma2 Velorum | Gam Vel | 1.9 |
| Regulus | 32-Alpha Leonis | Alf Leo | 1.3 |
| Rigel | 19-Beta Orionis | Bet Ori | 0.3 |
| Ruchbah | 37-Delta Cassiopeiae | Del Cas | 2.7 |
| Rukbat | Alpha Sagittarii | Alf Sgr | 4.1 |
| Sabik | 35-Eta Ophiuchi | Eta Oph | 2.6 |
| Sadalmelik | 34-Alpha Aquarii | Alf Aqr | 3.2 |
| Sadalsuud | 22-Beta Aquarii | Bet Aqr | 3.1 |
| Sadr | 37-Gamma Cygni | Gam Cyg | 2.3 |
| Saiph | 53-Kappa Orionis | Kap Ori | 2.2 |
| Scheat | 53-Beta Pegasi | Bet Peg | 2.6 |
| Schedar | 18-Alpha Cassiopeiae | Alf Cas | 2.5 |
| Seginus | 27-Gamma Boötis | Gam Boo | 3.0 |
| Shaula | 35-Lambda Scorpii | Lam Sco | 1.7 |
| Sheliak | 10-Beta Lyrae | Bet Lyr | 3.9 |
| Sheratan | 6-Beta Arietis | Bet Ari | 2.7 |
| Sirius | 9-Alpha Canis Majoris | Alf CMa | -1.6 |
| Skat | 76-Delta Aquarii | Del Aqr | 3.5 |
| Spica | 67-Alpha Virginis | Alf Vir | 1.2 |
| Sterope | 21 Tauri | 21 Tau | 5.9 |
| Suhail | Lambda Velorum | Lam Vel | 2.2 |
| Sulafat | 14-Gamma Lyrae | Gam Lyr | 3.3 |
| Syrma | 99-Iota Virginis | Iot Vir | 4.2 |
| Talitha | 9-Iota Ursae Majoris | Iot UMa | 3.1 |
| Tania Australis | 34-Mu Ursae Majoris | Mu UMa | 3.2 |
| Tania Borealis | 33-Lambda Ursae Majoris | Lam UMa | 3.5 |
| Tarazed | 50-Gamma Aquilae | Gam Aql | 2.8 |

| Common Name | Flamsteed-Bayer Designation | Abbrev. | Magnitude (SAO) |
|--------------------|------------------------------------|----------------|------------------------|
| Taygeta | 19 Tauri | 19 Tau | 4.4 |
| Thuban | 11-Alpha Draconis | Alf Dra | 3.6 |
| Trapezium | 41-Theta1 Orionis | Tet Ori | 5.4 |
| Unukalhai | 24-Alpha Serpentis | Alf Ser | 2.8 |
| UU | none | none | 5.1 |
| Vega | 3-Alpha Lyrae | Alf Lyr | 0.1 |
| Vindemiatrix | 47-Epsilon Virginis | Eps Vir | 3.0 |
| Wasat | 55-Delta Geminorum | Del Gem | 3.5 |
| Wazn | Beta Columbae | Bet Col | 3.2 |
| Wezen | 25-Delta Canis Majoris | Del CMa | 2.0 |
| Yed Posterior | 2-Epsilon Ophiuchi | Eps Oph | 3.3 |
| Yed Prior | 1-Delta Ophiuchi | Del Oph | 3.0 |
| Zaniah | 15-Eta Virginis | Eta Vir | 4.0 |
| Zaurak | 34-Gamma Eridani | Gam Eri | 3.2 |
| Zavijava | 5-Beta Virginis | Bet Vir | 3.8 |
| Zosma | 68-Delta Leonis | Del Leo | 2.6 |
| Zubenelgenubi | 9-Alpha2 Librae | Alf Lib | 2.9 |
| Zubeneschamali | 27-Beta Librae | Bet Lib | 2.7 |
| Sun | | | |
| Moon | | | |
| Venus | | | |
| Mars | | | |
| Jupiter | | | |

