EQASCOM

The software driver for direct control of the EQ series astronomical mounts.

This document describes the features and use of the EQASCOM driver. It may also document other related topics. This documentation is created using a collaborative approach so your feedback and input is essential.

Since the EQASCOM (frequently referred to as EQMOD) software is continually evolving, the absolute latest details may not be included here. If you have not done so already, you should consider joining the Yahoo technical group dedicated to EQASCOM (http://tech.groups.yahoo.com/group/EQMOD/) where you may find more up to date information. Also, be sure to look at http://eq-mod.sourceforge.net

This documentation is under constant development as EQASCOM evolves. Please send private mail to JonD to give suggestions, explanations or corrections.

Note: You may need to update to a more recent version in order to use some of the features that are documented here.

This version of the documentation was created:
2008-12-20 12:24:49 PM EDT
and was based upon v114g of EQMOD and v1.12 of EQMOD Mosaic and v1.08 of EQTour.
There are later releases. Check the "Summary of Recent Version Changes".

Note: The links in the PDF version work with Adobe Reader 8. Other readers or versions may not support linking within the PDF document. The free PDF reader "Foxit" also works:
http://www.foxitsoftware.com/pdf/reader_2/down_reader.htm

The on-line version of the documentation is available at:
http://www.welshdragoncomputing.ca/eqmod
and may have a link to a more recent PDF document.

For another source of current information, visit the Yahoo news group:
http://tech.groups.yahoo.com/group/EQMOD/

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Summary of Recent Changes since v1.14g

EQMOD_ASCOM_BETA_V115a

Automatic pier flip option added.
Park to current no longer redefines the user defined park. Previously temporarily parking the mount would redefine the "defined park" position.

EQMOD_ASCOM_BETA_V115b

.txt extension forced for limit file saves
ASCOM error messages corrected.

EQMOD_ASCOM_BETA_V115c

Manual guiding via slew controls using pulseguide movements. The "Other Settings" frame now has a "slew at pulseguide" checkbox. When selected the slew controls will move at sidereal +- the RA rate / DEC rate as specified in the ASCOM PulseGuide frame.

EQMOD_ASCOM_BETA_V115d

Setup form forced to top.

EQMOD_ASCOM_BETA_V115f

Alignment preset index saved on preset load and save (previously only saved on form closure).
Com port string prefix added for com10+ support

EQMOD_ASCOM_BETA_V115g

PolarScope view added. The Polaris Hour Angle display is now a button on in the Site Information frame. Hit the button and the polarscope view pops up (same sort of thing as the polarfinder app)

EQMOD_ASCOM_BETA_V115h

Custom mount support - test release awaiting test and feedback
PEC restructure (I have a new idea and this prepares the groundwork - everything is backwards compatible, no visible changes to the UI)

EQMOD_ASCOM_BETA_V116a

ASCOM CommandString Interface to support PEC Phase, PEC Gain (Pempro mod)
ASCOM CommandString change so the enabling/disabling PEC also starts/stops tracking (Pempro mod)
ASCOM CommandString Interface to support MOUNTVER, DRIVRVER and DLLVER
Go faster n-star calculations.

Max stars used in N-Star calc read from ini file
Resizeable polarscope view - Polarscope view line width and fontsize increase proportionally to window size making it easier to see from a distance.

Current "official" release is V115d although V115.g will be released shortly as the support of COM10+ is an important improvement.

Here are some additional notes on the pierflip option
Given the concerns expressed at inclusion of auto-flip capability the auto flip support itself is dependent on an EQASCOM setup screen option (as presented when selecting properties from the ASCOM chooser).
http://tech.ph.groups.yahoo.com/group/EQMOD/photos/view/78b4?b=30&m=f&o=0
<http://tech.ph.groups.yahoo.com/group/EQMOD/photos/view/78b4?b=30&m=f&o=0>

Only if this option is checked is the user able to set EQASCOM to perform automatic flips. Assuming this is the case the auto flip action itself can be enabled/disabled via Limits Setup form. If enabled the flip is applied whenever the RA limits are reached (so not necessarily at the meridian). The PC will issue a short two tone beep sequence prior to initiating the flip to give you time to clear the area. prepare catch falling eyepieces, cut any snagging cables and hit the emergency stop!

EQMOD ASCOM DRIVER

The EQMOD ASCOM Driver is a software module that allows direct control of Synta mounts such as EQG, EQ-6, EQ-5, Sirius, and upgraded older Atlas mounts sold by Orion USA or Skywatcher. It either requires a modification of the hand controller or a small module such as EQDIR from Shoestring Astronomy:

http://www.store.shoestringastronomy.com/index.htm

or a special adapter cable, such as the one available from Pierro Astro:

http://www.pierro-astro.com/

to convert RS-232 signals to TTL levels to communicate with the motor controller board in the mount directly (no hand controller will then be needed).

For those wishing to build their own interface, the details can be found here:

http://eq-mod.sourceforge.net/eqdirect.htm

although a commercial interface module is recommended since the cost is quite small.

