

# SkyWalker-Servo Owner's Manual

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Written for

Astrometric Instruments'  
SkyWalker-Servo  
Telescope Motor and Accessory Controller

This document is for units with serial numbers starting with the numerals "23"  
(Serial number is stamped on underside of RA Servo Drive Unit)

This document can be ordered as Astrometric Instruments' part DOC-06

**SkyWalker-Servo Owner's Manual**

## **Preface**

This document provides reference material on the use of SkyWalker-Servo. The following companion documents provide important precursory information:

- ◆ Introduction to the Astrometric Telescope Control System (For Losmandy G-11, GM-8 and HGM-200 Telescope Mounts) (Astrometric Instruments part number DOC-03C) **or** Introduction to the Astrometric Telescope Control System (For Celestron CI700 Telescope Mounts) (Astrometric Instruments part number DOC-03D). These documents introduce the user to the Astrometric Telescope Control System and provide instructions for installation on the associated telescope mount.
- ◆ SkyGuide User's Manual (Astrometric Instruments part number DOC-02). Describes how to use the Astrometric Telescope Control System in *System mode*.

Note: Italicized words are names that are specific to Astrometric Instruments' Telescope Control System components.

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## **Chapter 1: Introduction**

SkyWalker-Servo is a versatile telescope motor and accessory controller. SkyWalker-Servo operates in one of two modes:

- ◆ In *SkyWalker mode*: SkyWalker-Servo is a complete telescope controller that generates Sidereal/Lunar/Solar/King/Custom tracking rates, provides 5 programmable handpaddle rates (including high speed slew) and can control an electric focuser and illuminated reticle eyepiece. SkyWalker-Servo's DC servo control provides high torque and high "dynamic range": from very smooth tracking to high speed slew.
- ◆ In *System mode*: SkyWalker-Servo is connected to and controlled by SkyGuide for Windows (a.k.a. SkyGuide-Win). The resulting system has unmatched capability (refer to the "SkyGuide User's Manual" for complete details). All of SkyWalker-Servo's *SkyWalker mode* features (plus many more!) are available in *System mode*.

SkyWalker-Servo works with Astrometric Instruments' HP1 handpaddle. The handpaddle is used to provide "keyed" motion input to, and change state within:

- ◆ SkyWalker-Servo in *SkyWalker mode*.
- ◆ SkyGuide-Win and SkyWalker-Servo in *System mode*.

SkyWalker-Servo requires the following in order to operate as a telescope control system:

- ◆ 12VDC regulated power supply. SkyWalker-Servo requires 0.3 to 3.0 Amps depending on telescope loading.
- ◆ Astrometric Instruments' "HP1" handpaddle (included with SkyWalker-Servo).
- ◆ Cabling to provide power and connections to motors/motor drivers (also included with SkyWalker-Servo).

SkyWalker-Servo's functionality dramatically increases when the following (optional) devices are connected to SkyWalker-Servo:

- ◆ Windows95/98/ME PC running SkyGuide connected via SkyWalker-Servo's Com (RS232) port. With SkyGuide, SkyWalker-Servo is used as part of a versatile and sophisticated telescope control system operating in *System mode* (refer to the "SkyGuide User's Manual"). Without SkyGuide, SkyWalker-Servo still provides basic telescope control in *SkyWalker mode*.
- ◆ Autoguider
- ◆ Optical encoders. SkyWalker-Servo reads optical shaft encoders that track telescope position when the telescope is moved manually (when connected to SkyGuide).
- ◆ Electric Focuser (e.g. JIM NGF series) and illuminated reticle eyepiece.

Note: SkyWalker-Servo is carefully assembled with special jigs to assure alignment of internal components. Please do not open the SkyWalker-Servo enclosure. It can lead to a voided warranty.

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## **Chapter 2: SkyWalker Mode Operation**

Note: this chapter can be skipped if SkyWalker-Servo will not be operated in *SkyWalker mode* (i.e. only in *System mode*).