APPENDIX D: CONSTELLATION ABBREVIATIONS

| | | | |
|-----|------------------|-----|---------------------|
| And | Andromeda | LMi | Leo Minor |
| Ant | Antlia | Lep | Lepus |
| Aps | Apus | Lib | Libra |
| Aqr | Aquarius | Lup | Lupus |
| Aql | Aquila | Lyn | Lynx |
| Ara | Ara | Lyr | Lyra |
| Ari | Aries | Men | Mensa |
| Aur | Auriga | Mic | Microscopium |
| Boo | Boötes | Mon | Monoceros |
| Cae | Caelum | Mus | Musca |
| Cam | Camelopardalis | Nor | Norma |
| Cnc | Cancer | Oct | Octans |
| CVn | Canes Venatici | Oph | Ophiuchus |
| CMA | Canis Major | Ori | Orion |
| CMi | Canis Minor | Pav | Pavo |
| Cap | Capricornus | Peg | Pegasus |
| Car | Carina | Per | Perseus |
| Cas | Cassiopeia | Phe | Phoenix |
| Cen | Centaurus | Pic | Pictor |
| Cep | Cepheus | Psc | Pisces |
| Cet | Cetus | PsA | Piscis Austrinus |
| Cha | Chamaeleon | Pup | Puppis |
| Cir | Circinus | Pyx | Pyxis |
| Col | Columba | Ret | Reticulum |
| Com | Coma Berenices | Sge | Sagitta |
| CrA | Corona Australis | Sgr | Sagittarius |
| CrB | Corona Borealis | Sco | Scorpius |
| Crv | Corvus | Sci | Sculptor |
| Crt | Crater | Sct | Scutum |
| Cru | Crux | Ser | Serpens |
| Cyg | Cygnus | Sex | Sextans |
| Del | Delphinus | Tau | Taurus |
| Dor | Dorado | Tel | Telescopium |
| Dra | Draco | Tri | Triangulum |
| Equ | Equuleus | TrA | Triangulum Australe |
| Eri | Eridanus | Tuc | Tucana |
| For | Fornax | UMa | Ursa Major |
| Gem | Gemini | UMi | Ursa Minor |
| Gru | Grus | Vel | Vela |
| Her | Hercules | Vir | Virgo |
| Hor | Horologium | Vol | Volans |
| Hya | Hydra | Vul | Vulpecula |
| Hyi | Hydrus | | |
| Ind | Indus | | |
| Lac | Lacerta | | |

APPENDIX E: COMMON OBJECT NAMES

These objects are listed in the order in which they appear on the window.

| | | |
|---------------------------|--------------------------|---------------------|
| 47Tuc | Hourglass Nebula | Eta Carina Nebula |
| Andromeda Galaxy | Hubble's Variable Nebula | Gamma Cas Nebula |
| Antennae | Jewel Box | Gamma Cygnus Nebula |
| Barnard's Galaxy | Lacework Nebula | Kappa Cru Cluster |
| Baxendell's Nebula | Lagoon Nebula | Lambda-1 Cen Nebula |
| Bear Paw Galaxy | Little Dumbell | Lambda-2 Cen Nebula |
| Beehive Cluster | Little Gem | Omega Cen |
| Black-eye Galaxy | Maia Nebula | Rho Oph Nebula |
| Blinking Planetary | Merope Nebula | |
| Blue Snowball | The Mice | |
| Blue Planetary | Network-1 Nebula | |
| Bode's Nebula | Network-2 Nebula | |
| Box | North American Nebula | |
| Box Nebula | Omega Nebula | |
| Bubble Nebula | Owl Nebula | |
| Bug Nebula | Papillon | |
| Butterfly Cluster | Pelican Nebula | |
| Butterfly Nebula | Pin-wheel Nebula | |
| California Nebula | Polarissima Australis | |
| Christmas Tree Cluster | Polarissima Borealis | |
| Cocoon Nebula | Praesepe | |
| Cone Nebula | Ring Nebula in Lyra | |
| Copeland's Septet | Rosette Nebula | |
| Crab Nebula | Saturn Nebula | |
| Crescent Nebula | Sculptor Galaxy | |
| Double Cluster | Siamese Twins | |
| Dumbell Nebula | Sombrero Galaxy | |
| Eagle Nebula | Southern Pleiades | |
| Eight-burst Planetary | Spindle Galaxy | |
| Eskimo Nebula | Star Queen Nebula | |
| The Eyes | Stephan's Quintet | |
| Filamentary Nebula | Struve's Lost Nebula | |
| Flaming Star Nebula | Sunflower Galaxy | |
| Ghost of Jupiter | Tarantula Nebula | |
| Great Cluster in Hercules | Toby Jug Nebula | |
| Great Nebula in Andromeda | Triangulum Galaxy | |
| Great Nebula in Orion | Trifid Nebula | |
| Helix Galaxy | Veil Nebula | |
| Helix Nebula | Whirlpool Galaxy | |
| Hind's Variable Nebula | Wild Duck Cluster | |
| Horsehead Nebula | Witch Head Nebula | |

APPENDIX F: AITKEN'S DOUBLE STAR (ADS) LIST

These commonly observed double stars were chosen from R. G. Aitken's [New General Catalogue of Double Stars](#). Please note that the separations are approximate and may vary from year to year. If you are an avid double star observer, please consult an ephemeris for the most accurate data.