With the EQMOD ASCOM driver, the user will be able to control the EQ mount using any ASCOM compliant planetarium software at 0.144 arcsecond resolution. The driver supports almost all the ASCOM method and properties which include;

- SYNC (via ASCOM / Planetarium Software)
- GOTO/SLEW at 0.144 resolution (depending on the accuracy of the planetarium database)
- PARK TO HOME/PARK TO CURRENT/UNPARK
- 1-STAR ALIGNMENT & N-STAR alignment
- PULSEGUIDE (variable rates with 'duration' parameter support and duration override)
- ST4 guiding

Other EQMOD Functions:

- SIDEREAL, LUNAR, SOLAR TRACKING
- AUTOGUIDER PORT SPEED RATE SETTING (RA and DEC speeds can be set independently)
- VARIABLE SLEW SPEEDS which can be set from x1 to x800 of the sidereal rate
- NORTH and SOUTH Hemisphere support
- EQMOD SLEWPAD - Use a three button mouse use as a SLEW HAND PADDLE.
- GAME CONTROLLER/JOYSTICK control of mount
- GPS SUPPORT (using NMEA streams)
- USER PROGRAMMABLE TRACKING RATES (both on DEC and RA)
- PEC TRAINING (via hand control or PULSEGUIDE sequence) AND PLAYBACK (ring counter position accurate)

EQMOD Functions that may be supported:

- BACKLASH COMPENSATION (not active - most of the EQ designs do not require backlash)
- STORAGE/RECALL of alignment data

Note: This documentation sometimes refers to the “encoders” in the mount. Strictly speaking, the mount doesn't have optical encoders, instead, the mount uses 32bit ring counters to keep track of the stepper motor position. The more appropriate term to describe the stepper motor counters would be "RA position counter" or "DEC position counter" (or just "RA or DEC counter") instead of "encoder".

Copyright

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EQMOD ASCOM Driver is a software module that allows direct control of Synta mounts such as EQG, EQ-6, EQ-5, Sirius, and upgraded older Atlas mounts sold by Orion USA or Skywatcher.

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<http://www.gnu.org/licenses/>.

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Disclaimer & Warning

DISCLAIMER:

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Similarly, any hardware 'add-ons' are listed solely for information purposes. The authors cannot guarantee the functionality or quality of any of these third party add-on devices.

WARNING:

Circuit modifications &/or use of software control could invalidate any warranty that you may have. Use this information at your own risk. The modifications & software involve direct access to the stepper motor controls of your mount. Any "mis-control" or "mis-command" / "invalid parameter" or "garbage" data sent to the mount could accidentally activate the stepper motors and allow it to rotate "freely" damaging any equipment connected to your mount. It is also possible that any garbage or invalid data sent to the mount could cause its firmware to generate mis-steps pulse sequences to the motors causing it to overheat. Make sure that you perform the modifications and testing while there is no physical "load" or dangling wires on your mount. Be sure to disconnect the power once this event happens or if you notice any unusual sound coming from the motor assembly.

Reporting Bugs and Requesting New Features

If you have a request for a new feature or a bug report, enter it at source forge:
http://sourceforge.net/tracker/?group_id=182628

Of course you are welcome to first test the waters in Yahoo technical group dedicated to EQMOD (http://tech.groups.yahoo.com/group/EQMOD/) and see what others think. It probably makes sense to first browse the existing bugs & suggestions to see if you can find any issues relevant to what you're about to report. You can then add a comment about the bug or the new feature that you are suggesting. That gives an idea of how many are experiencing the same issue or would like the same improvement.

Hardware

Computer Hardware

The EQMOD driver itself does not require a high-powered computer. On the other hand, you will typically be running one or more other programs (notably a planetarium program) that will require a computer with more memory and processing power. A low-end computer that works satisfactorily has the following specifications:

- memory typically 512Mb minimum
- CPU (if they work with Windows 98 they'd be OK. This means just about any modern CPU)
- an on-board RS232 serial port or an adapter that uses a USB port.
- For imaging, additional ports will be needed for focus controllers, guide camera, image camera
- disk drive (the size of the drive has no impact on the use of EQMOD)
- a mouse is essential but you really should also have a game controller/joy stick &/or a second 3-button mouse or a numeric USB keypad

A computer with Windows XP SP2 with 512MB main memory and P4 1.6Mhz CPU is known to work satisfactorily. Other users are now starting to use Vista (usually requires more memory). Currently there is no specific support for Linux.

Mount Hardware

The EQMOD driver allows direct control of Synta mounts such as EQG, EQ-6, EQ-5, Sirius, and upgraded older Atlas mounts sold by Orion USA or SkywatcherOrion/SkyWatcher. It provides software that provides extensive features controlled by a computer. The computer controls the mount from a RS232 serial port or USB port.

The most common alternative is to replace the use of the hand controller with a small module such as EQDIR (from Shoestring Astronomy: http://www.store.shoestringastronomy.com/index.htm). This module is used with a **straight through serial cable** from the serial port on your computer to the DB9 connector on the mount. Another connection alternative is a special adapter cable, (such as the one available from http://www.pierro-astro.com/) that interfaces with a USB port. Pierro Astro also has a module (EDI) that does the direct connection via an RS232 port. Another source is Xagyl Communications who have a USB and an RS232 version.

