

## SynScan™ Serial Communication Protocol

### Version 3.3

This document describes the serial commands of Sky-Watcher® SynScan™ hand control. This information applies to the SynScan™ V3, SynScan™ V4 series GOTO mounts.

Communication to the hand control is 9600 bits/sec, no parity and one stop bit via the RS-232 port on the base of the hand control.

**Note:** This communication protocol applies to SynScan hand control with SynScan™ V3 firmware version 3.38 or SynScan™ V4 firmware version 4.38.06 or later.

### **Get Position Commands**

The following commands retrieve the position of the telescope in either RA/DEC or AZM-ALT coordinates. The position is returned as a hexadecimal value that represents the fraction of a revolution around the axis. Two examples are given below:

- If the Get RA/DEC command returns 34AB,12CE then the DEC value is 12CE in hexadecimal. As a percentage of a revolution, this is  $4814/65536 = 0.07346$ . To calculate degrees, simply multiply by 360, giving a value of 26.4441 degrees.
- If the precise GET AZM-ALT command returns 12AB0500,40000500 then the AZM value is 12AB05 in 24-bit hexadecimal. As a percentage of a revolution, this is  $1,223,429/16,777,216 * 360 = 26.252$  degrees. Note: the last two digits (00) of the AZM and ALT values are discarded or ignored.

The standard commands offer a precision of  $1/65536 * 360 * 60 * 60 =$  about 19.8 arcseconds per unit while the precise commands offer a precision of  $1/16777216 * 360 * 60 * 60 =$  about 0.08 arcseconds per unit (only the upper 24 bits are used).

**Note:** if the telescope has not been aligned, the RA/DEC values will not be meaningful and the AZM-ALT values will be relative to where the telescope was powered on. After alignment, RA/DEC values will reflect the actual sky, and the coordinates will be on J.2000 epoch basis.

Command Function	PC Command	Hand Control Response
Get RA/DEC	"E"	"34AB,12CE#"
Get precise RA/DEC	"e"	"34AB0500,12CE0500#"
Get AZM-ALT	"Z"	"12AB,4000#"
Get precise AZM-ALT	"z"	"12AB0500,40000500#"

### **GOTO Commands**

The following commands direct the telescope to GOTO a specified RA/DEC or AZM-ALT position. With the Get Position commands, the values are in hexadecimal and represent the fraction of a rotation around the axis.

**Notes:** GOTO RA/DEC commands will not work unless the telescope is aligned. The execution of GOTO RA/DEC commands will enable tracking if it is stopped.

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Command Function	PC Command	Hand Control Response
GOTO RA/DEC	"R34AB,12CE"	"#"
GOTO <i>precise</i> RA/DEC	"r34AB0500,12CE0500"	"#"
GOTO AZM-ALT	"B12AB,4000"	"#"
GOTO <i>precise</i> AZM-ALT	"b12AB0500,40000500"	"#"

### Sync Commands

To Sync to an object via serial commands, the user should center a known object in an eyepiece. Then the Sync serial command should be sent, using the celestial coordinates (RA and DEC in J.2000 epoch) for that object. This causes future GOTO or Get Position commands to use coordinates relative to the Sync'd position, improving pointing accuracy to nearby objects. The format for the RA/DEC positions in the Sync command is identical to the GOTO RA/Dec command.

Command Function	PC Command	Hand Control Response	Applies to Handset Versions
Sync RA/DEC	"S34AB,12CE"	"#"	3.37 or later 4.37.03 or later
Sync <i>precise</i> RA/DEC	"s34AB0500,12CE0500"	"#"	3.37 or later 4.37.03 or later

### Tracking Commands

The following commands retrieve or set the tracking mode.

Depending on the mount type, following tracking modes are available:

- 0 = Tracking off
- 1 = Alt/Az tracking
- 2 = Equatorial tracking
- 3 = PEC mode (Sidereal + PEC)

Command Function	PC Command	Hand Control Response
Get Tracking Mode	"t"	chr(mode) & "#"
Set Tracking Mode	"T" & chr(mode)	"#"

### Slewing Commands

The following commands allow you to slew (move) the telescope at fixed or variable rates.