### **SkyWalker Mode Introduction**

Once SkyWalker-Servo is properly connected to at least the HP1 handpaddle, motor drivers and a power supply, it is set to operate in *SkyWalker mode*. In *SkyWalker mode* there is no need to connect a PC to SkyWalker-Servo. SkyWalker-Servo and HP1 operate as a complete “stand-alone” telescope control system and provide a working sub-set of *System mode* capabilities.

Please refer to the “SkyGuide User’s Manual” for complete details on using SkyWalker-Servo in *System mode*.

Important: SkyWalker-Servo must be properly configured for use with each specific telescope mounting. Therefore, it is important that the instructions in Chapter 3 (“Configuring SkyWalker-Servo for use in SkyWalker mode”) be followed before SkyWalker-Servo is used to control a telescope.

To operate in *SkyWalker mode* be certain that the SW/Sys switch is set for *SkyWalker mode* (i.e. towards “SW”). Next, simply turn-on SkyWalker-Servo. SkyWalker-Servo and HP1 will both briefly be in their pre-initialized states (i.e. HP1 will present alternating indicators because communications with SkyWalker-Servo has not yet been established and SkyWalker-Servo will flash its Sync indicator). After approximately one second SkyWalker-Servo and HP1 will establish communications and begin operating in *SkyWalker mode*.

If the SkyWalker-Servo -to- HP1 connection is interrupted for any reason (e.g. HP1 disconnected from SkyWalker-Servo) then HP1 will automatically return to its pre-initialized state and SkyWalker-Servo will indicate a communications error by blinking the P MEC, Lbatt and Sync LEDs in unison. It is necessary to turn SkyWalker-Servo off and then back on again to restart *SkyWalker mode*.

If SkyWalker-Servo is running in *SkyWalker mode* and an attempt is made to connect SkyWalker-Servo to SkyGuide-Win and enter *System mode*, SkyWalker-Servo will simply ignore SkyGuide.

If the SW/Sys switch is changed when SkyWalker-Servo is powered-up, SkyWalker-Servo will immediately “restart” in the new mode. Often it is handy to use your instrument in *SkyWalker mode* (with out a PC) to move/track and then switch over to *System mode* to automatically acquire objects and use advanced features.

### **Use in SkyWalker Mode**

In *SkyWalker mode*, SkyWalker-Servo is entirely controlled from either the handpaddle or from Autoguider input. This section describes how to use SkyWalker-Servo in *SkyWalker mode*, and as such, the instructions primarily involve how to use the HP1 handpaddle. This section is largely redundant with chapter 8 (“Telescope Control Features: Handpaddle, Joystick and Autoguider”) in the “SkyGuide User’s Manual”.

Operation in *SkyWalker mode* is entirely done from the HP1 handpaddle. HP1 handpaddle operation is identical in *SkyWalker mode* and *System mode* with the exception that some of the AKey assignments that are available in *System mode* are not available in *SkyWalker mode*.

### **Tracking rates**

After powering up in *SkyWalker mode* SkyWalker-Servo will be issuing RA motor steps at the Sidereal tracking rate if programmed for use on a Polar aligned instrument. If programmed for use on an AltAz mount, no tracking pulses will be issued at start-up.

*SkyWalker mode* provides 6 tracking rates: Sidereal, Lunar, Solar, King, Custom and Drift. The rates that each of these track at is programmed from SkyGuide-Win (see chapter 3).

## HP1 handpaddle operation in SkyWalker mode

### Types of HP1 keys

There are three types of keys on the HP1 handpaddle:

- ◆ *Direction Keys* are the four large red (backlit) keys arranged in a diamond pattern and are used to initiate motion or perform “alternate” functions with the *Enable Keys*.
- ◆ *Event Keys* cause a one-time “event” (i.e. command) to occur.
- ◆ *Enable Keys* are used to “enable” the *Direction Keys* for alternate functions.