You could also modify your hand controller. Details or modification of the hand controller can be found here although using one of the commercial modules is typically the most common way to go.: http://eq-mod.sourceforge.net/index.htm

For those wishing to build their own interface, the details can be found here: http://eqmod.sourceforge.net/eqdirect.htm

These devices convert signals to TTL levels required to communicate directly with the motor controller board in the mount.

Caution: Never try connecting the computer ports to the mount without the appropriate adapter.

Software

Operating Systems

The EQMOD driver works on Windows(tm) most versions. Windows Vista(tm) is relatively new but EQMOD has been run successfully using the Windows XP compatibility mode (use a right click to set this mode). There is currently no specific support for Linux.

Planetarium Software

The EQMOD driver is known to work well with the following software applications:

- Starry Night (http://www.starrynight.com/) (sometimes known as SN or SN6)
- Hallo Northern Sky (http://www.hnsky.org/software.htm) (sometimes known HNSKY)
- Cartes du Ciel (http://www.stargazing.net/astropc/) (sometimes known as CdC)
- StarCalc (http://www.relex.ru/~zalex/files_eng.htm)
- Stellarium (http://www.stellarium.org/) . You will also need StellariumScope (http://www.bytearts.com/stellarium/index.html)

ASCOM software

- An essential component in the setup is the freely available ASCOM software. You can obtain it at the ASCOM web site (http://ascom-standards.org)
- The ASCOM driver software provides a mechanism for standardizing the interface between many of the pieces of hardware and software typically used in your observatory.
- It includes a component known as POTH (Plain Old Telescope Hub) that allows several devices to interface with the telescope at the same time. **Current releases of the EQMOD driver do not require the use of POTH.**

Guiding Software

- MaximDL (http://www.cyanogen.com/products/index.htm)- essentially imaging software but it does have some telescope control functions that permit guiding.
- PHD (http://www.stark-labs.com/) - free and highly recommended guiding software

Downloading the EQMOD Software

The software is best downloaded from the Yahoo EQMOD news group
(http://tech.groups.yahoo.com/group/EQMOD/files/A%20EQMOD%20Release/)

1. Login and go to the files section.
2. Look for the folder *A EQMOD Release*

Inside you will see several folders. The folder *EQASCOM* contains the latest release. Each version is identified with a name that includes a version number and probably a letter.

For example: *EQASCOM_V114f_Setup.exe*
or some future version such as:
EQASCOM_V115k_Setup.exe

You will typically want the most recent version since it will have the latest features and and fixes. If the most recent release exhibits some problems that have not been resolved you can always select a previous release.

There are also frequently versions that are in a “debug” testing state. In general, they are quite stable but you may encounter some issues (and these issues should be reported). The “debug” version will have the latest features.
http://tech.groups.yahoo.com/group/EQMOD/files/Debug/EQASCOM/

Previous releases can be found in the //archive// folder
(http://tech.groups.yahoo.com/group/EQMOD/files/Archive/)
although they may still be "in transit" from previous locations.

You may also be able to obtain the latest version from
https://sourceforge.net/project/showfiles.php?group_id=182628
without joining the Yahoo group.

Installing the EQMOD Driver

Before you try installing EQMOD, make sure you have installed the ASCOM driver:
(http://ascom-standards.org). EQASCOM will work with v4 of ASCOM but you are advised to update to the latest ASCOM version

Then:

1. Run the program file you downloaded (*EQASCOM_V114f_Setup.exe* for example). The file will have a name and number appropriate to the current release.
2. You will probably receive a warning from Windows but it is safe to proceed.
3. You will have the option of installing the source files but these would only be needed if plan on developing the code.
4. Finish the installation.
5. After you have completed the installation you should see the "EQMOD ASCOM Scope Driver" as an option when you try to connect to the mount from your planetarium program.
6. When you connect to EQASCOM, you will be able to confirm that you have the current version installed since the version is always displayed in the upper right of the window.

Old installation procedure:
This applies to versions before 1.14c (you should really consider using the current version though).

1. Copy the downloaded .zip file (EQMOD_ASCOM_V114a.zip for example) to an appropriate folder. The file will have a name and number appropriate to the release.
2. Unzip the file. You will find many files included in the folder.
3. Run the register.bat file by (typically) double clicking. If you are upgrading from a previous version, use reregister.bat. (The reregister.bat program effectively disconnects any previous links to earlier versions.)
4. Running the above .bat file adds the EQMOD drivers to the correct ASCOM folder. This will allow you to choose the EQMOD driver in your planetarium setup.

After you have run the register.bat program you may still be unable to see the "EQMOD ASCOM Scope Driver" as an option when you try to connect to the mount from your planetarium program. Follow the suggestions below to fix the problem.

Register and *Reregister* did not work. What next?