| ADS Number | Name | Separation | ADS Number | Name | Separation |
|------------|----------------------|------------|------------|----------------|------------|
| 00111 | Kappa1 Sci | 1.4 | 04002 | Eta Ori | 1.5 |
| 00191 | 35 Psc | 11.6 | 04066 | Beta Lep | 2.5 |
| 00434 | Lambda Cas | 0.6 | 04134 | Delta Ori | 52.6 |
| 00513 | Pi And | 35.9 | 04177 | 19 Cam | 1.3 |
| 00520 | Beta 395 Cet | 0.5 | 04179 | Lambda Ori | 4.4 |
| 00558 | 55 Psc | 6.5 | 04186 | Theta1 Ori | |
| 00624 | HN 122 | 36.1 | 04241 | Sigma Ori | 0.2 |
| 00671 | Eta Cas | 12.9 | 04263 | Zeta Ori | 2.3 |
| 00683 | 65 Psc | 4.4 | 04334 | Gamma Lep | 96.3 |
| 00755 | 36 And | 0.9 | 04566 | Theta Aur | 3.6 |
| 00782 | Gamma Cas | 2.1 | 04773 | 41 Aur | 7.7 |
| 00899 | Psi1 Psc | 30.0 | 04841 | Eta Gem | 1.6 |
| 00996 | Zeta Psc | 23.0 | 04990 | Mu Gem | 121.7 |
| 01003 | 37 Cet | 49.7 | 05012 | Epsilon Mon | 13.4 |
| 01081 | 42 Cet | 1.6 | 05107 | Beta Mon | 7.3 |
| 01129 | Psi Cas | 25.0 | 05166 | 20 Gem | 20.0 |
| 01394 | Epsilon Scl | 4.7 | 05253 | Nu1 CMa | 17.5 |
| 01457 | 1 Air | 2.8 | 05400 | 12 Lyn | 1.7 |
| 01477 | Alpha UMi | 18.4 | 05423 | Alpha CMa | 4.6 |
| 01507 | Gamma Ari | 7.8 | 05514 | 14 Lyn | 0.4 |
| 01538 | Sigma 186 Cet | 1.1 | 05559 | 38 Gem | 5.2 |
| 01563 | Lambda Ari | 37.4 | 05605 | Mu CMa | 3.0 |
| 01598 | 48 Cas | 0.9 | 05654 | Epsilon CMa | 7.5 |
| 01615 | Alpha Psc | 1.8 | 05961 | Lambda Gem | 9.6 |
| 01630 | Gamma And | 9.8 | 05983 | Delta Gem | 5.8 |
| 01631 | 10 Ari | 1.1 | 06101 | Eta CMi | 4.0 |
| 01683 | 59 And | 16.6 | 06175 | Alpha Gem | 3.9 |
| 01697 | 6 Tri | 3.9 | 06190 | n Pup | 9.6 |
| 01703 | 66 Cet | 16.5 | 06255 | k Pup | 9.9 |
| 01778 | Omicron Cet | 0.1 | 06321 | Kappa Gem | 7.1 |
| 01860 | Iota Cas | 2.5 | 06420 | 9 Pup | 0.2 |
| 01954 | Omega For | 10.8 | 06650 | Zeta Cnc | 6.0 |
| 02080 | Gamma Cet | 2.8 | 06724 | Sigma 1193 UMa | 43.1 |
| 02157 | Eta Per | 28.3 | 06815 | Phi2 Cnc | 5.1 |
| 02200 | 20 Per | 14.1 | 06914 | Beta 208 Pyx | 1.6 |
| 02257 | Epsilon Ari | 1.4 | 06988 | Iota Cnc | 30.5 |
| 02312 | Rho2 Eri | 1.8 | 06993 | Epsilon Hya | 2.7 |
| 02362 | Beta Per | 81.0 | 07114 | Iota UMa | 2.0 |
| 02402 | Alpha For | 5.1 | 07203 | Sigma2 UMa | 3.9 |
| 02616 | 7 Tau | 0.8 | 07292 | 38 Lyn | 2.7 |
| 02799 | Omicron Sigma 65 Tau | 0.2 | 07307 | Sigma 1338 Lyn | 1.0 |
| 02843 | Zeta Per | 12.9 | 07351 | Kappa Leo | 2.1 |
| 02867 | Omicron Sigma 67 Cam | 12.9 | 07390 | Omega Leo | 0.6 |
| 02888 | Epsilon Per | 8.8 | 07402 | 23 UMa | 22.7 |
| 03079 | 39 Eri | 6.4 | 07545 | Phi UMa | 0.3 |
| 03093 | Omicron2 Eri | 83.4 | 07555 | Gamma Sex | 0.6 |
| 03137 | Phi Tau | 52.1 | 07654 | Alpha Leo | 176.9 |
| 03161 | Chi Tau | 19.4 | 07724 | Gamma Leo | 4.4 |
| 03321 | Alpha Tau | 121.7 | 07846 | Beta 411 Hya | 1.4 |
| 03572 | Omega Aur | 5.4 | 08119 | Xi UMa | 1.8 |
| 03797 | Rho Ori | 7.0 | 08123 | Nu UMa | 7.2 |
| 03800 | Kappa Lep | 2.6 | 08148 | Iota Leo | 1.7 |
| 03823 | Beta Ori | 9.5 | 08153 | Gamma Crt | 5.2 |