### The HP1 Direction keys

The action of the *Direction Keys* depends on two factors:

1. State of *Enable Keys*: If any of the *Enable Keys* are depressed then the *Direction Keys* have “alternate” functions (i.e. functions other than causing telescope movement). “The HP1 Enable keys” section provides full descriptions of these alternate functions.
2. *Slew mode*: If the handpaddle is presently in *Slew mode* (described in “The HP1 Event keys” section that follows) then a *Direction Key* causes acceleration to the telescope’s *Slew Rate* in the direction dictated by the start-up settings (e.g. motor polarity) and operational settings (i.e. Mirror or Invert).

If the handpaddle is not presently in *Slew mode* then the *Direction Keys* cause acceleration to the present *View Velocity* (see “The HP1 Event keys” section that follows for instructions on selecting the present *View Velocity*). The HP1 handpaddle supports 4 user-programmable *View Velocities*.

Important: Do not view through the telescope when the handpaddle is in *Slew mode*. When not in *Slew mode*, handpaddle motion is at the presently selected *View Velocity* and is the only situation under which viewing should occur.

The velocity that the telescope is presently moving (under handpaddle control) can be “held” by depressing the *Direction Key* that is opposite of the presently depressed *Direction Key*. For example, if you have depressed the Up key and the telescope has begun to accelerate you can stop the acceleration and “hold” the present velocity at any time by simply depressing, and holding, the Down key.

Autoguider input is not dependent on *Slew mode* and commands only non-Slew movement at the present *View Velocity*. When *View* or *Slew* motion is commanded from both the handpaddle and Autoguider simultaneously the following two rules apply with rule #1 presiding over rule #2.

1. *View* motion has priority over *Slew* motion. For example, if the user tries to *Slew* from the handpaddle but the Autoguider has commanded *View* motion, then Autoguider *View* motion will preside.
2. Simultaneous *View* motion is serviced first from the handpaddle and then (if no handpaddle request), from the Autoguider.

### The HP1 Event keys

A one-time “event” will occur with the depression of an *Event Key*:

- ◆ Slew key: Toggles the handpaddle *Slew mode* On/Off. When handpaddle *Slew mode* is On, the *Direction Keys* causes telescope motion at the *Slew Rate* (i.e. fast). No observations should take place while slewing. When the handpaddle *Slew mode* is Off, the *Direction Keys* cause *View* motion. If presently in *Slew mode*, the Slew indicator (above the Slew key) will be lit.
- ◆ *Assignable Keys*: A assortment of “event” commands and functions can be assigned to these keys (as described in the “HP1 Assignable Keys” section below).

### The HP1 Enable keys

The *Enable Keys* are used to “enable” the *Direction Keys* for alternate functions:

- ◆ Focus/Dome key:
  - Enables the Up key for Focus-out and the Down key for Focus-in. The rate at which focus motion occurs is programmable from within SkyGuide-Win. Proper connection of an electric focuser to SkyWalker-Servo’s Declination Servo Drive Unit is necessary.
  - Enables the Left key for Dome-left and the Right key for Dome-right. Proper connection of a dome controller/driver to SkyWalker-Servo’s TCS port is necessary.
- ◆ Track key
  - Enables the Up & Down keys for changing the present *Track Rate* (i.e. Sidereal, Lunar, Solar, King, Custom and Drift).
  - While depressed, the *View/Track* display shows the presently selected *Track Rate*.
- ◆ View key
  - Enables the Up & Down keys for changing the present *View Velocity*. There are four *View Velocities* that are separately configurable from within SkyGuide-Win.
- ◆ Dim/Map key
  - Turns the Map light on.
  - Enables the Up key for display brightening and the Down key for display dimming.

### The HP1 Indicators

The HP1 “indicators” (i.e. LEDs) provide much information in *SkyWalker mode*. The purpose of each indicator is as follows:

- ◆ *Direction Key* “back lighting”: Each *Direction Key* has its’ own back light that, when lit, indicates that the *Direction Key* is presently usable.
- ◆ *Event Key* indicators: When an Event key is depressed there can be a change of mode internal to SkyWalker-Servo. The status of the particular mode is displayed on the *Event Key* indicators (located above each *Event Key*):
  - Slew indicator: Indicates the state of the handpaddle’s *Slew mode* (i.e. On or Off).
  - *Assignable Key* indicators: Provides status on the associated *Assignable Key* function. For instance, when an *Assignable Key* is used to Mirror the left and right buttons the associated LED will be on if Mirror is enabled and off if it is disabled.
- ◆ The *View/Track Display*:
  - If the Track key is not depressed, the four indicators in a vertical row at the lower left of the handpaddle indicate the present *View Velocity* as follows:

- *View Velocity 4*: All indicators On
- *View Velocity 3*: Bottom 3 indicators On
- *View Velocity 2*: Bottom 2 indicators On
- *View Velocity 1*: Bottom indicator On
- When the Track key is depressed, these four indicators show the present *Track Rate* as follows:
  - Sidereal: Top indicator On
  - Lunar: Top-middle indicator On
  - Solar: Bottom-middle indicator On
  - King Bottom indicator On
  - Custom: Blinking top (Sidereal) indicator
  - Drift: No indicators ON

The “King” tracking rate is a best-fit approximation of the Sidereal tracking rate when compensated for refraction and averaged across the sky.

The “Custom” track rate is set within SkyGuide- Win.

### HP1 Assignable Keys

Not all *Assignable Key* (AKey) functions that are available in *System mode* are available in *SkyWalker mode*. The following is a concise list of the AKey assignments that are available in *SkyWalker mode* and a very brief description of their function:

- ◆ **Drift**: Toggles in/out of the Drift TrackRate.
- ◆ **Indicator (i.e. reticle)**: When depressed the direction keys change Indicator on-time and period. If the Dim/Map is also depressed, the direction keys change indicator brightness.
- ◆ **Invert**: Inverts action of Up/Down direction keys.
- ◆ **Mirror**: Mirrors action of Left/Right direction keys.
- ◆ **Nothing**: No function for this AKey.

Note: Any AKey that is assigned a function that is not available in *SkyWalker mode* will behave, in *SkyWalker mode*, as if it is assigned the **Nothing** function.

### **Focus and Reticle control**

SkyWalker-Servo provides control of electric focusers and cable-powered illuminated reticle eyepieces. The connection and electrical details are contained in chapter 4. Functionally, the focus and reticle ports represent a subset of the “High Drive” capability that is included on our SkyWalker1 Telescope Motor and Accessory Controller and for which configuration of is provided in SkyGuide. Specifically, the focus is controlled by the BiDriveA and BiDriveB High Drive functions and the reticle is controlled by the UniDriveA High Drive function.





## **Chapter 3: Configuring SkyWalker-Servo for use in SkyWalker mode**

Note: this chapter can be skipped if SkyWalker will not be operated in *SkyWalker mode* (i.e. only in *System mode*).

SkyGuide-Win provides the software interface through which SkyWalker-Servo's internal settings are programmed for *SkyWalker mode*.

SkyWalker-Servo contains an on-board “non-volatile” configuration memory that can store all the configuration data needed to operate as a stand-alone telescope controller. This memory is pre-programmed to default settings at the factory. If you purchased a SkyWalker-Servo system for use on a commercial telescope mount then reasonable default configuration data is pre-programmed by Astrometric.

To configure SkyWalker-Servo one must configure SkyGuide-Win with the desired settings and then “connect” SkyGuide and SkyWalker-Servo for the settings to be transferred to SkyWalker. For use on commercial telescope mounts default settings in SkyGuide will be made during SkyGuide's installation.

Complete details on customizing SkyGuide-Win's settings are provided in the “SkyGuide for Windows User's Manual” chapters 4 and 5. In particular, the settings in SkyGuide-Win's Instrument Display's Settings/StartUp branch are important. Completely digesting this information is not mandatory if commercial mount defaults were selected during SkyGuide's installation.

Note: SkyGuide uses the latitude of the selected site to determine for which hemisphere (Northern or Southern) SkyWalker will be used in. SkyGuide then properly sets SkyWalker's tracking direction for use in *SkyWalker mode*.