This section only applies to versions earlier than 1.14c

Running *register.bat* simply copies both the *eqmod.exe* and *eqcontrl.dll* files to the ASCOM installation directory (typically this path is *c:\Program Files\Common Files\ASCOM\Telescope*). For some reason this does not always work. You might get a "0 files copied" message or the driver(s) do not appear in the ASCOM chooser dialog. If it is registered, you can invoke EQMOD from the planetarium software such *Starry Night* or *Cartes du Ciel* or *Hallo Northern Sky* or *StarCalc* or *StellariumScope*.

For times when initial registration fails, use the information below to try and resolve the problem.

As of v114, here's the code in register.bat:

```
copy "EQMOD.EXE" "%CommonProgramFiles%\ASCOM\Telescope"
copy "EQMOD_SIM.EXE" "%CommonProgramFiles%\ASCOM\Telescope"
copy "eqcontrl.dll" "%CommonProgramFiles%\ASCOM\Telescope"
copy "eqmod??.dll" "%CommonProgramFiles%\ASCOM\Telescope"

cd "%CommonProgramFiles%\ASCOM\Telescope"

"EQMOD.EXE" /regserver
"EQMOD_SIM.EXE" /regserver

pause
```

You can accomplish this manually:

1. Confirm whether *eqmod_sim.exe* and *eqmod.exe* and *eqcntrl.dll* driver are installed in the folder that contains the other ASCOM driver such as the ones for Meade, Celestron, etc. This path is usually *c:\Program Files\Common Files\ASCOM\Telescope*
2. If the files do not exist in the ASCOM folder, copy them from your "unzip" folder.
3. Double click the *eqmod.exe* program itself (the copy of *eqmod.exe* that is in the ASCOM sub-directory).
4. A popup window will appear but just ignore it and the program will exit.
5. Repeat steps 3 & 4 for *eqmod_sim.exe*

Once this is done, check again on the ASCOM Telescope Chooser dialog in your planetarium program (i.e. try to connect to a telescope and look for the "EQMOD ASCOM Scope Driver").

You should also see EQMOD ASCOM Simulator as a choice. Information about running the simulator version is documented later on in this manual.

Typical Configurations

In this hobby there are virtually an infinite number of combinations of equipment. This is certainly true for guiding. The examples listed here come from working installations and may be useful in setting up your specific equipment environment.

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Example #2

Equipment:
· EQ6 Pro
· Homemade EQDIR adapter
· USB Powered Hub
· 5m USB Active extension cable
· HugePine USB-RS232 converter
· 2m RS232 Extension cable
· Rumblepad II wireless gamepad.
· Desktop PC (Windows XP Pro™ SP2)
· PC PSU providing 12V supply to Mount & 5V supply to USB Hub
· B&W Philips Vesta Pro LX modified webcam for guiding

EQ6 is connected as follows:
EQ6 -> RS232 extension cable -> EQDIR module -> RS232-USB converter ->
USB hub -> 5m USB Active extension cable -> PC.

Software:
· Cartes du Ceil Version 3 beta 0.1.2 - planetarium
· K3CCDTools 3.4.7.1078 – capture/drift analysis/ guiding
· PHD guiding (http://www.stark-labs.com/) - guiding
· EQTour – for alignment star list
· EQMosaic – for CCD targeting/framing and mosaics.

Using EQMOD with a Planetarium program

EQMOD is not a stand-alone program. It is software that acts as a driver between other applications (such as your planetarium program). For this reason you should start the planetarium program and then connect to the mount from within the planetarium program. This will start up the EQMOD driver. (Note: Other add-on modules such as *EQTour* and *EQMosaic* will also start up EQMOD even without a planetarium program. Information about these add-on modules can be found in a later section in this documentation).

Because there are many different combinations of software (and hardware) you will have to use the following examples to guide your own startup steps.

Caution: It's very important that EQMOD and your planetarium program agree upon your Latitude/Longitude. A common problem is forgetting to set these values in **both** the planetarium program and EQMOD. Setting an accurate time is also very important. GPS or Internet time is a good idea.

Information: If the "EQMOD ASCOM Scope Driver" does not appear in the ASCOM chooser window in the instructions below, you have an EQMOD installation issue. Check the installation instructions earlier in this manual.

Examples of planetarium usage follows:

Cartes du Ciel (CdC)

1. Start the planetarium program
2. Select "Telescope | Select Scope Interface" and click ASCOM
3. In the ASCOM Telescope interface window that appears click [Select]. If the window does not appear select "Telescope | Configuration Panel" first.
4. In the ASCOM "chooser" window that appears, select "EQMOD ASCOM Scope Driver"
5. In the ASCOM Telescope interface window that appears click [Select]. If the window does not appear select "Telescope | Configuration Panel" first.
6. When connected the EQMOD ASCOM driver window will appear.
7. Verify that CdC and EQMOD agree upon settings for time/date/Latitude/Longitude.

