SkyWalker User's Manual

Using the Astrometric Telescope Control System

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Written for

The Astrometric Telescope Control System (ATCS)
based on the SkyWalker Telescope controller with
firmware version 0.01.000 or later.

This document can be ordered as Astrometric Instruments' part DOC-10

Warning

Observing the sun through a telescope, even for the briefest moment, will cause severe eye damage.

SkyWalker should never be used to observe near the sun. SkyWalker's automatic slew capability (i.e. GoTo) should be used with extreme care during the daytime. Automatic telescope control should not be relied upon to avoid pointing at the sun. The user should carefully verify that the telescope is not pointing anywhere near the sun before observing.

If there is any confusion in regard to this warning please contact Astrometric customer service at support@astrometric.com

Preface

This document describes how to use the Astrometric Telescope Control System (ATCS). ATCS is based upon the SkyWalker telescope controller. There are several SkyWalker models however they are all nearly identical in functionality. This manual applies to all SkyWalker models.

It is highly recommended that the "Introduction to the Astrometric Telescope Control System" be read prior to this manual since a complete overview of ATCS is provided there and is not replicated here.

Notes

- *Italicized* words are names that are specific to the Astrometric Telescope Control System (ATCS). *Italicized* names are defined in Appendix A: "Glossary of Terms".
- All notes and documentation describing new features and differences in the latest version of SkyWalker firmware are included in the firmware release notes available from our support page at **www.astrometric.com.**
- If using Astrometric's S-Box upgrade for older (pre Oct-2004) SkyWalkers then the term "SkyWalker" in this manual actually refers to the S-Box, not to the older SkyWalker.
- Important notes on using SkyWalker are "accented" in this document as follows:

Important: Please read important notes.

- Documentation upgrades are available as PDF files to be viewed with (the free) Adobe Acrobat Reader v4.0 or later. Registered users can download PDF documentation from our support page at **www.astrometric.com** or request a file be returned via email by sending a request to **support@astrometric.com**. Replacement printed documentation will be provided, at cost, if requested by a registered user.

Other ATCS documentation

- "Introduction to the Astrometric Telescope Control System". Provides an overview of ATCS and instructions for installing ATCS on various telescope mountings. There are several versions of this document each tailored to a particular type of SkyWalker controller and/or particular type of telescope mounting.
- A "Hardware Reference Manual" exists for each SkyWalker model. These include electrical, mechanical and environmental specifications/requirements and connector pin-out diagrams.

Chapter 1: Introduction

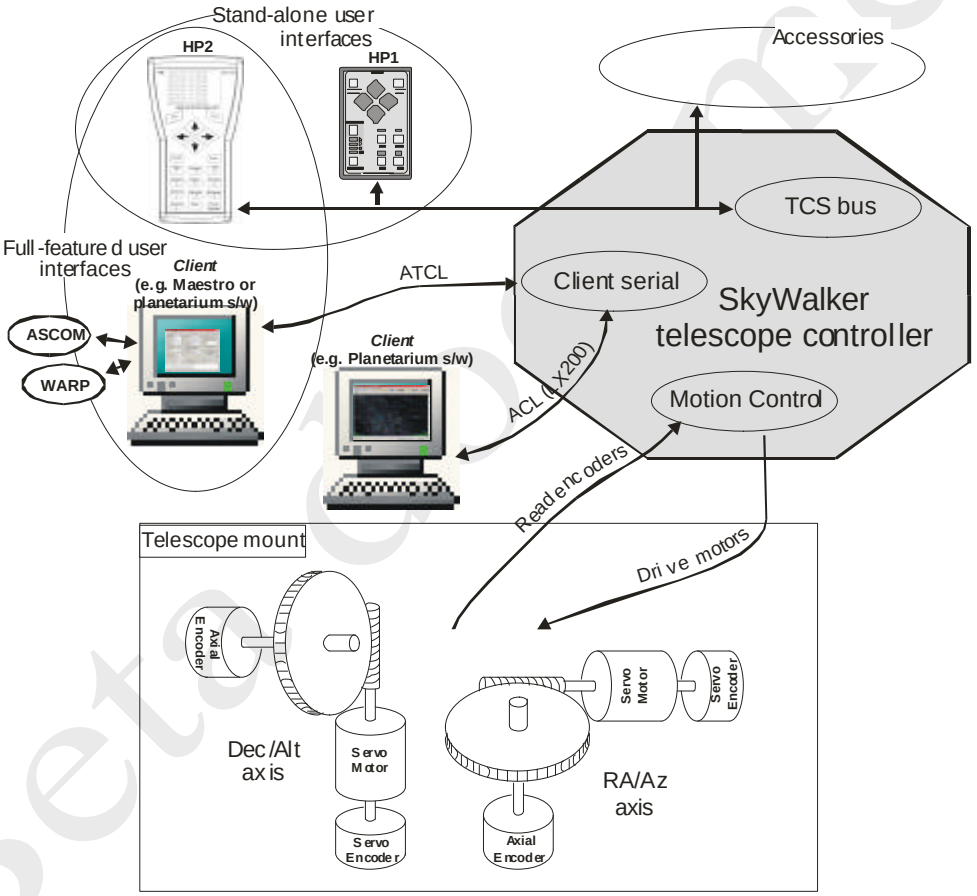
This chapter provides an introduction to SkyWalker and how it can be used to control all aspects of a complete telescope system.

What is SkyWalker?

SkyWalker is the heart of the versatile Astrometric Telescope Control System (ATCS). SkyWalker is designed to provide sophisticated, yet easily utilized, control for all types of telescopes and accessories. SkyWalker works with any type of telescope mount. Polar alignment is not necessary. SkyWalker performs the necessary coordinate translations between the mount's coordinate system (e.g. Alt/Az) and the celestial sphere.

The following is a block diagram of SkyWalker at the center of a full-featured telescope control system showing all the components with which SkyWalker can function:

Astrometric Telescope Control System



Suggested approach to reading this manual

The interaction of SkyWalker and each ATCS system component is detailed in this manual. The remaining part of this section provides an introduction to the structure of this manual pursuant with the above diagram. Armed with this introduction you should be able to narrow-in on the sections of the manual that are important to you.

Note: for first-time SkyWalker users it is **highly** recommended that you read at least this chapter and chapter 2 in detail.

Motion control

SkyWalker's primary purpose is to control telescope motion using targeting algorithms to acquire and track celestial objects. Because of this primary purpose, the bulk of this manual is dedicated to describing how to use SkyWalker as a telescope motion controller. To physically achieve this motion control, SkyWalker is designed to directly drive (and control) motors over a very large dynamic range thus enabling low-speed and smooth tracking while also providing high speed slew for object acquisition (i.e. GoTo).

Refer to chapter 14 ("The SkyWalker pointing model") for details on SkyWalker's motion control algorithms.

Instrumental settings

The initial settings necessary for SkyWalker to provide motion control for an arbitrary telescope mount are described in chapter 6 ("Instrumental settings"). For Retro-fit installations, the instrumental settings will be largely predefined as part of the "Start-up checklist" (later in this chapter) and thus chapter 6 can be skipped. For custom installations chapter 6 should be read in detail and applied in its entirety.

Operational settings

Chapter 7 ("Operational settings") addresses settings associated with actually using the system. These are settings that the user will likely change regularly (versus the instrumental settings, which the user will likely change infrequently once properly set for the first time).

Alignment and Calibration

Before SkyWalker can be used for anything other than rudimentary motion control, it must be aligned to the celestial sphere. This process is described in chapter 8 ("Celestial alignment"). SkyWalker's alignment can be refined (i.e. calibrated) during operation as necessary to improve pointing. This process is described in chapter 9 ("Celestial alignment calibration").

Celestial object acquisition

A fundamental capability of a telescope control system is "GoTo". SkyWalker is no exception. Any object from SkyWalker's extensive built-in celestial object database (described in chapter 10), arbitrary coordinates, or a target provided by *Client* software is available as a GoTo target. SkyWalker's GoTo feature includes several convenient sub-features (e.g. AutoCalibration, Consistent Approach GoTo) and is effected by several settings as described in chapter 11 ("GoTo").

Miscellaneous telescope control features

On of SkyWalker's strengths is that it includes several tools and features which go beyond simple telescope motion control. Descriptions of these features are provided in chapter 12 ("Other telescope control features"). These include features such as autoguider support, coordinate mark and return, time tools, and motor driver monitoring.

The *Pointing Model*

The motion control algorithms that SkyWalker uses to acquire and track celestial objects are called its *Pointing Model*. SkyWalker's *Pointing Model* is detailed in chapter 14 and is the key component that allows SkyWalker to work as a sophisticated telescope motion controller. In this capacity, SkyWalker sequences motors to acquire and track celestial objects with a plethora of advanced error correction/compensation techniques.

Correcting for gearing errors

Chapter 15 describes how to use SkyWalker's Periodic Error and Backlash correction features to remove the most common errors in typical telescope gear reduction.