| ADS Number | Name | Separation | ADS Number | Name | Separation |
|------------|-----------------------|------------|------------|----------------|------------|
| 08175 | 57 UMa | 5.4 | 11635 | Epsilon Lyr | 207.7 |
| 08196 | 88 Leo | 8.4 | 11639 | Zeta Lyr | 43.7 |
| 08197 | Omicron Sigma 235 UMa | 0.6 | 11745 | Beta Lyr | 45.7 |
| 08406 | 2 Com | 3.7 | 11853 | Theta Ser | 22.3 |
| 08539 | Sigma 1639 Com | 1.7 | 12197 | Eta Lyr | 28.1 |
| 08572 | Delta Crv | 24.2 | 12540 | Beta Cyg | 34.4 |
| 08573 | Beta 28 Crv | 2.2 | 12789 | Sigma 2573 Dra | 18.2 |
| 08600 | 24 Com | 20.3 | 12880 | Delta Cyg | 2.5 |
| 08630 | Gamma Vir | 1.8 | 12962 | Pi Aql 1.4 | |
| 08682 | Sigma 1694 Cam | 21.6 | 13007 | Epsilon Dra | 3.1 |
| 08695 | 35 Com | 1.2 | 13148 | Psi Cyg | 3.2 |
| 08706 | Alpha CVn | 19.4 | 13371 | Sigma 2640 Dra | 5.6 |
| 08801 | Theta Vir | 7.1 | 2 | Theta Sge | 11.9 |
| 08891 | Zeta UMa | 14.4 | 13524 | Kappa Cep | 7.4 |
| 08974 | 25 CVn | 1.8 | 13632 | Alpha1 Cap | 45.4 |
| 09000 | 84 Vir | 2.9 | 13645 | Alpha2 Cap | 6.6 |
| 09025 | Tau Boo | 4.8 | 13765 | Gamma Cyg | 41.2 |
| 09085 | au Vir | 80.0 | 13887 | Rho Cap | 0.5 |
| 09173 | Kappa Boo | 13.4 | 14158 | 49 Cyg | 2.7 |
| 09198 | Iota Boo | 38.5 | 14259 | 52 Cyg | 6.0 |
| 09273 | Phi Vir | 4.8 | 14279 | Gamma Del | 9.6 |
| 09338 | Pi Boo | 5.6 | 14296 | Lambda Cyg | 0.9 |
| 09343 | Zeta Boo | 0.8 | 14360 | 4 Aqr | 0.8 |
| 09372 | Epsilon Boo | 2.8 | 14499 | Epsilon Equ | 0.8 |
| 09396 | Mu Lib | 1.8 | 14636 | 61 Cyg | 30.3 |
| 09406 | 39 Boo | 2.9 | 14787 | Tau Cyg | 0.8 |
| 09413 | Xi Boo | 6.6 | 15032 | Beta Cep | 13.3 |
| 09425 | Omicron Sigma 288 Boo | 0.8 | 15270 | Mu Cyg | 1.2 |
| 09494 | 44,i Boo | 2.2 | 15281 | Kappa Peg | 0.2 |
| 09532 | Iota1 Lib | 57.8 | 15536 | Eta PsA | 1.7 |
| 09584 | 5 Ser | 11.2 | 15600 | Xi Cep | 8.2 |
| 09617 | Eta CrB | 0.8 | 15719 | Sigma 2883 Cep | 14.6 |
| 09626 | Mu Boo | 108.3 | 15753 | 41 Aqr | 5.0 |
| 09701 | Delta Ser | 4.4 | 15764 | Sigma 2893 Cep | 28.9 |
| 09737 | Zeta CrB | 6.3 | 15828 | Sigma 2894 Lac | 15.6 |
| 09909 | Xi Sco | 0.4 | 15934 | 53 Aqr | 3.1 |
| 09913 | Beta Sco | 13.6 | 15971 | Zeta Aqr | 2.1 |
| 09951 | Nu Sco | 41.1 | 15987 | Delta Cep | 41.0 |
| 09979 | Alpha CrB | 7.1 | 16095 | 8 Lac | 22.4 |
| 10049 | Rho Oph | 3.1 | 16261 | Xi Peg | 11.5 |
| 10058 | Eta Dra | 5.2 | 16268 | Tau1 Aqr | 23.7 |
| 10074 | Alpha Sco | 2.6 | 16538 | Pi Cep | 1.1 |
| 10087 | Lambda Oph | 1.5 | 16633 | Psi1 Aqr | 49.6 |
| 10157 | Zeta Her | 0.8 | 16666 | Omicron Cep | 2.8 |
| 10279 | 20 Dra | 1.3 | 16672 | 94 Aqr | 12.7 |
| 10345 | Mu Dra | 1.9 | 16836 | 72 Peg | 0.5 |
| 10418 | Alpha Her | 4.6 | 16957 | 78 Peg | 1.0 |
| 10424 | Delta Her | 8.9 | 16979 | 107 Aqr | 6.6 |
| 10526 | Rho Her | 4.1 | 17022 | 6 Cas | 1.6 |
| 10628 | Nu Dra | 61.9 | 17140 | Sigma Cas | 3.0 |
| 10660 | 26 Dra | 1.7 | 17175 | 85 Peg | 0.7 |
| 10759 | Psi1 Dra | 30.3 | | | |
| 10786 | Mu Her | 33.8 | | | |
| 10875 | 90 Her | 1.6 | | | |
| 11005 | Tau Oph | 1.7 | | | |
| 11046 | 70 Oph | 4.5 | | | |
| 11061 | 40/41 Dra | 19.3 | | | |
| 11483 | Omicron Sigma 358 Her | 1.3 | | | |