Using EQMOD with a Planetarium program (continued)

Hallo Northern Sky (HNSKY)

1. Start the planetarium program
2. Select "Screen | ASCOM Telescope driver"
3. In the ASCOM "chooser" window that appears, select "EQMOD ASCOM Scope Driver"
4. EQMOD will connect
5. You will want to move the EQMOD window aside to reveal the message window underneath.
6. Click the [OK] button to dismiss the message window (otherwise you may have trouble accessing some of the HNSKY features).
7. When connected the EQMOD ASCOM driver window will appear.
8. Verify that HNSKY and EQMOD agree upon settings for time/date/Latitude/Longitude.

Hint: If you select HNSKY's "File | Save status" before exiting the program, HNSKY will remember that you use EQMOD the next time it is started.

Starry Night

1. Start the planetarium program
2. Click the "Telescope" tab
3. If necessary, expand the setup form
4. Click the [Configure] button
5. In the ASCOM "chooser" window that appears, select "EQMOD ASCOM Scope Driver"
6. Click the [Connect] button
7. When connected the EQMOD ASCOM driver window will appear.
8. Verify that Starry Night and EQMOD agree upon settings for time/date/Latitude/Longitude. You should be aware that programs such as Starry Night that have the more realistic view of the sky use a greater amount of CPU processing on the computer.

StarCalc

1. Start the planetarium program
2. Select Telescope | Choose menu item
3. In the ASCOM "chooser" window that appears, select "EQMOD ASCOM Scope Driver"
4. Select Telescope | Driver setup menu item. Complete appropriate details.
5. Select Telescope | Connect EQMOD ASCOM driver menu item
6. Select Telescope | Options menu item .
7. Verify that StarCalc and EQMOD agree upon settings for time/date/Latitude/Longitude.

Stellarium

In order to integrate *Stellarium* with EQMOD, you will need to install both *Stellarium* and *StellariumScope*.

StellariumScope provides the necessary interface between *Stellarium* and the EQMOD. It is available at

http://www.bytearts.com/stellarium/index.html

1. Start *StellariumScope*. It will start *Stellarium*.
2. Select the Scope Drive (typically EQMOD Scope Driver or EQMOD ASCOM Simulator).
3. Click on “Connect” in StellariumScope.
4. Select Configuration | Location menu item in Stellarium.
5. Verify that *Stellarium* and EQMOD agree upon settings with respect to time/date/Latitude/Longitude.

A comment about CPU usage:

You should be aware that programs such as Stellarium that have the more realistic view of the sky use a greater amount of CPU processing on the computer. This may pose a problem if you have a slower computer or are running remote control operations that also need significant CPU processing.

You can reduce the impact upon CPU usage by minimizing the program when you don't need to see the display.

Using a GPS module

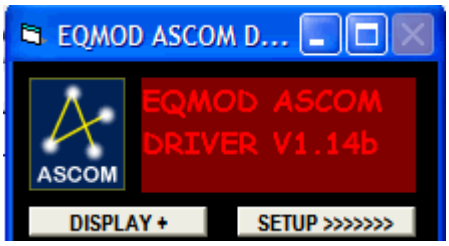
The GPS module that is sold as an EQ mount accessory works well with EQMOD. It typically comes ready to connect to the hand controller with an adapter or directly to a USB port on your computer. There is a CD included with driver software for the computer.

Other GPS modules may also work.

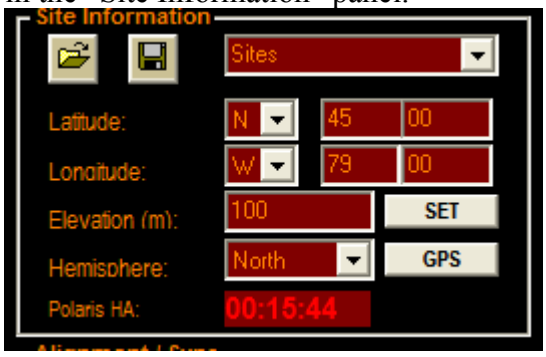
When the GPS module is used with the handset it is set to binary mode. This mode will not work with your computer (or EQMOD). It is necessary to install the software application that comes with the GPS module. Once you have it working with the computer (it will require you to change the output format to "NMEA"), you can then close the application that came with the GPS module.