SkyWalker-Servo's internal settings (for *SkyWalker mode*) are checked against SkyGuide-Win's associated settings (for *System mode*) every time the system enters *System mode*. If there are any differences, a “SkyWalker and System mode settings differences” window pops-up and lists SkyWalker-Servo's internal settings and associated SkyGuide-Win settings for each item for which a difference is detected. A separate pop-up window asks the user if they want to:

- A. Update *SkyWalker mode* settings with *System mode* settings (i.e. update SkyWalker-Servo's internal settings, for use in *SkyWalker mode*, from SkyGuide-Win's internal settings, for use in *System mode*) and then enter SkyGuide-Win's *Land mode*.
- B. Enter SkyGuide-Win's *Land mode* with no updates to SkyWalker-Servo's internal settings.
- C. Cancel (i.e. do not enter SkyGuide-Win's *Land mode*).

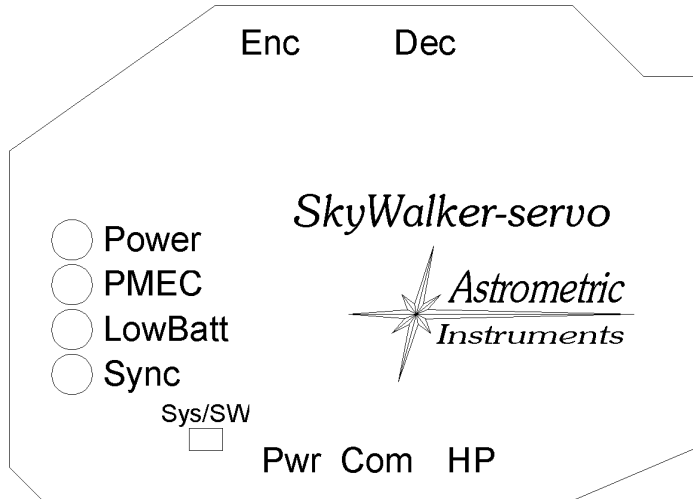
The “SkyWalker and System mode settings differences” window does not close until either the user closes it or exits SkyGuide-Win. This allows the user to attend to each discrepancy at their leisure. Note: several of the AKey and assignments that are available in *System mode* are not available in *SkyWalker mode*. Under the “SkyGuide value” column in the “SkyWalker and System mode settings differences” these are listed as “Nothing” with their *System mode* assignment provided in parentheses for reference.

While SkyGuide-Win is reading/writing SkyWalker-Servo's configuration memory, SkyWalker-Servo's indicator LEDs (except the Power LED which is always On) are all Off and the HP1 handpaddle's *Direction Key* backlight LEDs display a “rolling” pattern.



## Chapter 4: Connections, Pin-outs and Indicators

### RA Servo Drive Unit connections and pin-outs



(Note: all connector views are looking “into” SkyWalker-Servo)

#### **Pwr – 2.5mm x 5.5mm:**

##### Function

Connection for 12VDC power supply.

##### Pin-out

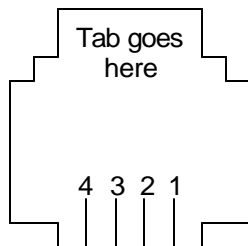
Center contact is positive and outside contact is ground.

#### **Com port – Handset MJ (MJ11):**

##### Function

Provides RS-232 connection to the PC running SkyGuide. SkyWalker-Servo is provided with a Com cable that includes the MJ11 connection on one end and an industry standard 9-pin female D-Sub (DB-9F) RS-232 connection on the other end.

##### Pin-out



Pin 1	RxD (receives RS-232 on this pin)
Pin 2	Signal ground
Pin 3	no connection
Pin 4	TxD (transmits RS-232 on this pin)

**HP (handpaddle) port – 8 pin MJ45:**

Function

Provides connection to SkyWalker-Servo's HP1 hand paddle. The required cable is included with HP1.

Pin-out

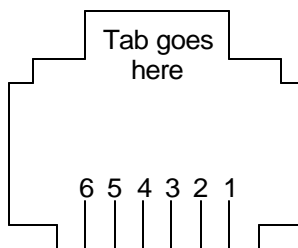
The HP port pin-out is Astrometric Proprietary.