Encoder feedback

In addition to the encoders that are included as standard equipment on SkyWalker's servomotors (used to position the motor shaft with sub-arcsecond precision) SkyWalker supports reading axial encoders placed on the telescope axes. This provides for no loss of alignment when the telescope is moved manually or is otherwise "decoupled" from the motors. Use of axial encoders is described in chapter 16.

User interfaces

SkyWalker supports two categories of user interfaces: **Stand-alone user interfaces** and **Full-featured user interfaces**.

Stand-alone user interfaces

Stand-alone user interfaces allow SkyWalker to operate without connection to a PC. Stand-alone user interfaces are dedicated handpaddle devices. Astrometric Instruments offers two handpaddle models: HP1 and HP2.

HP1 is a basic handpaddle that does not provide a display and keypad interface to SkyWalker. HP1 is used when a full user interface is provided to SkyWalker through another means such as our Maestro *Client* software or our HP2 handpaddle. HP1 does provide for full stand-alone operation of SkyWalker within the constraints of the functionality available from HP1 (e.g. movement keys, track rate and "view velocity" settings, focus).

HP2 is our full-featured handpaddle which includes all the functions of HP1 with the addition of a full user interface from an LCD display showing SkyWalker's *Instrument Display* and a keypad for command entry.

The use of HP1 and HP2 is described in chapter 3 "SkyWalker's handpaddles".

Full-featured user interfaces

Client software (running on a local or remote computer) and the HP2 handpaddle both provide full-featured user interfaces to SkyWalker's functionality.

Client software interfaces to SkyWalker via serial (RS232 or RS422/USB/Ethernet with proper converter) connection and can expose all SkyWalker's features to the user. Astrometric Instruments offers a *Client* called Maestro which runs on Microsoft Windows based PCs. Maestro is described in chapter 4 "Maestro: SkyWalker control software".

As mentioned above, HP2 is full-featured in that it provides a keypad and *Instrument Display* interface.

Note: full-featured user interfaces can display a variety of system status and provide useful system diagnostic tools as described in chapter 13 ("Status and Diagnostics").

Message reporting to the user

Regardless of the user interface used, SkyWalker provides a diverse set of messages associated with system events.

General support for *Client* software

Additional features are available because SkyWalker provides an extensive serial interface protocol which allows local or remote PC-based *Client* software to extend SkyWalker's capabilities.

Capabilities include "point and click" object acquisition from PC-base star chart (i.e. planetarium) software, full "scripted" telescope control, joystick control and connection to nearly any software supporting telescope control through SkyWalker's diverse support of interface standards (some of which are provided by Astrometric's SkyWalker *Client*, Maestro, running on a Microsoft Windows based PC). Full details are provided in chapter 18 ("Telescope Control via Client software").

Accessory control

<<Section needed>>

Host software interface

<<Section needed>>

SkyWalker functionality categorized

As mentioned in the previous section, SkyWalker supports two types of user interfaces: a handpaddle or *Client* software running on an attached computer. Regardless of the type of user interface, SkyWalker, at the highest-level, provides four basic categories of functionality. These categories are important to introduce and delineate since the structure of SkyWalker's user interfaces are based around them. The functional categories are:

1. Initiating **actions** (i.e. "controlling" the telescope). For example:
   - Automatic slewing or "GoTo" arbitrary coordinates
   - Handpaddle and autoguider input
   - Coordinate and time "marking"
   - Timer and Alarm functions
2. **Object** GoTo and object data access
   - Automatic GoTo (coordinate, Planet or over 16000 deep sky objects).
   - Complete/current data on planets and deep sky objects
3. Specify/change system **settings**. This includes items such as:
   - Instrumental settings (for example: the details of a particular telescope mount)
   - Operational settings (for example: the velocities associated with handpaddle motion)
   - Location settings (for example: the latitude/longitude of observing sites)
   - Preferences (for example: the time and coordinate formats that SkyWalker uses)
   - Telescope alignment.
   - Error correction details for compensation of gearing and mount errors.
4. Access to system **status**
   - Coordinates
   - Various time and date formats
   - System hardware and accessory status
   - Complete control status (modes, rates, error correction status)

What next?

The next chapter takes you through the basic operation of SkyWalker and serves as an introduction to SkyWalker's features and methods of use.

The most **important** section of the next chapter is the **"Start-up checklist"**. This list should be carefully read prior to using SkyWalker under the stars.

Chapter 2: Using SkyWalker for the first time

This chapter provides an overview of SkyWalker's operation. It is organized as a tour of the main features of SkyWalker. More complete details on the use of SkyWalker can be found in the remaining chapters of this manual. It is best to read this chapter while actually using SkyWalker hence it is organized as a working tour and includes instructions on running SkyWalker. The following sections are included:

- First power-on
- Selecting a user interface
- *Instrument Display* introduced
- Important initial settings
- Making SkyWalker take action
- Status of ATCS
- Object GoTo and object data access
- Viewing and changing ATCS settings
- Controlling SkyWalker from *Client* (e.g. planetarium) software
- SkyWalker's messages
- Next steps: using SkyWalker night after night
- Start-up checklist

Being an overview, this chapter makes much reference to more detailed descriptions in the other chapters of this manual.

Important: The most important section of this chapter, to **read and understand**, is the **"Start-up checklist"**. If you don't want to study other sections of this chapter and other chapters in the manual **please** be sure to at least go through the "Start-up checklist" in detail. It contains important information/instructions on the use of SkyWalker. Failure to adhere to items on the "Start-up checklist" can lead to problems, or at least confusing behavior.

The "Start-up checklist" is presented at the end of this chapter since the introductory material, in the preceding sections of this chapter, provide important background.

First power-on

When SkyWalker is first powered-on it will energize its motors and begin tracking. The rate at which it tracks will simply be based on its arbitrary initial settings since no settings specific to your telescope installation have been made.

Important: Verify that the clutches on your telescope mount are fully loosened before first power-on. This will assure that no damage to your system will result while you learn the basics of using SkyWalker. After carefully completing the "Start-up checklist" at the end of this chapter you will be ready to use your system with clutches engaged.

Selecting a user interface

Simply powering-on SkyWalker is not sufficient to begin using it. You need to select a user interface.

Recall from chapter 1 that Astrometric Instruments provides two full-featured user interfaces to SkyWalker: HP2 and Maestro. HP2 is a dedicated hardware handpaddle with LCD display and keypad (described in chapter 3). Maestro is Astrometric Instruments' SkyWalker *Client* software for use on a Microsoft Windows based PC (described in chapter 4).

Either the HP2 or Maestro (or 3rd party software which can act as a SkyWalker *Client*) must be present to use SkyWalker (otherwise you, the user, would have no interface to SkyWalker!).

To use the HP2 simply plug it into a spare "HP/TCS" port on SkyWalker prior to turning SkyWalker on.

To use Maestro you must first install it and start it up per the instructions in the beginning of chapter 4.

Note: you can actually use SkyWalker with only an HP1 however the functionality is necessarily limited to that accessible from the HP1 keypad (e.g. directional movement, track rate selection, velocity selection, focus, *Quick Key* functions, etc.).

Note: you can use HP2 and Maestro simultaneously. The functionality contained in the *Instrument Display* is actually implemented inside SkyWalker (not in HP2 or Maestro) and SkyWalker provides two independent *Instrument Display* interfaces.

Instrument Display introduced

Both the HP2 and Maestro provide an *Instrument Display* interface to SkyWalker. In Maestro (chapter 4), the *Instrument Display* is shown on the "HP2 Emulator" tab (along with a "tree view" map of the entire *Instrument Display* menu structure). On HP2, the *Instrument Display* **is** the display used to interface with the user (see chapter 3).

The *Instrument Display* is an 8-line display providing very rich top-down menu access to all of SkyWalker's features in a minimal amount of space. The *Instrument Display* interface is all the user need to fully utilize SkyWalker. Of course a PC-based *Client* (such as Maestro) can provide much "broader" exposure to SkyWalker's features but without the advantage (to some) of the full stand-alone (i.e. PC-less) capability of the HP2 *Instrument Display* user interface.

From the *Instrument Display*, access to the following is available:

- **"Settings"** necessary to control a telescope system.
- **"Actions"** important to controlling a telescope system.
- **"Object"** database (with automatic GoTo support).
- **"Status"** of the telescope system.

The remainder of this section describes how to navigate and use the *Instrument Display*. Details on use of the features available from the *Instrument Display* are provided with the descriptions of those features in the remaining chapters of this manual. As mentioned in the previous section, the *Instrument Display* is designed to provide full access to nearly all of SkyWalker's features in a minimal amount of space.

The Instrument Display topology and naming conventions

The *Instrument Display* is composed of 8 lines of text each normally 21 characters wide. The top line of the *Instrument Display* (see figure below) is always the *Menu Page* title. This line provides the name of the present *Menu Page*. The title of a *Menu Page* is indicative of its location in the menu tree. For example, you can access SkyWalker's mark and return features from the *Menu Page* with the Actions/Mark&Return/MarkedCoords title. If the title does not occupy the full 21-character width of the *Menu Page* then it is padded with dashes. If the title is longer then 21 characters then only the end of the title is displayed.