Once you have EQMOD up and running,

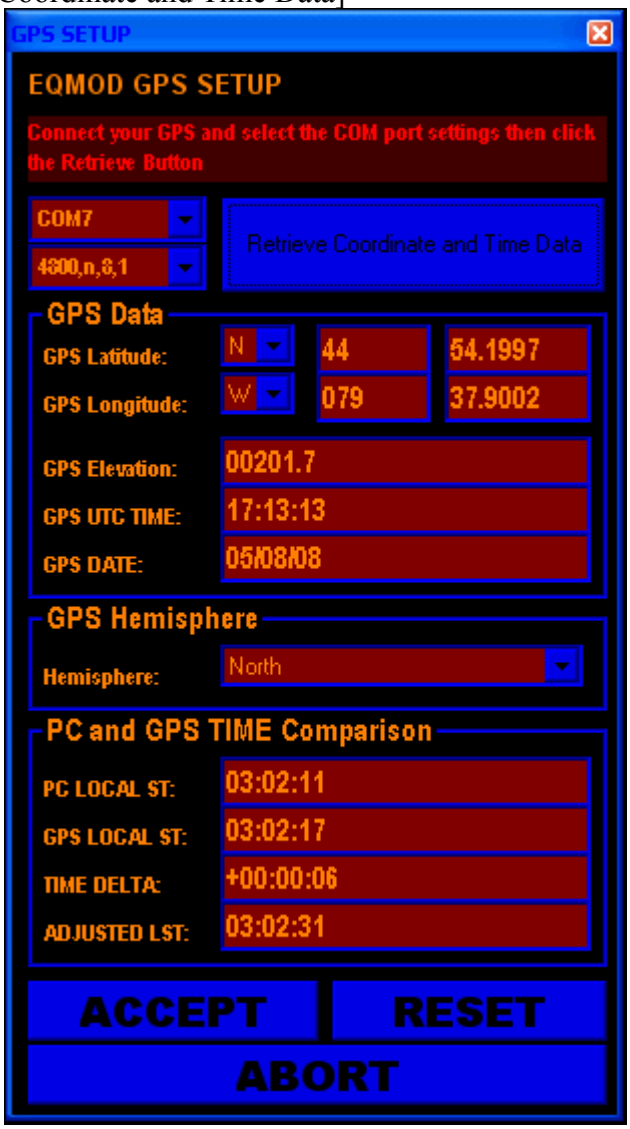
1. Expand the EQMOD ASCOM Driver window by clicking the [Setup] button in the near the EQMOD ASCOM title at the top of the EQMOD window.



2. Click the [GPS] button in the "Site Information" panel.



3. In the GPS setup window, set &/or verify the com ports and speed (e.g. they should match the ones you used when you setup the GPS module with the supplied application).
   Click the [Retrieve Coordinate and Time Data]



4. Observe the "Time Delta" line to see how the computer time compares to the GPS time
5. If appropriate, open your computer clock window and adjust the time to match. See below for more information about the “Time Delta”
6. Click the [Accept] button (in the GPS setup window)

About the Time Delta

The delta (offset) value is an important piece of the puzzle that synchronizes the whole setup from the GPS clock. In EQMOD, the PC clock is used to compute the Local Sidereal Time. The on-board PC time is not changed whenever a GPS receiver is used. The EQMOD driver gets the atomic time from the GPS receiver, it also reads the current PC time-of-day which is converted to UTC. The two values are then compared and the time delta (time discrepancy between PC and GPS) is then computed.

When the EQMOD driver computes the Local Sidereal Time, it reads the PC clock, applies an offset using the delta value, then derives the Local Sidereal Time. This is done without any adjustment on the on-board PC clock. In fact, you can actually remove the GPS receiver once it gets the delta and coordinate values. The driver will function on its own using the PC clock + the delta value as the time reference.

This process (using GPS) means that the time "drift" typical of most computers is not an issue. You could, of course, always correct the PC clock each time you startup the computer and the delta would then be 0. **Note:** Most planetarium programs use the PC clock. It would be wise to have the PC clock close to the correct time (a very small delta value).

Using the GPS on the Hand Controller

If you want to use the GPS module with your handset, you will have to use the GPS application program that you installed in your computer to set the output format back to binary.

Controlling the Mount

Using the Slew Controls

In the EQMOD ASCOM driver window you will find the "Slew Controls" panel. Assuming that the mount is unparked, clicking &/or holding the mouse down on one of the N/S/E/W buttons will move the mount in the appropriate direction.

You may need to select the RA or DEC reverse options to move the mount in the way you would expect.

You can drag the rate controls to adjust how the mount responds to the direction buttons.

The [Stop] button will stop tracking as well as GOTO slews. Stopping the mount will not affect alignment. Simply click the appropriate track rate button to restart tracking.

The extra icons at the bottom of the the slew controls provide some extra functionality.

Click this icon to jump to *EQTour* (assumes that *EQTour* has already been started). If *EQTour* is not already running, a file dialog will appear allowing you to browse to the location of *EQTour.exe*. Clicking on *EQTour* will start the program.

Click this icon to jump to *EQMosaic* (assumes that *EQMosaic* has already been started). If *EQMosaic* is not already running, a file dialog will appear allowing you to browse to the location of *EQMosaic.exe*. Clicking on *EQMosaic* will start the program.

Click and hold on this icon to initiate a spiral slew of the mount. Setting the slider will control whether it is a small or large spiral. Use this feature to help centre an object.