APPENDIX G: THE GREEK ALPHABET

We have included this list for your reference to help you translate Greek letter designations that may be used in your star atlas or other reference. The abbreviations are used in the keypad's Stars/Constell Tour as described previously under the heading "Greek Star Names, organized by constellation." They are also used in Appendices C & D and in many publications and planetarium programs.

| Symbol | | Translation | Abbreviation |
|---------------|---|--------------------|---------------------|
| A | α | Alpha | Alf |
| B | β | Beta | Bet |
| Γ | γ | Gamma | Gam |
| Δ | δ | Delta | Del |
| E | ε | Epsilon | Eps |
| Z | ζ | Zeta | Zet |
| H | η | Eta | Eta |
| Θ | θ | Theta | Tet |
| I | ι | Iota | Iot |
| K | κ | Kappa | Kap |
| Λ | λ | Lambda | Lam |
| M | μ | Mu | Mu |
| N | ν | Nu | Nu |
| Ξ | ξ | Xi | Xi |
| O | ο | Omicron | Omi |
| Π | π | Pi | Pi |
| P | ρ | Rho | Rho |
| Σ | σ | Sigma | Sig |
| T | τ | Tau | Tau |
| Υ | υ | Upsilon | Ups |
| Φ | φ | Phi | Phi |
| X | χ | Chi | Chi |
| Ψ | ψ | Psi | Psi |
| Ω | ω | Omega | Omg (or Ome) |

APPENDIX H: SUGGESTED STARS FOR THE GTO QUICK STAR DRIFT METHOD

The following list of stars is intended to make the GTO Quick Star Drift Method much quicker and easier. Since hunting through a star atlas for suitable stars can take as long as performing the actual method itself, we put together this list of suggested stars to give you a big head start in most situations. The paired columns suggest pairs of stars that are found in the keypad's database for the northern and southern hemispheres. The stars in each row are very close in Right Ascension, but differ substantially in Declination. Use the pairings for the azimuth portion of this method. Since the rows are all relatively close in RA, you usually have the option of choosing a replacement star if one of the suggested stars is obstructed in some way. Stars on the list that are near the celestial equator are good choices for the altitude iterations.

Two additional partial columns of stars were added in the middle to increase your number of choices. Stars were added here if we felt that a gap needed filling in a particular RA row, or if one of the polar stars was very close to the pole, and therefore not suitable for a non-orthogonal system. There are, unfortunately, some parts of the sky where suitable stars are simply not to be found.

For the altitude portion of the adjustment, most people will find that the ideal star will be in the column for the other hemisphere's non-polar side. In other words, people in the north may find the best choice in the southern hemisphere's "NORTH" column, and those in the south will find good choices in the northern hemisphere's "SOUTH" column. These will tend to be stars that are not too far from the celestial equator, but are also somewhat overhead. If there is a star listed in the "Optional Additional Star" column, it may also be an excellent choice for the altitude adjustment. Choose a star that is slightly south of your zenith if you are in the northern hemisphere, and north of your zenith if you are down under. This is to protect your instrument from hitting the pier when you flip sides.

For the azimuth portion, make sure that BOTH stars are on the same side of the meridian. For example, in the southern hemisphere, if the LST is at 06:30, do not choose Canopus at RA 06:23 and Alhena at RA 06:37. Choose a pairing one or two rows above or below them in the list. Alternatively, you could wait a few minutes until the LST has gone past the higher RA, or you could activate the meridian delay feature to put both stars on the same side of the meridian. Also, keep in mind that you can be several hours east or west of the meridian with your azimuth pairs. The main advantage to being relatively close to the meridian is that you won't be as likely to lose stars in the atmospheric soup.