Figure 2.1: SkyWalker's *Menu Page* layout

The naming convention used for *Menu Pages* is as follows:

<Top *Menu Page*>/<2nd level *Menu Page*>/<3rd level *Menu Page*>/...

The Actions/Mark&Return/MarkedCoords *Menu Page* that was mentioned above is an example of this naming convention. This naming convention is used to refer to specific *Menu Pages* throughout this manual.

Instrument Display navigation and contents

Each field (figure 2.1) of the *Instrument Display's* text window contains either the name of a link, name of a command or status information. If a field contains a link or command then it is "active", which is to say that it can be selected to activate a link to another *Menu Page* or to execute a command.

Lower level *Menu Pages* are accessible via links from upper level *Menu Pages*. All *Menu Pages* sit under one of the four main *Menu Branches*; Objects, Status, Actions or Settings, available from the top *Menu Page* (figure 2.2). These four main *Menu Branches* are designed to provide access to all of SkyWalker's features (i.e. "Objects", "Status", "Actions" and "Settings" as introduced above).

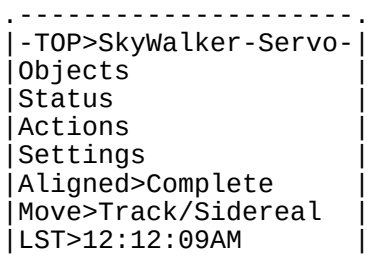


Figure 2.2: The *Instrument Display's* top *Menu Page*

As an illustrative example, Figure 2.2 shows a picture of the top *Menu Page*. Each field has the following function:

Field number	Field type	Details
1	Link	Links to the Object *Menu Page*
2	Link	Links to the Status *Menu Page*
3	Link	Links to the Actions *Menu Page*
4	Link	Links to the Settings *Menu Page*
5	Status	Indicates alignment status (i.e. "NotYet", "Preliminary", "Complete")
6	Status	Indicates *Move Mode*
7	Status/Command	Status: Local Standard Time Command: toggle between 12hr and 24hr LST format.

Note: some status fields will also execute a command (e.g. field 7 in the above example). A command associated with a status field is always germane to the status being displayed (e.g. changes the format). If a status field has an associated command then it is an active field (normally, status fields are not active).

The way that an active field (e.g. fields 1,2,3&4 in figure 2.2) is selected, to take a link or execute a command, depends on the device that is displaying the *Instrument Display:*

- For HP2 the selected field is displayed in larger font than unselected fields. To select a field, press the **Cursor** key and use the **Up/Down** arrows (more information in chapter 3). Once the field, for the link or command you want, is selected then press **Enter** to take the link or execute the associated command.
- For the *Instrument Display* in Client software (e.g. Maestro) a field is selected, to take an associated link or executing an associated command, by clicking the button to the left of the field. An active field is indicated with arrows (">>>") contained inside its associated button.

The *Instrument Display* also includes a **Back** button which "links" to the *Menu Page* displayed previous to the current *Menu Page*. You can press the **Back** button successively to retrace your path back all the way to the top *Menu Page*.

Some *Menu Pages* display a list of items from which to select one as shown in figure 2.3.

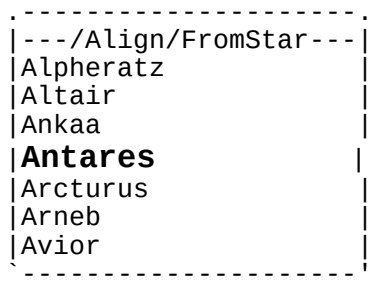


Figure 2.3: A list on the *Instrument Display*

When a list is displayed, the 5th field (containing "Antares" in figure 2.3) is the selected field. The method to use to move a different list item into the selected field depends on the device that is displaying the *Instrument Display:*

- For HP2 press the **Cursor** key and use the **Up/Down** arrows (more information in chapter 3) to scroll up/down the list. If the **Cursor** key is depressed for more than 1 second the list will page up/down rather than scroll up/down. Once the list item you want is in field 5 then press **Enter** to select the item from the list.
- For the *Instrument Display* in Client software (e.g. Maestro) there are scroll up/down and page up/down buttons to the right of the *Instrument Display*. Simply click these to move through the list and place the list item you want in field 5. Then click the active button to the left of field 5 to select the item from the list.

Important initial settings

The **very first step** in using SkyWalker is to properly configure it for your specific telescope installation (i.e. make the necessary "instrumental" settings). The approach to use depends on whether your mount is a commercial mount, for which SkyWalker is a popular accessory, or if it is a custom mount/installation:

- For commercial mounts commonly configured with SkyWalker: go to the Settings/Instrumental/Defaults *Menu Page* and select your mount from the list of choices.
- For custom installations, the details of making proper settings are covered in chapter 6 ("Instrumental settings").

Once instrumental settings are made then there are a few **important** operational settings to next make (the full list of operational settings is detailed in chapter 7 "Operational settings"). These include:

- Site settings and selection: from the Settings/SiteTimeDate/SiteSetup *Menu Page*, enter the name (optional), latitude, longitude and offset from GMT (in hours) for the current site. Select this site so that SkyWalker uses its settings. Note: GMT offset must be inclusive of any daylight savings time effects. For example, in the US (for all states except Arizona) from early April until late October the GMT offset is one less than the time zone.
- Time and Date: from the Settings/SiteTimeDate/Time&Date *Menu Page*, enter the current time and date.

Note: SkyWalker uses the site settings, time, date, and GMT offset to calculate local sidereal time. SkyWalker then uses the local sidereal time to properly avoid telescope-mount limits. In particular, if *Meridian Avoidance* is used (as is the case for all German Equatorial Mounts) it is **imperative** that SkyWalker is setup to correctly calculate the local sidereal time.

A summary of the above steps, with additional important steps, is summarized in the **important** "Start-up checklist" section at the end of this chapter.

Making SkyWalker take action

Once all necessary instrumental and key operational settings are made (previous section), and you have a familiarity with the *Instrument Display* from the HP2 or Maestro user interface, you are ready to begin using SkyWalker to control a telescope. Again, for commercial mounts commonly adapted with SkyWalker, instrumental settings can be pre-configured to reasonable defaults from the Settings/Instrumental/Defaults *Menu Page.*

Not-yet aligned

Once powered-up, SkyWalker and peripherals (e.g. HP1, HP2) are operating as a telescope control system but the telescope is not yet aligned to the celestial sphere. In this not-yet aligned state, all telescope and accessory control that does not require celestial alignment is available. For example, you can move the telescope around via the handpaddle at slew or any "view" rate but you cannot

automatically GoTo a celestial object until celestial alignment is completed. If a polar aligned (or "nearly" polar aligned) type mount has been specified (from the Settings/AlignmentSetup/MountAssumption *Menu Page*) SkyWalker will be tracking at the correct sidereal rate. In this case, polar alignment (or near to it) is assumed and celestial alignment is not necessary for at least approximate sidereal tracking.

Aligning

If your instrument is presently polar aligned then celestial alignment is simply a matter of centering a bright star and selecting it from the Settings/Align/FromStar(s) *Menu Page*. If your telescope is not polar aligned then it is necessary to sight 2 stars. Full details are provided in chapter 8: "Celestial alignment".

More detail: SkyWalker determines the number of star sightings to achieve alignment from the *Mount Assumption* which is set from the Settings/AlignmentSetup/MountAssumption *Menu Page*. If the mount is polar-aligned, or a level Alt/Az with its Az axis vertical, and accurate time/date and site information set, then only one star needs to be sighted.

Once aligned: all of SkyWalker's telescope control capabilities are available.

SkyWalker is a complete "Goto" telescope controller. This is a general term that means that SkyWalker will automatically slew-to the position of objects and/or arbitrary coordinates. SkyWalker's numerical GoTo accuracy is equal to the size of the servo feedback encoder precision (sub-arcsecond). In practice, GoTo accuracy is never this good because of mechanical errors in the telescope mount and optical assemblies.

SkyWalker provides an automatic calibration feature for systems with large errors or for applications that require the highest possible GoTo accuracy. When this *Auto-calibration* feature is enabled (see chapter 11: "GoTo") every GoTo that SkyWalker performs will first go to a bright star (equal to or brighter than magnitude 5.0) that is nearby the final destination. SkyWalker then prompts the user to center and acknowledge before finishing the GoTo to the final destination.

To access SkyWalker's GoTo features refer to the sections below (specifically "The Actions *Instrument Display Menu Branch*" and "Object GoTo and object data access") and to chapters 10 and 11.

SkyWalker's handpaddle and autoguider support

When SkyWalker is powered-on, any attached handpaddle is fully functional, a joystick attached to the PC can be used with SkyWalker (via suitable Client software such as Maestro), and guiding corrections from an autoguider attached to SkyWalker are accepted. Handpaddle use is covered in chapter 3, Autoguider use is covered in chapter 12 and joystick use is provided by Maestro as described in chapter 4.