Using a Planetarium program to control mount

Once the planetarium program is connected to EQMOD (and the mount is unparked) you can select an object in the planetarium program and slew the mount to that object. The exact method varies from program to program. Possibilities:

- Right click the object and select GOTO or "slew to" in the popup menu

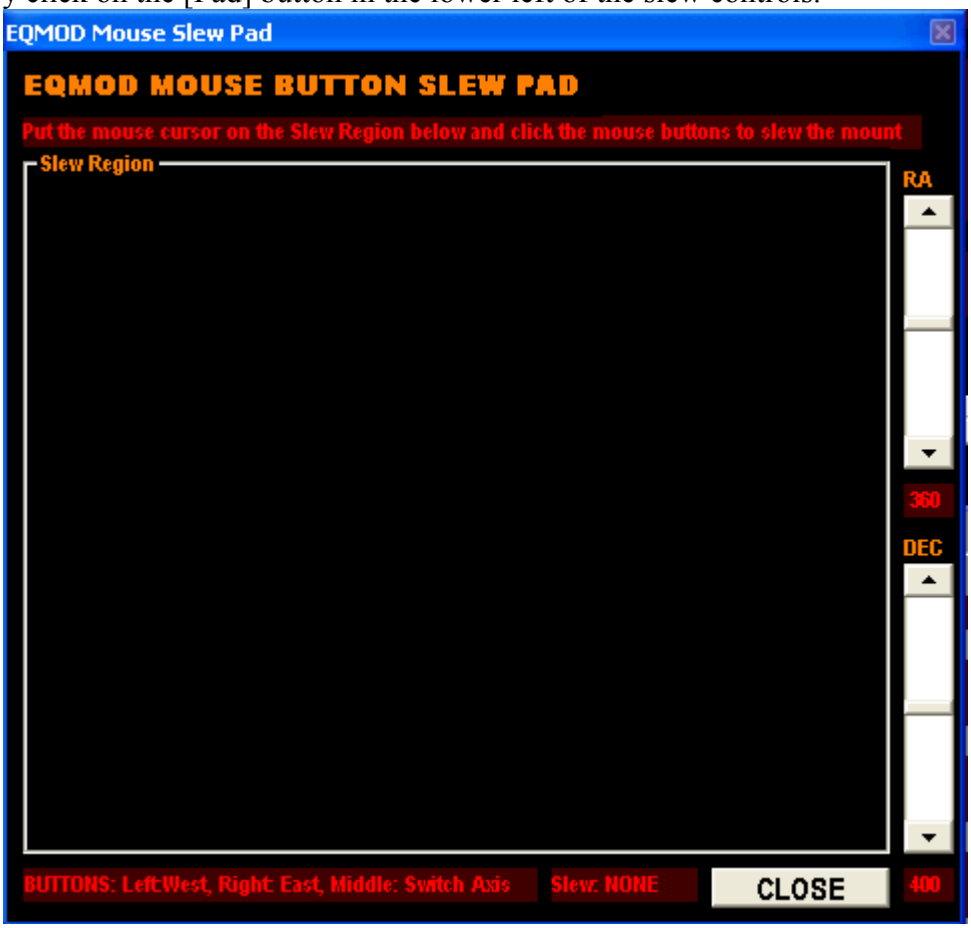
or

- Double left click the object.

There may be other possibilities depending upon the program. The mount will only slew correctly to the object if it has been carefully aligned (preferably with 3 or more stars).Using the slew pad and mouse to control mount

Using the slew pad and mouse to control mount

You can use a 3-button mouse to slew the mount using a special slew pad window. Open up the slew pad window by click on the [Pad] button in the lower left of the slew controls.



- You will probably want to have two mice.
- You can adjust the size of the slew pad by dragging and dropping the borders so that it takes less of the available screen space.

Using the slew pad and mouse to control mount (continued)

- Use a 3-button mouse with the tracking ball removed for the slew control. You will only be using the buttons to control the mouse and you need the mouse to stay within the slew pad. Removing the trackball will mean you won't need to concerned about moving the mouse out of the slew pad area as you use it to slew the mount.
- Position the mouse within the slew pad area (with your regular mouse). Use the modified mouse to slew the mount.
- The left button is used for West & North
- The right mouse button is used for East & South
- The middle button toggles the modes of the left & right buttons.
- If the middle button does not toggle the modes as expected, you may have to go into your windows mouse setup and assign the middle button to just "middle button". It may have been set to some other function such as "double click" or "help" or "minimize" etc.

If you have just one mouse:

1. Use the mouse to open the slew pad by clicking the [Pad] button.
2. Click anywhere within the slew pad (the middle is probably the safest in case you accidentally move the mouse while slewing the mount)
3. Use the mouse buttons to control the mount. Try to avoid moving the tracking ball so the screen mouse stays within the slew pad.

Assuming you have 2 mice:

1. Use your regular mouse to open the slew pad by clicking the [Pad] button.
2. Using the regular mouse, click anywhere within the slew pad.
3. Use the modified mouse to control the mount

Using a numeric Keypad to control mount

You can use the regular numeric keys on your regular keyboard. However, a more useful setup is a separate numeric USB keypad that is a frequent add-on for notebook computers. This allows you to hold the keypad in much the same way as you would have used the original hand controller.