**Enc (Encoder) port – 6 pin MJ12:**

Function

Provides connection for an optical shaft encoder. The industry standard Tangent/BBox pinout is supported. 5VDC power for encoders is limited to 100mA for each axis.

Pin-out



Pin 1	No connection
Pin 2	Quad B
Pin 3	Regulated 5VDC
Pin 4	Quad A
Pin 5	Signal ground
Pin 6	(optional) Axial Index

**Dec (connection to Declination Servo Drive Unit) port: DB9**

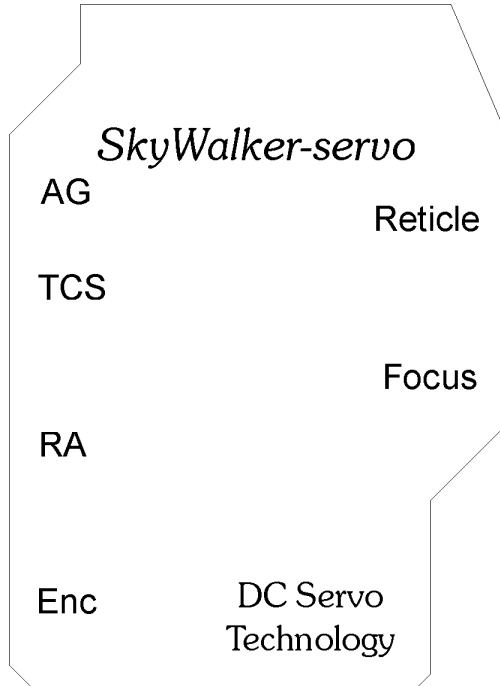
Function

Carries power to, and signals to/from, the Declination Servo Drive Unit.

Pin-out

The Dec port pin-out is Astrometric proprietary however it is one to one identical to the RA port pin-out on the Declination Servo Drive Unit.

## Dec Servo Drive Unit connections and pin-outs



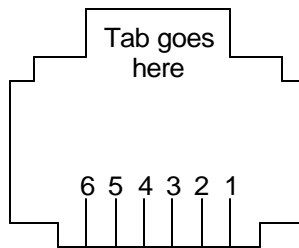
(Note: all connector views are looking “into” SkyWalker-Servo)

### AG (AutoGuider) port – 6 pin MJ12:

#### Function

This connection is for an AutoGuider and uses the industry standard 6 pin MJ12 modular connector pinout. An SBIG relay adapter box is **not** required.

#### Pin-out



Pin 1	No connection
Pin 2	Signal ground
Pin 3	Right
Pin 4	Down
Pin 5	Up
Pin 6	Left

### TCS (Telescope Control System) Expansion Port - 6 pin MiniDIN:

#### Functions

The TCS port provides for connection to future peripheral devices. Included are connections for 12VDC and a proprietary two-wire serial communications bus.

Pin-out

The TCS port pin-out is Astrometric Proprietary.

**RA (connection to Right Ascension Servo Drive Unit) port: DB9**

Function

Carries power from, and signals to/from, the Right Ascension Servo Drive Unit.

Pin-out

The RA port pin-out is Astrometric proprietary however it is one to one identical to the Dec port pin-out on the Right Ascension Servo Drive Unit.

**Enc (Encoder) port – 6 pin MJ12:**

Identical to the End port on the RA Servo Drive Unit.

**Reticle port - 3.5mm Phono jack:**

Function

Provides adjustable power source (up to 24mA) for cable-driven LED illuminated reticle eyepieces. Brightness and “blink” adjustments are available from the “Indicator” HighDrive function in SkyGuide.

Pin-out

Center contact is the power source and outside contact/shell is ground.

**Focus port – 3.5mm Phono jack:**

Function

Provides direct handpaddle control of popular 9v motorized focusers. Provides variable speed drive (up to 250mA).

Pin-out

Non-polarized 2 contacts.