Important: The handpaddle's *Direction Keys* (described below) work such that if any one of them is depressed during a GoTo (i.e. during automatic slew) the GoTo will be immediately canceled.

A brief list of the features available from the handpaddle is provided below. Note: Maestro's Actions tab provides a handpaddle emulator with a subset of the functionality of SkyWalker's handpaddle.

- *Direction Keys*: four large red (backlit) keys arranged in a diamond pattern are used to initiate motion or perform "alternate" functions with the *Enable Keys*. Motion is "fast" if in *Slew mode* (Slew is toggled from the HP's Slew button). Motion is at one of the four slower *View Velocities* if not in *Slew mode.*
- *Event Keys*: cause a one-time "event" (i.e. command) to occur. For example, the Slew key is an *Event Key* and toggles *Slew mode* on/off.

- *Enable Keys*: used to "enable" the *Direction Keys* for alternate functions. In brief these alternative functions are:
  - Track key enables the up/down keys to change the *Track Rate.*
  - View key enables the up/down keys to change the *View Velocity.*
  - Dim/Map key turns on the Map light and enables the up/down keys to change the handpaddle's indicator brightness.
  - *Quick Keys* can be setup to provide a rich assortment of "enable" key functions as described in the chapter 3. HP1 has three *Quick Keys* and HP2 has seven.
  - Focus/Dome key enables the up/down keys for focus motion and the right/left keys for dome motion. Suitable peripheral hardware, attached to SkyWalker, is necessary (see chapter 17 for more detail).
- *Direction Key* "back lighting" indicates which *Direction Key* is presently enabled to perform a function (i.e. telescope motion unless an *Enable Key* is depressed).
- *Event Key* indicators exhibit the mode associated with the function of the *Event Key* (for example *Slew mode* is indicated when the Slew key, or associated LED, is lit).
- The *View/Track Display* shows the present *View Velocity* (VeiwVel1 if 1 LED lit, ViewVel2 if 2 lit, etc.) or the present *Track Rate* if the Track key is depressed.

When an autoguider is connected to SkyWalker's AG port, ATCS can be controlled by the left/right/up/down output from the autoguider at the currently selected *View Velocity.*

The Actions *Instrument Display Menu Branch*

You can control a telescope in several ways from the Actions *Instrument Display Menu Branch.* Full instructions are provided in chapter 12: "Other Telescope Control Features". Features include:

- Several "automatic motion" features are provided, including GoTo coordinate, GoTo coordinate of last GoTo and "anchor" (i.e. return to the point that a handpaddle *Direction Key* was released).

Note: GoTo objects is provided from the Objects *Instrument Display Menu Branch.*

- Coordinate "marking" and the ability to "return" to marked coordinates. The offset of the present telescope position from the marked coordinates is provided in RA/Dec and Separation/Position-angle formats.
- A Timer function provides timing of fixed intervals. The Timer can be used to control *High Drive* outputs to drive accessories with precise timing.
- An Alarm function provides timing to absolute Universal or Local Standard Time. The Alarm can be used to control *High Drive* outputs to drive accessories with precise absolute timing.
- A "time stamp" feature records the present time and provides a "delta" from the last time stamp.

Status of ATCS

From the Status *Instrument Display Menu Branch* (or from the Status tab in Maestro), the operational status of ATCS is available. The following categories are provided:

- Coordinates status is associated with how/where SkyWalker is pointing. SkyWalker must be in aligned to access other than *Scope* coordinates status.

- Time/Date status is provided in standard and astronomical time/date formats.
- Alignment status describes SkyWalker's present alignment with respect to the celestial sphere.
- System status describes the version and operational state of telescope control system components.
- Control status describes the way in which SkyWalker is controlling the telescope. One important status is called *Move Mode*. The *Move Mode* describes the way that SkyWalker is presently moving the telescope. SkyWalker includes four main *Move Modes* (others are described in chapter 13: "Status and Diagnostics"):
  - **Track**: tracking a celestial object
  - **View**: moving, under handpaddle, joystick or autoguider control, at one of four *View Velocities*.
  - **Slew**: moving, under handpaddle or joystick control, at fast slewing speed.
  - **GoTo**: automatically seeking an object or coordinate.

Complete details on SkyWalker's status are contained in chapter 13.

Object GoTo and object data access

SkyWalker has an extensive built-in object database available from the Objects *Instrument Display Menu Branch* (or from the Objects tab in Maestro).

SkyWalker's object database includes the following:

- 110 Messier objects
- 7840 NGC objects
- 5386 IC objects
- 9017 Stars magnitude 7.00 or brighter
- All planets except Pluto and Earth.

For each object, a GoTo can be directly requested or complete object data viewed. Details are provided in chapter 10: "Celestial object database". Object data includes:

- Magnitude
- Size for deepsky objects and planets
- Distance (in astronomical units for planets, light years for stars)
- Objects altitude above the Earth's horizon
- Popular name (e.g. Orion Nebula) for deepsky objects and proper name for stars (e.g. Sirus).
- Alternative catalog (e.g. NGC # for M objects, M # for NGC objects if applicable).
- Type for deepsky objects (e.g. Galaxy, Nebula).
- SAO number, Bayer (i.e. Greek) letter and spectral type for stars
- The Airmass for which objects are presently visible through.

Viewing and changing ATCS settings

Settings are accessible from the Settings *Instrument Display Menu Branch* (or from the Settings and Instrumental tabs in Maestro). SkyWalker manages the following categories of settings:

- Instrumental settings: specify important details that are necessary **before** SkyWalker can be used to control a telescope and are described in chapter 6: "Instrumental settings". Examples include:
  - Motor driver and gearing details (e.g. steps per revolution).
  - Encoder counts per revolution.
  - Velocity and acceleration limits.
  - Motion limits for different mount types (e.g. dictating behavior at the meridian or horizon).
- Operational settings: specify the operation of SkyWalker **after** it has been setup to control a specific telescope (i.e. **after** instrumental settings are correctly configured). Operational settings are described in chapter 7: "Operational Settings". Examples include:
  - Alignment: settings that effect celestial alignment.
  - Control: settings that affect the way in which SkyWalker controls the telescope.
  - Sites: settings that provide the details of the seven separate observing sites that SkyWalker supports.
  - Time&Date: for setting local standard time and date (SkyWalker contains an accurate clock/calendar chip).
  - Preferences: settings associated with the individual preferences of the observer.

Controlling SkyWalker from *Client* (e.g. planetarium) software

SkyWalker can interface to *Client* software, running on a local or remote computer, via serial (RS232 or RS422/USB/Ethernet with proper converter) connection. Astrometric Instruments offers a free SkyWalker *Client* called Maestro which runs on Microsoft Windows based PCs. Maestro is described in chapter 4 "Maestro: SkyWalker control software".

Through direct serial connection to SkyWalker, or through Microsoft Windows based software-to-software connection with Maestro, virtually all software (which supports telescope control) can be used as a SkyWalker *Client* (i.e. to control SkyWalker). Typically, one would use planetarium software to control SkyWalker however any program that uses the correct communications protocol will work. Features available include "point and click" GoTo, continual coordinate update on a star chart, scripted control of SkyWalker, simulated handpaddle and "calibration" of SkyWalker's celestial coordinates from selected object/coordinate. Depending on the *Client* software used, many other features are available.

SkyWalker supports the following connections and protocols from *Client* software:

- **ACL (LX200 variant):** SkyWalker emulates a Meade LX200™ telescope via direct communicates over an RS232 serial connection. SkyWalker powers-up in LX200™ emulation mode. To use LX200 control software, simply make the serial connection to SkyWalker and select "LX200" as the telescope type in the control software.
- ***ATCL:*** SkyWalker's primary interface protocol is called the Astrometric Telescope Control Language (ATCL). ATCL is typically communicated over serial link (e.g. RS232 or RS422/USB/Ethernet with suitable converters) to SkyWalker's Client interface port (labeled "Com"). ATCL provides a very rich syntax for telescope control and is available for use by independent software developers. Maestro uses ATCL to control SkyWalker. ATCL is introduced in chapter 18 ("Telescope Control via Client software").

- **Through Maestro:** With Maestro running on a Windows based PC the following program-to-program protocols are available for controlling SkyWalker through Maestro:
  - Windows Astronomical Resource Protocol (WARP). Maestro is a fully compliant WARP "provider". Maestro's support for WARP is described at www.astrometric.com/support/resources/WARP.html.
  - The Astronomy Component Object Model protocol (ASCOM). Maestro is an ASCOM "telescope server". Maestro's support for ASCOM is described at www.astrometric.com/support/resources/ASCOM.html.
  - Software Bisque's "TeleAPI". The TeleAPI interface allows for simultaneous use of Maestro and TheSky (running on the same PC) to control SkyWalker.

Complete details on using *Client* software with SkyWalker are provided in chapter 18.