For **variable rates**, multiply the desired rate by 4 and then separate it into a high and low byte. For example if the desired tracking rate is 150 arcseconds/second, then:

$\text{trackRateHigh} = (150 * 4) \setminus 256 = 2$ , and

$\text{trackRateLow} = (150 * 4) \text{ mod } 256 = 88$

For **fixed rates**, simply use a value from 1-9 (or 0 to stop) to mimic the equivalent hand control rates.

**Note:** in most configurations, issuing the slew commands will override (or conflict with) the tracking mode of the mount. Hence it is always best to disable tracking first using the **Tracking Commands**, issue the slew command, and then re-enable tracking. The main exception to this is when tracking equatorially - the **fixed rate** slews at 1 or 2 will not override tracking. This can be useful to simulate auto-guiding.

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Command Function	PC Command	Hand Control Response	Applies to Handset Versions
Variable rate Azm (or RA) slew in positive direction	"P" & chr(3) & chr(16) & chr(6) & chr(trackRateHigh) & chr(trackRateLow) & chr(0) & chr(0)	"#"	3.03 or later 4.01.01 or later
Variable rate Azm (or RA) slew in negative direction	"P" & chr(3) & chr(16) & chr(7) & chr(trackRateHigh) & chr(trackRateLow) & chr(0) & chr(0)	"#"	3.03 or later 4.01.01 or later
Variable rate Alt (or Dec) slew in positive direction	"P" & chr(3) & chr(17) & chr(6) & chr(trackRateHigh) & chr(trackRateLow) & chr(0) & chr(0)	"#"	3.03 or later 4.01.01 or later
Variable rate Alt (or Dec) slew in negative direction	"P" & chr(3) & chr(17) & chr(7) & chr(trackRateHigh) & chr(trackRateLow) & chr(0) & chr(0)	"#"	3.03 or later 4.01.01 or later
Fixed rate Azm (or RA) slew in positive direction	"P" & chr(2) & chr(16) & chr(36) & chr(rate) & chr(0) & chr(0) & chr(0)	"#"	3.03 or later 4.01.01 or later
Fixed rate Azm (or RA) slew in negative direction	"P" & chr(2) & chr(16) & chr(37) &	"#"	3.03 or later 4.01.01 or later

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	chr(rate) & chr(0) & chr(0) & chr(0)		
Fixed rate ALT (or DEC) slew in positive direction	"P" & chr(2) & chr(17) & chr(36) & chr(rate) & chr(0) & chr(0) & chr(0)	"#"	3.03 or later 4.01.01 or later
Fixed rate ALT (or DEC) slew in negative direction	"P" & chr(2) & chr(17) & chr(37) & chr(rate) & chr(0) & chr(0) & chr(0)	"#"	3.03 or later 4.01.01 or later

### **Time/Location Commands (Hand Control)**

The following commands set the time and location in the hand control.

The format of the location commands is: ABCDEFGH, where:

- A is the number of degrees of latitude.
- B is the number of minutes of latitude.
- C is the number of seconds of latitude.
- D is 0 for north and 1 for south.
- E is the number of degrees of longitude.
- F is the number of minutes of longitude.
- G is the number of seconds of longitude.
- H is 0 for east and 1 for west.

For example, to set the location to 118°20'17" W, 33°50'41" N, you would send (note that latitude is before longitude):

```
"W" & chr(33) & chr(50) & chr(41) & chr(0) & chr(118) & chr(20) & chr(17) & chr(1)
```

The format of the time commands is: QRSTUVWX, where:

- Q is the hour (24 hour clock).
- R is the minutes.
- S is the seconds.
- T is the month.
- U is the day.
- V is the year (century assumed as 20).
- W is the offset from GMT for the time zone. **Note:** if zone is negative, use 256-zone.
- X is 1 to enable Daylight Savings and 0 for Standard Time.