Remember also that any given RA value is equivalent to that same value plus or minus 12. What this means is that people in far northern or far southern latitudes can often substitute a circumpolar star 12 hours different in RA for one of the suggested stars. No matter what time of day or year, you should have available stars within one or two hours of the meridian. For example: assume you are at a latitude of +50 deg, and the LST is 02:30. You would choose the row with Eta Persei that has RA values near 02:50. Eta Persei, however, might be fine for someone at a latitude of 30 degrees, but at a latitude of 50, it is almost directly overhead. For the northern star in the azimuth routine, you could substitute Kochab which will have an equivalent RA of 14:50 and will be much lower in the north. Likewise, a person using this method from the southern tip of New Zealand when the LST is at 06:30 might decide that Canopus at RA 06:23 is much too straight overhead and choose Zeta Pavonis at R.A. 18:43 as the southern star instead in the azimuth routine.

Please note: The stars below that are listed by their Bayer designation must be accessed through the 1=Objects => 8=Tour => 1=Stars/Constell. menu system. The stars listed with common names are accessed through 1=Objects => 5=Strs.

SUGGESTED STARS FOR GTO QUICK STAR DRIFT METHOD

| | Northern Hemisphere Azimuth Pairs | | | Southern Hemisphere Azimuth Pairs | |
|-------|--------------------------------------|-----------------------------------|---------------------------|--------------------------------------|-----------|
| | North | South | Optional Additional Stars | North | South |
| | | (Southern Hemisphere Altitude) | | (Northern Hemisphere Altitude) | |
| Star: | Caph | Iota Cent | Beta Tuc | Algenib | Beta Hyi |
| RA: | 00:09:11 | 00:19:25 | 00:31:33 | 00:13:14 | 00:25:45 |
| Dec: | +59°09:00 | -08°49:00 | -62°57:00 | +15°11:01 | -77°15:00 |
| Star: | Teta Cas | Eta Cent | | Epsilon Psc | Zeta Phe |
| RA: | 01:11:06 | 01:08:35 | | 01:02:56 | 01:08:23 |
| Dec: | +55°09:00 | -10°10:00 | | +07°53:00 | -55°14:00 |
| Star: | Epsilon Cas | Baten Kaitos | Alrescha | Sheratan | Alf Hyi |
| RA: | 01:54:23 | 01:51:28 | 02:02:03 | 01:54:38 | 01:58:46 |
| Dec: | +63°40:00 | -10°20:05 | +02°45:49 | +20°48:28 | -61°34:00 |