SkyWalker's messages

SkyWalker provides several types of messages back to the user, through the user interface, to notify of anything from medial status to important alerts. The manner in which the message is presented depends on the user interface. The HP2 handpaddle either presents the message on the *Instrument Display* (with a prompt for dismissal) or flashes it for a few seconds. Maestro places the message in its *Message Area* (see figure 4.?) and provides audio feedback (speaker beep or special sound if the PC has wave file output capability). Maestro's *Message Area* is a scrollable list of the last 3 messages. Maestro also "pops-up" some messages because immediate user attention or acknowledgement is required.

The types of messages provided by SkyWalker are as follows:

- **Status**: issued when an event or condition that the user should be aware of occurs. For example, when celestial alignment is completed a "status" message is posted. Status messages are briefly flashed on the HP2 display and noted in Maestro's *Message Area* but do not involve pop-up windows in Maestro.
- **Warning**: issued when SkyWalker warns the user of a condition. For example, if the user is trying to slew the telescope too low (i.e. below the *Down Limit*) SkyWalker will issue a warning message. As another example, if the user has entered an invalid value a warning message will be issued. Warning messages are presented on the HP display with a prompt for dismissal and involve a pop-up in Maestro.
- **Alert**: Issued when SkyWalker requires the user's immediate attention. An alert indicates that there is a problem that keeps SkyWalker from proceeding. Important events (such as SkyWalker's *Hard Limit* input being asserted) will cause an alert. Expiration of SkyWalker's Timer or Alarm will cause an alert. Alert messages are presented on the HP display with a prompt for dismissal and involve a pop-up in Maestro.
- **InternalError**: Issued when SkyWalker has detected an illegal condition internal to its code (SkyWalker has extensive internal "checks" and will fault if an illegal condition is detected). Please report any internal error to Astrometric support (support@astrometric.com). InternalError messages are presented on the HP display with a prompt for dismissal and involve a pop-up in Maestro.

Note: Maestro's pop-up dialog boxes can be disabled through the WARP or ASCOM interfaces as described in chapter 18. This can be important for remote operation of a SkyWalker-controlled telescope.

When using Maestro, all messages include audio feedback. The sounds Maestro uses for audio feedback are unique to the message type (i.e. Alert, Warning and Status). Maestro's PC must include sound output (wave file) capability for the audio feedback to be heard.

Next steps: using SkyWalker night after night

This chapter has introduced SkyWalker in the context of running it for the first time. The instructions in this chapter may suffice for users wishing to not dive deeper into learning about SkyWalker's advance telescope control system features. **Do, however, at least read the Start-up checklist in the next section!**

For those that want to take advantage of SkyWalker's full capability, please read through the remaining chapters of this manual. We have tried to order the chapters sensibly but there is no requirement that they be read consecutively. If you encounter any ambiguous "ATCS specific" terms refer to Appendix A: "Glossary of Terms". The "What is SkyWalker" section of chapter 1 provides a guide to SkyWalker's features and where, in this manual, they are discussed. **Enjoy!**

Start-up checklist

This section provides a quick summary of the steps necessary to get SkyWalker working correctly with your system. **This checklist should be carefully followed at least the first time you use your system.**

Note: this checklist assumes that the mount is polar aligned (or near enough to get started using SkyWalker and gaining familiarity with the system) and that "Polar" has been selected as a *Mount Assumption* from the Settings/AlignmentSetup/MountAssumption *Menu Page.*

- ❑ Establish connection to SkyWalker with a user interface.

  If using the HP2, simply plug it into an available "HP/TCS" port and turn-on SkyWalker (or power-cycle SkyWalker if it was already plugged-in).

  If using Maestro, install it on your PC (chapter 4) and select the communications port that Maestro will use to communicate with SkyWalker from the Windows tab, "SkyWalker Interface" section.

- ❑ Configure the instrumental settings for the telescope mount used.

  Each type of telescope mount has unique restrictions in terms of range of motion. Pre-configured defaults are available for retrofit kit packages from the Settings/Instrumental/Defaults *Menu Page*. After completing this checklist, refer to the "Standard Meridian settings in SkyWalker" section below for information on changing the instrumental settings that may not be appropriately defaulted. For custom installations, the instructions on setting up SkyWalker in chapter 6 ("Instrumental settings") should be followed in detail.

- ❑ Assure that SkyWalker's local time, date and GMT offset (i.e. time zone) are accurate.

  SkyWalker uses local time, date, GMT offset **and** site settings (next item) to calculate local sidereal time. SkyWalker then uses the local sidereal time to properly avoid telescope-mount limits. In particular, if *Meridian Avoidance* is used (as is the case for all German Equatorial Mounts) it is **imperative** that SkyWalker is setup to correctly calculate the local sidereal time.

  Make these settings from the Settings/SiteTimeDate/Time&Date *Menu Page.* If you are using Maestro, and the PC's time is known to be accurate, you can use the "Set SkyWalker time" button from Maestro's Settings tab as a shortcut.

Note: the GMT offset is the difference between your local time and Greenwich Mean Time (i.e. Universal Time). The GMT offset is a function of daylight savings time. For example, in the summer in the US Eastern Time zone, GMT offset is 4:00W however in the winter it is 5:00W.

Note: SkyWalker can be used with its local time set to the Universal Time. See the "Site details" section of chapter 7 for instructions.

- ❑ Setup the site (i.e. observing location) information.

  Set the longitude and latitude for the observing site from the Settings/SiteTimeDate/SiteSetup *Menu Page*. Be sure that the site that has been setup (Site1-7) is currently selected.

- ❑ Verify that SkyWalker's sidereal time is correct.

  When using Meridian Avoidance it is crucial to verify that the sidereal time reported by SkyWalker (from the Status/Time&Date *Menu Page* or Maestro's Status tab) is reasonably accurate (within a few minutes). Two effective ways to verify sidereal time:

  1. Determine the Right Ascension (RA) of an object on or near the celestial meridian. This RA is the same as the local sidereal time. Verify this against the sidereal time that SkyWalker reports.
  2. Use software (such as planetarium software) to verify SkyWalker's sidereal time. Note: Maestro does not calculate sidereal time: it merely reports SkyWalker's sidereal time.

  If the sidereal time is incorrect then the SkyWalker's local time, date, GMT offset or site longitude is incorrect.

- ❑ Verify that the motor polarities are correct.

  1. Point the telescope into the sky in the general direction of the celestial equator. **Note:** if using a German Equatorial mount, point the telescope to the side of the celestial meridian from which observing sessions will generally be started. Stay clear of the celestial meridian by a wide margin (>30degrees) for this procedure.
  2. Place the handpaddle in *Slew mode* (verify that the LED above the Slew button is lit).
  3. Press the handpaddle's UP button:
     - If motion is "up" (i.e. towards the celestial pole) then the Declination motor polarity is correct. Proceed to step 4.
     - If motion is "down" (i.e. away from the celestial pole) then go to the Settings/Instrumental/Motors&Gearing *Menu Page* and toggle the "PolarityDec" setting. Re-do steps 1-3 to verify proper operation.
  4. For German Equatorial mounts: go to the Settings/Instrumental/MotionLimits/MeridianLimtis *Menu Page* and verify that the "DecPolValid" setting is consistent with the side of the celestial meridian the telescope **was** pointing while steps 1-3 were performed.
  5. Press the handpaddle's LEFT button:
     - If motion is to the "left" (i.e. eastward in the Northern hemisphere or westward in the Southern hemisphere) then the RA motor polarity is correct.
     - If motion is to the "right" then go to the Settings/Instrumental/Motors&Gearing *Menu Page* and toggle the "PolarityRA" setting. Re-do steps 1,2&5 to verify proper operation.

- ❑ Complete Celestial Alignment.

Chapter 8 ("Celestial alignment") provides complete details on celestial alignment. For purposes of this "first use" of SkyWalker we will assume that the mount is reasonably polar aligned and hence SkyWalker's one star alignment can be used. Follow these steps:

- Go to the Settings/Align *Menu Page* and select "FromStar(s)".
- For GEM mounts, you will be prompted to select that side of the sky (i.e. side of the celestial meridian) that alignment will be completed in.
- Next, either:
  - Pick a bright star that is not too close to the celestial pole, is at an altitude exceeding 20°, and, if the mount is a GEM, separated widely (say, >30deg) from the celestial meridian.
  - Allow SkyWalker to recommend a suitable star.
- Use the handpaddle's *Direction Keys* to carefully center the star in the telescope's field of view.
- Click the AlignOnStar button on the *Menu Page* titled "---/Align/FromStar---".

If after alignment GoTo motion is of incorrect direction: there is a problem with SkyWalker's local time, date, GMT offset, site or instrumental settings. To help sort out the issue, go to the Status/Coordinates/Scope *Menu Page* and, using the handpaddle, move the telescope until the TargetX value reads near to 0. If the telescope is not pointing at the celestial meridian at this point, then SkyWalker's sidereal time is incorrect and therefore a time/date or site setting is erroneous. If the telescope is pointing at the celestial meridian then there is likely a problem with the Declination motor polarity or DecPolValid setting.

Congratulations, you're telescope is now under full SkyWalker control!