For example, to set the time to 3:26:00PM on April 6, 2005 in the Eastern time zone (-5 UTC: 256-5 = 251) you would send:

```
"H" & chr(15) & chr(26) & chr(0) & chr(4) & chr(6) & chr(5) & chr(251) & chr(1)
```

**Note:** All values are sent in binary format, not ASCII.

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Command Function	PC Command	Hand Control
Get Location	"w"	chr(A) & chr(B) & chr(C) & chr(D) & chr(E) & chr(F) & chr(G) & chr(H) & "#"
Set Location	"W" & chr(A) & chr(B) & chr(C) & chr(D) & chr(E) & chr(F) & chr(G) & chr(H)	"#"
Get Time	"h"	chr(Q) & chr(R) & chr(S) & chr(T) & chr(U) & chr(V) & chr(W) & chr(X) & "#"
Set Time	"H" & chr(Q) & chr(R) & chr(S) & chr(T) & chr(U) & chr(V) & chr(W) & chr(X)	"#"

### Miscellaneous Commands

Command Function	PC Command	Hand Control Response	Notes
Get Version	"v"	Replies 6 hexadecimal digits in ASCII and ends with "#", i.e. if the version is 04.37.07, then the hand control will responses "042507#",	Hand Control responses its firmware version in 6 hexadecimal digits in ASCII. Each hexadecimal digits will be one of '0' ~ '9' and 'A' ~ 'F'.

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		where 37 is 0x25 in hex.	
Get Device Version Devices include: 16 = AZM/RA Motor 17 = ALT/DEC Motor	"P" & chr(1) & chr(dev) & chr(254) & chr(0) & chr(0) & chr(0) & chr(2)	chr(major) & chr(minor) & "#"	Hand Control responds the motor controller firmware version.
Get Model 0 = EQ6 GOTO Series 1 = HEQ5 GOTO Series 2 = EQ5 GOTO Series 3 = EQ3 GOTO Series 4 = EQ8 GOTO Series 5 = AZ-EQ6 GOTO Series 6 = AZ-EQ5 GOTO Series  128 ~ 143 = AZ GOTO Series 144 ~ 159 = DOB GOTO Series 160 = AllView GOTO Series	"m"	chr(model) & "#"	Hand Control responds the model of mount.
Echo - useful to check communication	"K" & chr(x)	chr(x) & "#"	
Is Alignment Complete? - align=1 if aligned and 0 if not	"J"	chr(align) & #	
Is GOTO in Progress? - Response is ASCII "0" or "1"	"L"	prog & "#"	
Cancel GOTO	"M"	"#"	
Get Mount Pointing State	"p"	"E" or "W" & "#"	Hand Control responds the mount current pointing state. For northern "E" means no flipping (OTA is on the eastern side of meridian), "W" means flipped (OTA is on the western side). For southern hemisphere, "E" means flipped, "W" means not flipped.

### **Additional Commands**

Sending a Slow-Goto command through RS232 to the hand control

1. Convert the angle position to a 24bit number. Example: if the desired position is 220°, then  $POSITION\_24BIT = (220/360) * 2^{24} = 10,252,743$ .
2. Separate POSITION\_24BIT into three bytes such that ( $POSITION\_24BIT = PosHighByte * 65536 + PosMedByte * 256 + PosLowByte$ ). Example: PosHighByte = 156, PosMedByte = 113, PosLowByte = 199.
3. Send the following 8 bytes:
  - a. Azm Slow Goto: 'P', chr( 4), chr(16), chr(23), chr(PosHighByte), chr(PosMedByte), chr(PosLowByte), chr(0).
  - b. Alt Slow Goto: 'P', chr(4), chr(17), chr(23), chr(PosHighByte), chr(PosMedByte), chr(PosLowByte), chr(0).
4. The character '#', chr(35), is returned from the hand control.

Resetting the position of Azm/RA or Alt/Dec

1. Convert the angle position to a 24bit number, same as Slow-Goto example.
2. Send the following 8 bytes:
  - a. Azm (or RA) Set Position: 'P', chr(4), chr(16), chr(4), chr(PosHighByte), chr(PosMedByte), chr(PosLowByte), chr(0).
  - b. Alt (or Dec) Set Position: 'P', chr(4), chr(17), chr(4), chr(PosHighByte), chr(PosMedByte), chr(PosLowByte), chr(0).
3. The character '#', chr(35), is returned from the hand control.

### **Developer Notes**

#### Timeouts

If the hand control is sent a command that requires it to communicate with another device, then the hand control will make multiple attempts to get the message through in the event of communications problems. Examples include "Get Position" commands, "GOTO in Progress" commands, etc.

Software drivers should be prepared to wait up to 5.0s (worst case scenario) for a hand control response. If serial commands are "blindly" sent without waiting for a response, then some commands may be dropped or the software driver could see responses that are for earlier commands.