| | Northern Hemisphere | | Optional Stars | | Southern Hemisphere | |
|-------|---------------------|---------------|----------------|-----------|---------------------|-------------|
| | North | South | | | North | South |
| Star: | Eta Per | Tau 2 Eri | Azha | Acamar | Mu Cet | Nu Hyi |
| RA: | 02:50:41 | 02:51:02 | 02:56:26 | 02:58:16 | 02:44:56 | 02:50:28 |
| Dec: | +55°53:00 | -21°00:00 | -08°53:53 | -40°18:18 | +10°06:00 | -75°04:00 |
| Star: | Gam Cam | Tau 8 Eri | Lam Tau | Del Ret | Atik | Gam Hyi |
| RA: | 03:50:21 | 03:53:42 | 04:00:40 | 03:58:44 | 03:54:08 | 03:47:14 |
| Dec: | +71°19:00 | -24°36:00 | +12°29:00 | -61°24:00 | +31°53:02 | -74°14:00 |
| Star: | Alf Cam | Omg Eri | | | Aldebaran | Alf Dor |
| RA: | 04:54:03 | 04:52:53 | | | 04:35:55 | 04:33:59 |
| Dec: | +66°20:00 | -05°27:00 | | | +16°30:33 | -55°02:00 |
| Star: | Menkalinan | Eta Lep | | | Betelgeuse | Gam Pic |
| RA: | 05:59:32 | 05:56:24 | | | 05:55:10 | 05:49:49 |
| Dec: | +44°56:52 | -14°10:00 | | | +07°24:25 | -56°10:00 |
| Star: | Tet Gem | Adhara | Sirius | | Alhena | Canopus |
| RA: | 06:52:47 | 06:58:38 | 06:45:09 | | 06:37:43 | 06:23:57 |
| Dec: | +33°57:00 | -28°58:19 | -16°42:57 | | +16°23:57 | -52°41:45 |
| Star: | Pollux | Alf Mon | | Chi Car | Procyon | Zet Vol |
| RA: | 07:45:19 | 07:41:14 | | 07:56:46 | 07:39:18 | 07:41:49 |
| Dec: | +28°01:34 | -09°33:00 | | -52°58:00 | +05°13:29 | -72°36:00 |
| Star: | Rho Uma | Gam Pyx | Alphard | | Acubens | Miaplacidus |
| RA: | 09:02:32 | 08:50:31 | 09:27:35 | | 08:58:29 | 09:13:12 |
| Dec: | +67°37:00 | -27°42:00 | -08°39:31 | | +11°51:27 | -69°43:03 |
| Star: | Tania Australis | Mu Hya | Rho Leo | Tet Car | Algieba | Gam Cha |
| RA: | 10:22:20 | 10:26:05 | 10:32:48 | 10:42:57 | 10:19:58 | 10:35:28 |
| Dec: | +41°29:59 | -16°50:00 | +09°18:00 | -64°23:00 | +19°50:28 | -78°36:00 |
| Star: | Giausar | Zet Crt | Zavijava | | Denebola | Lam Mus |
| RA: | 11:31:24 | 11:44:45 | 11:50:42 | | 11:49:04 | 11:45:36 |
| Dec: | +69°19:53 | -18°21:00 | +01°45:52 | | +14°34:18 | -66°43:00 |
| Star: | Alioth | Psi Vir | | Mimosa | Vindematrix | Del Mus |
| RA: | 12:54:02 | 12:54:21 | | 12:47:43 | 13:02:11 | 13:02:16 |
| Dec: | +55°57:36 | -09°32:00 | | -59°41:20 | +10°57:32 | -71°32:00 |
| Star: | Mizar (brighter) | Spica | | | Zet Vir | Eps Cen |
| RA: | 13:23:50 | 13:25:12 | | | 13:34:41 | 13:39:53 |
| Dec: | +54°55:31 | -11°09:41 | | | -00°35:00 | -53°27:00 |
| Star: | Thuban | Pi Hya | Tau Vir | | Muphrid | Hadar |
| RA: | 14:04:23 | 14:06:22 | 14:01:38 | | 13:54:41 | 14:03:49 |
| Dec: | +64°22:34 | -26°40:00 | +01°32:00 | | +18°23:51 | -60°22:23 |
| Star: | Kochab | Zubenelgenubi | Mu Vir | Alf Aps | Izar | Alf Cen |
| RA: | 14:50:42 | 14:50:53 | 14:43:03 | 14:47:51 | 14:44:59 | 14:39:36 |
| Dec: | +74°09:20 | -16°02:30 | -05°39:00 | -79°02:00 | +27°04:26 | -60°50:00 |
| Star: | Tet Dra | Del Sco | Mu Ser | | Gam Ser | Bet TrA |
| RA: | 16:01:53 | 16:00:19 | 15:49:37 | | 15:56:27 | 15:55:08 |
| Dec: | +58°33:00 | -22°37:00 | -03°25:00 | | +15°39:00 | -63°25:00 |
| Star: | Eta Dra | Antares | Lam Oph | Eps Nor | Kornephoros | Gam Aps |
| RA: | 16:23:59 | 16:29:24 | 16:30:54 | 16:27:11 | 16:30:13 | 16:33:27 |
| Dec: | +61°30:00 | -26°25:55 | +01°59:00 | -47°33:00 | +21°29:22 | -78°53:00 |
| Star: | Del Umi | Xi Ser | Rastaban | | Rasalhague | Del Ara |
| RA: | 17:32:12 | 17:37:35 | 17:30:23 | | 17:34:56 | 17:31:05 |
| Dec: | +86°35:00 | -15°23:00 | +52°18:04 | | +12°33:36 | -60°41:00 |

| Northern Hemisphere | | | Southern Hemisphere | | | |
|---------------------|-----------|---------------|---------------------|-----------|-----------|-----------|
| | North | South | Optional Stars | | North | South |
| Star: | Chi Dra | Kaus Borealis | Eta Ser | | Vega | Xi Pav |
| RA: | 18:21:03 | 18:27:58 | 18:21:18 | | 18:36:56 | 18:23:13 |
| Dec: | +72*43:00 | -25*25:18 | -02*53:00 | | +38*47:01 | -61*29:00 |
| Star: | Rho Dra | Eta Aql | | | Gam Sge | Del Pav |
| RA: | 20:02:48 | 19:52:28 | | | 19:58:45 | 20:08:43 |
| Dec: | +67*52:00 | +01*00:00 | | | +19*29:00 | -66*10:00 |
| Star: | Alfirk | Sadalsuud | Pi 1 Cyg | Del Ind | Enif | Nu Oct |
| RA: | 21:28:39 | 21:31:34 | 21:42:05 | 21:57:55 | 21:44:11 | 21:41:28 |
| Dec: | +70*33:40 | -05*34:15 | +51*11:00 | -54*59:00 | +09*52:30 | -77*23:00 |
| Star: | lot Cep | Skat | | Eps Gru | Homam | Bet Oct |
| RA: | 22:49:40 | 22:54:39 | | 22:48:33 | 22:41:27 | 22:46:03 |
| Dec: | +66*12:00 | -15*49:14 | | -51*19:00 | +10*49:53 | -81*22:00 |

APPENDIX F: PRE-DEFINED PARK POSITIONS

The Mach2GTO does not require starting from pre-defined park positions, but it is often helpful to finish the evening in one.