If you use a German Equatorial mount then one last important recommendation: read the "Introduction to *Meridian Limits* and SkyWalker's *Meridian Avoidance* feature" section that follows…

Introduction to *Meridian Limits* and SkyWalker's *Meridian Avoidance* feature

A complete description of SkyWalker's *Meridian Avoidance* feature is provided in chapter 6. A brief introduction is present here to avoid celestial alignment and mount/tube interference problems from the get-go. Separate descriptions are provided for Northern and Southern Hemisphere installations.

For Northern Hemisphere installations

Refer to the following figure for an understanding of *Meridian Limits* (note: this diagram is from the perspective of an observer on the ground **looking into the sky**):

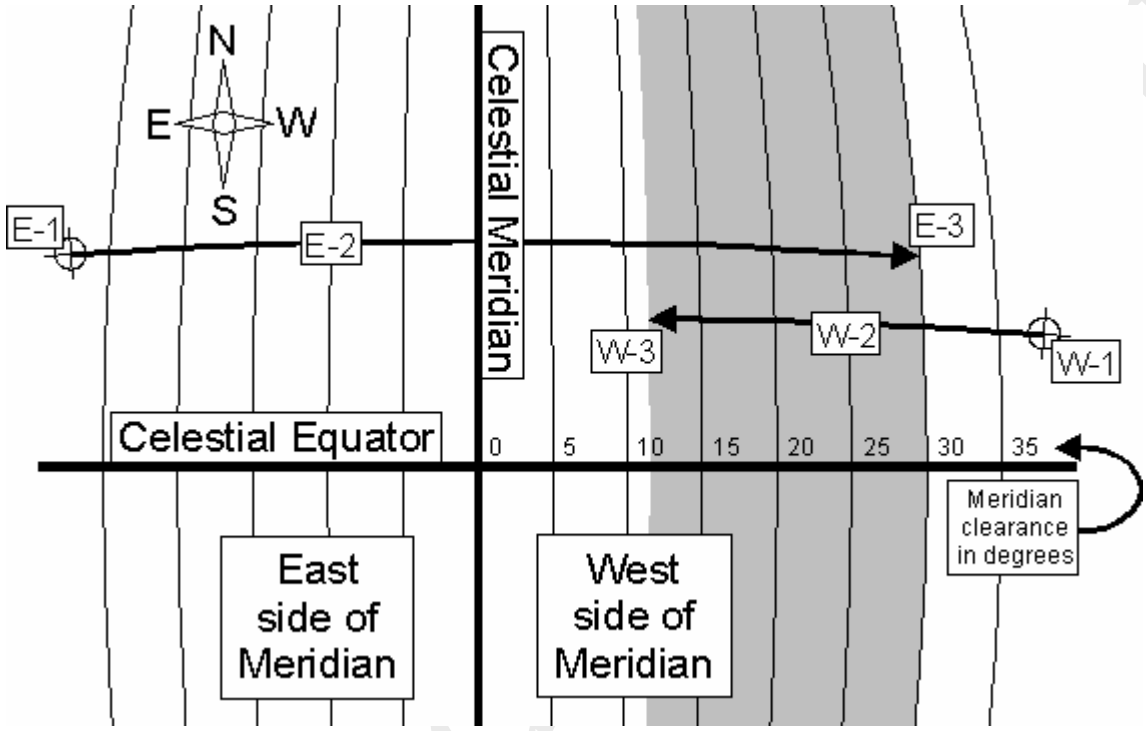


Figure 2.4: Default *Meridian Limits* for Losmandy G-11 located in the Northern Hemisphere

Referring to figure 2.4; here is the speedy introduction (using the Losmandy G-11 default settings for the SkyWalker2 retrofit kit as an example):

- In Celestial mode, SkyWalker permits motion from the East (starting at example origin E1) westward through the celestial meridian (example path E2) up to 30° through the celestial meridian (E3).
- In Celestial mode, SkyWalker permits motion from the West (starting at example origin W1) eastward towards the celestial meridian (example path W2) up to 12° short of the celestial meridian (W3).

This asymmetric *Meridian Avoidance* is necessary to prevent the telescope from hitting the RA retrofit kit Drive Unit while providing maximum celestial meridian passage from the East (enabling tracking 2 hours past the celestial meridian).

For Southern Hemisphere installations

Refer to the following figure for an understanding of *Meridian Limits* (note: this diagram is from the perspective of an observer on the ground **looking into the sky**):

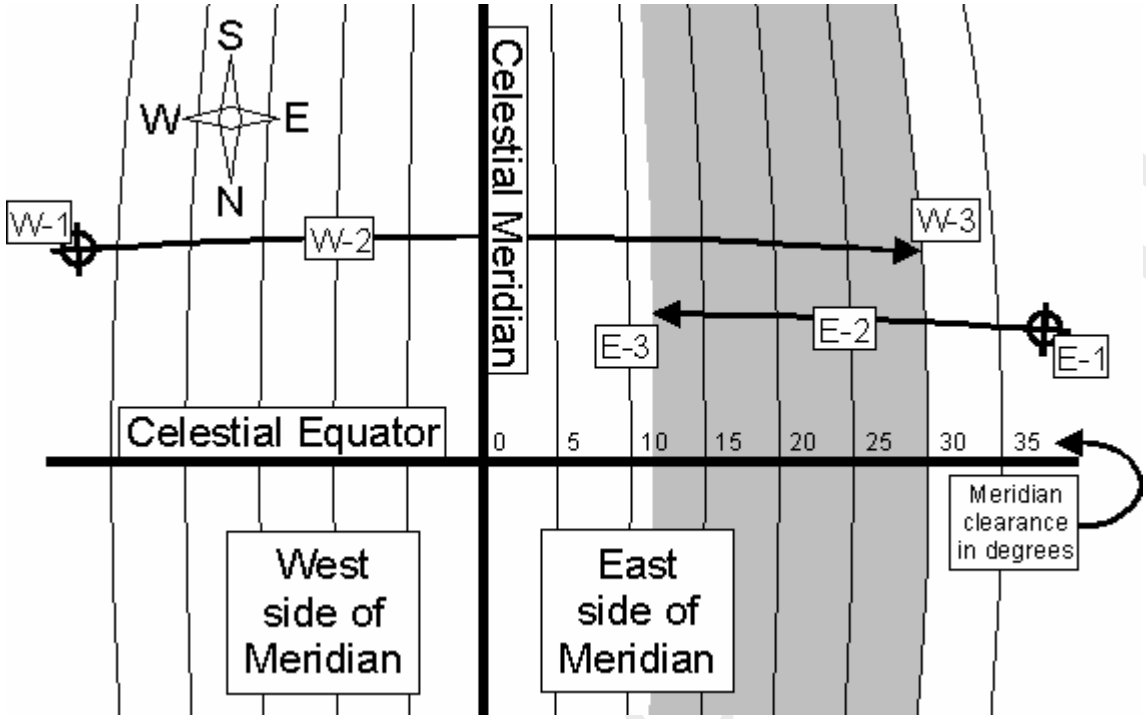


Figure 2.5: Recommended *Meridian Limits* for Losmandy G-11 located in the Southern Hemisphere

Referring to figure 2.5 here is the speedy introduction (using the Losmandy G-11 default settings for the SkyWalker2 retrofit kit as an example):

- In Celestial mode, SkyWalker permits motion from the East (starting at example origin E1) westward through the celestial meridian (example path E2) up to 12° short of the celestial meridian (E3).
- In Celestial mode, SkyWalker permits motion from the West (starting at example origin W1) eastward towards the celestial meridian (example path W2) up to 30° through the celestial meridian (W3).

This asymmetric *Meridian Avoidance* is necessary to prevent the telescope from hitting the RA retrofit kit Drive Unit while providing maximum celestial meridian passage from the West (enabling tracking starting 2 hours East of the celestial meridian).