**Indicator LEDs**

**Normal operation**

SkyWalker-Servo's four indicator LEDs have the following functions in *SkyWalker mode*:

1. Power indicator: Lit if SkyWalker-Servo is powered-up
2. PMEC indicator: Normally off since PEC and backlash compensation is not available in *SkyWalker mode*.
3. LBatt indicator: Lit if under voltage is present on the power port. In battery-powered systems this indicates eminent battery failure.
4. Sync indicator: Slowly “flashes” to indicate operation in *SkyWalker mode*. When SkyWalker-Servo is powered-up but not yet communicating with the handpaddle the Sync indicator will flash rapidly.

All indicators will dim/brighten on command from the Handpaddle.

**Fault conditions**

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SkyWalker-Servo is designed to use its Power, P MEC, LBatt and Sync indicator LEDs to display various “fault” conditions when in *SkyWalker mode*:

Fault Condition	Power	P MEC	LBatt	Sync	Notes
Stall, Over-current, Over-temp, Under-voltage	On	Flashing slow	See note	Flashing slow	1,2
HP1 not found or connection broken.	On	Flashing fast	Flashing fast	Flashing fast	3
SkyWalker-Servo configuration not yet programmed.	Flashing fast	Flashing fast	Flashing fast	Flashing fast	4
Hardware fault	Flashing fast	Flashing fast	Off	Off	5
Internal error in SkyWalker-Servo code	Flashing fast	Off	Off	Off	6

### Notes:

1. For Stall and Over-current faults, SkyWalker will re-try use of the motor after approximately 5 seconds.
2. If Under-voltage then the LBatt LED will be on as well. Otherwise it will be off.
3. When SkyWalker-Servo is turned-on the handpaddle should also turn on immediately and communications between SkyWalker-Servo and handpaddle should commence within one second (at which point the Sync LED will go into a “flashing slow” state). If SkyWalker-Servo does not find the handpaddle when powered up, or if the connection to handpaddle is interrupted, then SkyWalker-Servo will go into this mode. Turn SkyWalker-Servo off, check the connection to HP1 and turn SkyWalker-Servo back on again.
4. Be sure to complete all the “StartUp” settings within SkyGuide-Win and run SkyGuide-Win in *Land mode* at least once before using SkyWalker-Servo in *SkyWalker mode*.
5. The Hardware fault will be signaled if the cable connecting the RA and Dec Servo Drive Units is not connected when SkyWalker is powered up.
6. Report this error to Astrometric Instruments. Please provide a complete description of the situation leading up to this error.



## **Chapter 5: Specifications**

### Size

- ◆ Both RA and Dec Servo Drive Units: 5.2" long x 2.9" wide x 2.3" thick (132mm x 74mm x 58mm)
- ◆ HP1 handpaddle: 3.60" x 5.75" x 1.20" (92mm x 146mm x 31mm) excluding cord.

### Internal Time-base Accuracy:

- ◆ +/-30ppm from -20C to 50C ambient

### Accuracy and resolution:

- ◆ Servo motor position is controlled to 0.09 arcsecond on mounts with 360:1 additional reduction beyond the Servo Drive Unit.
- ◆ Servo Drive Unit output shaft position resolution: to 1 out of 40,000 steps. Each step represents one servo motor encoder position.

### Slew rate

- ◆ 480 RPM max at Servo Drive Unit output shaft.

### Internal Gear reduction:

- ◆ Custom-made 10:1 worm-gear reduction included in each Servo Drive Unit.
- ◆ All-metal gears: bronze worm-gear and stainless steel worm.

### Power Supply (2.5mm connector)

- ◆ 10.8VDC to 14.2VDC.
- ◆ <300mA typical when tracking (with no optional accessories such as dew heaters, axial encoders, etc. attached).
- ◆ 3A maximum when slewing, typically much lower (load dependent).

### Environmental Requirements

- ◆ -20C to 50C ambient
- ◆ 5% - 95% relative humidity, non-condensing

### Axial Encoder sampling rate

- ◆ Detects up to 20,000 encoder quadrature transitions per second.

### PC Comm port (MJ-11, used in *System mode*):

- ◆ 9600 Baud, 1 Stop bit, No Parity
- ◆ 50 ft. (15m) maximum