Recommended: **Park 3** is a safe and balanced position. **Park 2** is a convenient position for loading and unloading your scope. **Park 5** is a safe, low profile position with minimum cable twisting.

PARK 1



Northern Hemisphere

The scope is level on the west side of the mount, facing the northern horizon. The counterweight shaft is also level and pointing due east. This position is also called the Reference Park Position.

Both Hemispheres: RA is horizontal, North: Dec = (90-Latitude) South: Dec = (-90-Latitude)

The southern hemisphere is mirror reversed. The scope is still level on the west side of the mount, but is facing the southern horizon. The counterweight shaft is also still level and pointing due east.

Southern Hemisphere



PARK 2



Northern Hemisphere

The scope is level on top of the mount facing the eastern horizon. The counterweight shaft is pointing down.

Both Hemispheres: RA axis is vertical, Dec = 0

The southern hemisphere is mirror reversed. The scope still points to the eastern horizon, but east is to the left when facing the southern pole.

Southern Hemisphere



PARK 3

Northern Hemisphere & Southern Hemisphere



The scope is pointing to the pole. The counterweight shaft is pointing down.

RA axis is vertical, Dec = 90

PARK 4

Northern Hemisphere

The scope is level on the east side of the mount, facing the southern horizon. The counterweight shaft is also level and pointing due west. This position is the New Reference Park Position.



Both Hemispheres: RA is horizontal,
North: Dec = (-90+Latitude) South: Dec = (90+Latitude)

The southern hemisphere is mirror reversed. The scope is still level on the east side of the mount, but is facing the northern horizon. The counterweight shaft is also still level and pointing due west.



Southern Hemisphere

PARK 5

Northern Hemisphere

The scope is level on the east side of the mount, facing the northern horizon. The counterweight shaft is also level and pointing due west.



Both Hemispheres: RA is horizontal,
North: Dec = (90-Latitude) South: Dec = (-90-Latitude)

The southern hemisphere is mirror reversed. The scope is still level on the east side of the mount, but is facing the southern horizon. The counterweight shaft is also level and pointing due west.



Southern Hemisphere

HOME POSITION

(Mach2GTO / GTOCP5)

Northern Hemisphere & Southern Hemisphere

This is a very special position that is established by Astro-Physics when programming the Absolute Encoders. It is highly precise.



APPENDIX G: HOW DOES KEYPAD V5.X DIFFER FROM V4.19.3?

We offer this information so that users of the previous v4.19.3 can quickly identify differences between the two programs. This should help to aid the transition from one to the other.

- You must use your keypad with a GTOCP5 (minimum version P02-07) or GTOCP4 (not publicly released yet).
- There are feature differences depending if your mount has a GTOCP4 or GTOCP5. The keypad will detect whether you have the proper version and will display the features that are available to your mount.
- The button pad has two significant changes: New keypads have these updated buttons. Older keypads can be used successfully even if you have the original button pad. You simply have to remember that the buttons have different functions.
 - FOC button is now RECAL. However, to prevent unintended recalibration, you must also press NEXT> simultaneously.
 - RA/DEC REV button is now ENT. and is used to confirm your entries rather than using GOTO. The RA/DEC Reverse function can be accessed with the +- button.
- The Sync command is no longer available and the RECAL button is readily available as mentioned above.
- You don't have to power cycle the mount if you change your location unless you are changing from the northern to southern hemisphere or vice versa.
- There are no polar alignment routines within the program. However, the various park positions can help you complete the Daytime Polar Alignment Routine.
- The startup routines are simplified.
- The keypad will automatically adjust to solar or lunar rate when you slew to the sun or moon, respectively. Note that the Main Menu will not display these two rates as current status or provide an option to toggle them. They are only active when you have slewed to the sun or moon.
- Pointing accuracy for stars has improved with proper motion added.
- Time Zone and Daylight Savings are now part of Date/Time setup.
- Very simple process to change to and from Daylight Savings.
- What's Up Now and Search have been combined into a more useful function.
- The keypad loader has been updated to a Java-based version that is more user friendly and can be used across platforms with Windows, Mac and Linux operating systems.
- New features include:
 - Flip scope option.
 - Model options: Point & Track, Drift and Ortho
 - Bookmark favorite objects for quick access or to preplan an observing session.
 - Set power level low, medium or high. (GTOCP5 only).
- These 4.19.3 features are no longer available: focus adjustment, illuminated reticle brightness adjustment, Safe Zone Limits, Horizon Limits, RA and Dec backlash adjustment and SmartGuide.