Standard meridian settings in SkyWalker

The meridian "avoid angle" default settings provided with retrofit kit installations may require modification. Possible reasons include having a long tube instrument or bulky camera attachment that will not allow the default angle of passage through the meridian. These settings are changed from the Settings/Instrumental/MotionLimits/MeridianLimts *Menu Page.*

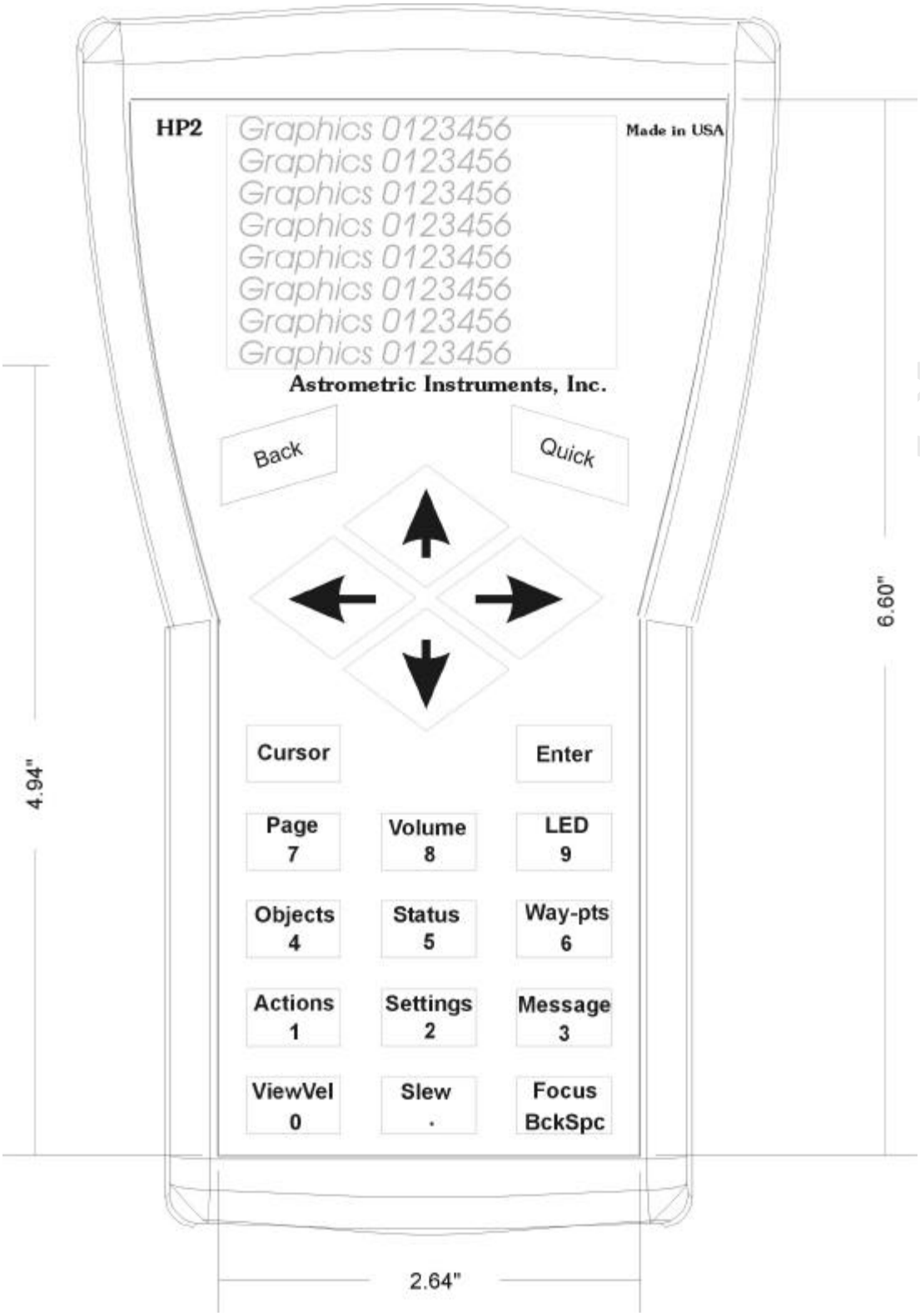
Table 2.1 shows the default meridian "avoid angles" for several of Astrometric Instrument's retrofit kits for Northern and Southern hemisphere installations.

Mount	Hemisphere	SkyWalker model	AvoidAngleEast	AvoidAngleWest
Losmandy G-11	Northern	SkyWalker2	-30°	+12°
		SkyWalker-Servo	-30°	0°
	Southern	SkyWalker2	+12°	-30°
		SkyWalker-Servo	0°	-30°
Losmandy GM-8	Northern	SkyWalker2	-20°	5°
		SkyWalker-Servo	-20°	0°
	Southern	SkyWalker2	5°	-20°
		SkyWalker-Servo	0°	-20°
Celestron CI700	Northern	SkyWalker2	-30° (1)	0°
		SkyWalker-Servo	-30° (1)	0°
	Southern	SkyWalker2	0°	-30° (1)
		SkyWalker-Servo	0°	-30° (1)

Table 2.1: standard Meridian "avoid angles"

Note 1) to achieve the -30° setting for the CI700 it is necessary to remove the RA "stop" on the side of the mount **opposite** the RA retrofit kit Drive Unit. **Do not** remove the RA "stop" on the Drive Unit side!

Chapter 3: SkyWalker's handpaddles



Chapter 4: Maestro: SkyWalker control software

Maestro is Astrometric Instruments' SkyWalker *Client* software. Maestro exposes SkyWalker's *Instrument Display* interface **and** provides a full Microsoft Windows based graphical user interface to SkyWalker.

Maestro communicates to SkyWalker via the Astrometric Telescope Control Language (ATCL). ATCL is typically communicated over serial link (e.g. RS232 or RS422/USB/Ethernet with suitable converters) to SkyWalker's Client interface port (labeled "Com"). ATCL provides a very rich syntax for telescope control and is available for use by independent software developers. ATCL is introduced in chapter 18 ("Telescope Control via Client software").

Maestro system requirements

The minimum PC requirements to run Maestro are:

- Microsoft Windows98 or later (including Windows ME, 2000 and XP)
- Pentium 400MHz or faster
- 64MB (or greater) RAM
- VGA (or higher resolution) display
- Minimal hard drive space (10Meg)
- One serial port (RS232) to connect to SkyWalker. Maestro automatically configures the port's Buad rate and other settings. There is no need to set these manually from the Windows Device Manager. Note: Maestro/SkyWalker **can** be used with inexpensive USB-to-serial converters (e.g. Aten UC232A).

Optional PC requirements

- DirectX hardware video acceleration for use of Virtual Telescope in high-resolution mode. DirectX version 8 or greater is required.
- A sound card to use Maestro's sound output capabilities.
- Joystick for joystick control of SkyWalker.

Installing Maestro

Maestro is distributed as an installation executable file either on CD or for download off our support web page at www.astrometric.com/support/support_upgrades.html. The installation executable filename is always of the format "MaeM_NN_RRR.exe", where "M" is the major release version, "NN" is the minor release version and "RRR" is the revision number. For example, the installation executable filename for Maestro release 1.02.001 is "Mae1_02_001.exe".

To install Maestro simply run the "MaeM_NN_RRR.exe" file. This can be accomplished through one of the following means:

1. Clicking on the filename from our support page listed above and selecting "Open".
2. Clicking on the filename from our support page listed above and selecting "Save" and saving the "MaeM_NN_RRR.exe" file on your computers hard drive and then following the next step…
3. Find the "MaeM_NN_RRR.exe" file on your computer (e.g. on the CD provided with the SkyWalker shipment or in the folder on your hard drive where you saved the file off our support page) and double click its name to run it.

Once the "MaeM_NN_RRR.exe" file is running you will be prompted for where to install Maestro and then lead through the remainder of the installation process. If you are performing an upgrade, simply answer "yes" to any file-overwrite warnings presented.

Note: installing Maestro involves installation of shared system files to your PC. It is possible that more recent versions of these shared files are already on your PC. In this case the installation will prompt you for confirmation to overwrite the more recent files. It is recommended that you do **not** allow the Maestro installation to overwrite more recent shared files on your PC. Maestro should work fine with the files already on your PC.

Using Maestro for the first time

To start Maestro, select it from the Start button under the Programs/Astrometric section.

When Maestro starts for the first time it will open its main window and its Status window. Maestro's main window contains many separate overlaid "tabs" that group functionality into categories. The main window is always present when Maestro is running however the Status window, if closed, will not re-open the next time Maestro is run unless the "Status window" box is checked from the Preferences group on the Windows tab of Maestro's main window.

In addition to the main window, and the optional Status window, there is one other optional window: the Virtual Telescope window. The Virtual Telescope window is disabled when Maestro is first run because it can use a lot of compute power. Read the section on the Virtual Telescope window (below) before enabling it.

Connecting to SkyWalker

When Maestro starts it will immediately start searching for (polling for) SkyWalker on the communications port specified from the SkyWalker interface area of the Windows tab on the main window. Verify that the port specified is the port that SkyWalker is connected to Maestro from. Once the proper port is selected, and Maestro/SkyWalker are connected (and SkyWalker is powered on), Maestro will automatically begin communications with SkyWalker (there is no additional user action necessary).

The main window

On Maestro's main window (i.e. the window with the title "Maestro"), access to SkyWalker functionality is categorized into the groups accessible via separate tabs. The most recent 3 messages are displayed along the bottom of each tab in the message area.

Tab functions

HP2 Emulator tab has two functions:

1. Access to SkyWalker's *Instrument Display*. From the left side of the HP2 Emulator tab the *Instrument Display* is presented as seen on the HP2 handpaddle. There are 8 fields of text with the 1st field representing the *Menu Page* title and the 2nd-8th fields providing links, commands or status. If a field is active (i.e. if it is a link to another *Menu Page* or if it executes a command) the button next to the field contains a group of right arrows (i.e. ">>>").
2. Provides "tree view" access to all *Menu Pages* accessible from the *Instrument Display*. From the right side of the HP2 Emulator tab a hierarchical and collapsible/expandable map of the entire menu structure of the *Instrument Display* is available. The active *Menu Page* is indicated with a red icon and inactive pages with white icons. If the *Instrument Display* is currently sitting on a *Menu Page* that is not on the map then a yellow icon highlights the *Menu Page* below which the current page sits (this can happen for selectively accessible *Menu Pages*).

Objects tab provides access to SkyWalker's internal object database.

Status tab provides operating, coordinate, time, system and power status.

Actions tab provides access to SkyWalker's telescope control features including GoTo (other than GoTo objects which is provided from the Objects tab), emulation of the handpaddle's direction and velocity selection keys, marked coordinates and access to the handpaddle's *Quick Keys*.

Settings tab provides access to commonly used operational settings within SkyWalker (which are described in more detail in chapter 7). The Settings tab also contains an alignment "wizard" that leads the user step-by-step through the alignment process.

Instrumental tab provides access to SkyWalker's instrumental settings (which are described in more detail in chapter 6). Note: most of these settings, if changed, will void celestial alignment.

Messages tab provides a list of the most recent 27 messages. Both messages from SkyWalker and messages issued by Maestro (that are not initiated from SkyWalker) are displayed here. Note: the most recent 3 messages are displayed at the bottom of all tabs in the message area.

Windows tab provides access to settings and features that are specific to Maestro running under the Microsoft Windows operating system and are not otherwise available from SkyWalker. The Windows tab functionality is described in more detail in the "The Windows tab" section below.

Diagnostics tab provides access to status related to SkyWalker's operation. The Diagnostics tab also provides a field where an arbitrary ATCL command can be entered and sent to SkyWalker. The response (return value) to the ATCL command is displayed in the Response field.

Entering data

To enter data (i.e. number, coordinate, etc.) into a field on Maestro's main window, which accepts data entry, simply click on the field and type over the existing data and then either a) click enter or b) click on another control for Maestro to accept the data entry.

The Status window

The Status window is a free-floating window separate from Maestro's main window. It contains key status information on the operation of SkyWalker such as current coordinates, time, alignment status, *Move Mode* and interface information.

The Status window is (when not iconified) always "floating" on-top of other windows on the desktop. If it is closed then it will not reopen unless the Status window box is checked in the Preferences area of the Windows tab.

The Virtual Telescope window

The Virtual Telescope window shows a simulated view of the telescope that SkyWalker is controlling.

To use the Virtual Telescope, the PC running Maestro must have DirectX version 8.0 or later installed. To use the Virtual Telescope in "high detail" mode, DirectX-compliant video hardware acceleration is recommended.

To enable the Virtual Telescope, check the "Display telescope" checkbox from the Virtual Telescope area of the Windows tab. **Note:** if the PC running Maestro does not include video hardware acceleration then **before** the Virtual Telescope is enabled it is strongly recommended that the "Override detail" box is checked with the "Low" option selected from the Virtual telescope area of the Windows tab.

Type of mount simulated

Maestro queries SkyWalker for the type of mount to simulate in the Virtual telescope. Possible types include:

- Fork Alt/Az
- Fork Equatorial
- German Equatorial

Maestro also queries SkyWalker for latitude to determine the hemisphere (i.e. Northern or Southern) and the polar axis angle (with respect to the horizon) to use when drawing the Virtual telescope.

Changing the viewing angles

To change the angle from which the Virtual telescope is viewed simply click and drag (with the left mouse button in the Virtual telescope window) to the desired X and Y angles. To reset the angles to 0, press the "Reset Viewing Angles" button.

The Windows tab

The Windows tab provides access to:

- Key settings that dictate how Maestro operates and…
- Features that are specific to Maestro (running under Windows) and not otherwise included in SkyWalker.

SkyWalker Interface

As described in the "Using Maestro for the first time" section (above), the communications port that Maestro uses to communicate with SkyWalker is selected from the SkyWalker interface area. In addition to COM1-COM8 there is a SSW_Demo option that allows Maestro to communicate with Astrometric's smart-SkyWalker demo program running on the same PC as Maestro (for more information on smart-SkyWalker demo see TBD).

Preferences

Maestro provides several user preferences accessible from the Preferences area of the Windows tab. The states of these preferences are saved in the Windows registry so they are not lost session to session. Each preference is described:

- "Night vision mode": if checked, the default colors for windows applications changes to a red color scheme that is less damaging to night vision. For first use this is **unchecked**.
- "Status window": if checked, the Status window is active (and always "on top"). If unchecked the Status window is absent. For first use this is **checked**.
- "Confirm on quit": if checked, Maestro will ask you if you really want to quit when you close Maestro (via the big X in the upper right corner of the main window). For first use this is **unchecked**.
- "Quiet comm errors": if checked, Maestro will not cause pop-up messages when a communications error is detected with SkyWalker. The SkyWalker/Maestro communications protocol is very robust and recovers well from errors so there is generally no need to uncheck this box since occasional "line events" happen with RS232 communications. For first use this is **checked**.

- "Log messages": if checked, Maestro saves all messages to the Maestro.log file. In addition, any existing Maestro.log is renamed to Maestro_previous.log. Both files reside in Maestro's working folder. For first use this is **checked**.
- "Balloon help": if checked, Maestro will provide a "balloon help hint" at the location of the mouse pointer if the mouse is left motionless over a Maestro control for more than a fraction of a second. For first use this is **checked**.
- "Force f/w update": if checked, Maestro will automatically update SkyWalker's firmware if it detects that a version newer, than that currently in SkyWalker, is available when it connects to SkyWalker. For first use this is **unchecked**.

Virtual telescope

Several options are available to specify how the Virtual telescope is displayed. They include:

- "Display telescope": if checked, the Virtual telescope window is active and simulates the orientation of the telescope which SkyWalker is controlling. For first use this is **unchecked**.
- "Override detail": if checked, the level of detail that the Virtual telescope is displayed can be forced to be High or Low. If the PC does not have video acceleration hardware then it is **strongly** recommended that "Low" and "Override detail" be checked before "Display telescope" is unchecked.

Sounds

In the Sounds area, the sound that is associated with each possible action that Maestro reports on can be selected. In addition, each sound can be tested (with the "Test" button) and the volume that all sounds are played at adjusted. A "Set defaults" button is provided to return the sound associations to the defaults applied when Maestro is first run.

Joystick

SkyWalker provides motion from joystick control if a joystick is plugged into the Windows-based PC. Joystick motion is fully "proportional". The further the joystick is pushed the faster the telescope will move. If *Slew mode* has been selected from the handpaddle, or from the Actions tab, then the joystick will cause motion at up to the telescope's maximum velocity otherwise motion is up to the presently selected *View Velocity*.

The following Maestro controls, all available from the Joystick area on the Windows tab, affect the behavior of the joystick:

- A list of joysticks currently available on the PC is provided. Only one joystick can be selected at a time to control SkyWalker through Maestro.
- Up to four joystick buttons are support by Maestro and directly map (button 1-4) to *Quick Key* functions 1-4. All joystick buttons can be enabled/disabled with the "Buttons enabled" checkbox. When a joystick button is pressed, the associated function is displayed in the box within the "Buttons" area. Note: *Quick Key* functions are accessible, and settable, from the Actions tab.
- Because joystick motion causes fully proportional telescope motion it is important to properly "trim" the joystick to prevent the joystick from causing slow motion when it is in its neutral position. The "width" of the neutral position must be wide enough to assure no motion when in neutral. To assist with this, there is a "Deadband" setting. Increasing deadband increases the size of the neutral position.

Quick Key keyboard support

Each of SkyWalker's seven *Quick Keys* can be assigned to a keyboard "hot key" from the "Quick Keys" area. The keys 1-7 and F1-F7 are the keys available for assignment along with the modifiers "Alt", "Ctrl" and "Shift". Note: at least one modifier must be selected when using numeral keys.

Upgrading SkyWalker's firmware using Maestro

To upgrade SkyWalker's firmware, using Maestro, follow this procedure:

1. Go to our Software Upgrades web page (www.astrometric.com/support/beta/support_upgrades_beta.html) and click on the link for the latest SkyWalker firmware "Upgrade File".
2. Save the Upgrade File to a temporary location on your local PC.
3. Run the Upgrade File from your local PC and follow the instructions provided by this "self extracting" file to load the necessary firmware files to the SkyWalkerUpgrades folder under your Maestro installation folder (i.e. typically c:\Program Files\Astrometric\Maestro\SkyWalkerUpgrades).
4. Start Maestro (or exit and restart Maestro if it is already running).
5. Maestro should automatically detect that a SkyWalker firmware upgrade is necessary and confirm with you that the upgrade should be made. Acknowledge by pressing the "Upgrade Now" button.

The firmware download (to SkyWalker) and upgrade should commence. It may take several tens of minutes to complete depending on the magnitude of the upgrade.

Note: when the upgrade is complete, SkyWalker will be **non-functional** (and Maestro will report that the interface to SkyWalker is "down") until it is turned-off and then back on again.