Keypad information:

- Slewing Functions via numeric keypad (USB Keypad, or Keyboard Keypad).
- The keypad functions is only attached to the 'SLEWPAD' window. Just select the slew pad window and all key press commands will be recognized. You can reduce the size of the slew pad so that it does not hide any parts of the screen that you need to view.
- You can slew 'diagonally' using the keypad:
- Button 7: Slew North West
- Button 8: Slew North
- Button 9: Slew North East
- Button 4: Slew West
- Button 6: Slew West
- Button 1: Slew South West
- Button 2: Slew South
- Button 3: Slew SouthEast
- Left Arrow: Slew West
- Right Arrow: Slew East
- Up Arrow: Slew North
- Down Arrow: Slew South
- Button 5: EMERGENCY STOP/Disable Tracking
- Button 0: Activate Sidereal Tracking
- Keypad Slew rates are based on the SLEWPAD Rate slider buttons

Using a Joystick to control mount

Install the Joystick with the associated installation software.

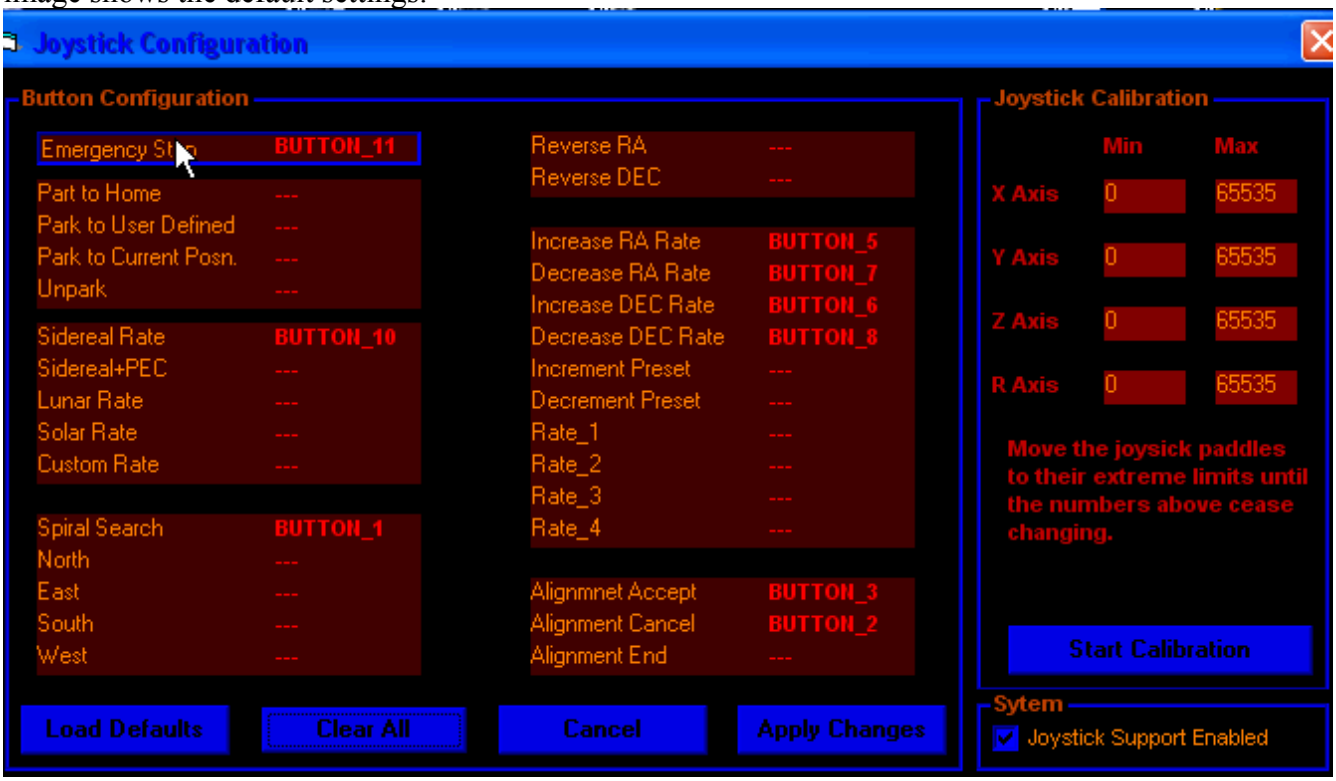
1. Start up EQMOD in the usual fashion.
2. There is an [Initialise] button in the expanded EQMOD window. It's located in the lower right under "Joystick Configuration". You can use this [Initialise] button if the joystick disconnects.
3. Typically the left joystick will control the slewing of the mount. You will also find you can move the joystick diagonally to move the mount in Dec and RA at the same time.
4. Default buttons on Joystick/Game controller:
    - 1 spiral search
    - 2 alignment cancel
    - 3 alignment accept
    - 4 unused
    - 5 increase RA rate
    - 6 increase Dec rate
    - 7 decrease RA rate
    - 8 decrease Dec rate
    - 9 unused
    - 10 start tracking sidereal
    - 11 (press left Joystick down) Emergency Stop stops slews and tracking
    - 12 unused
    - 13 unused

Only one button can be assigned to a function so there is only one emergency stop button.

Defining the Mapping of Buttons on a Joystick/Game Controller

The Joystick is sought out automatically if your Joystick is present at start-up. If the Joystick is not detected, try using the "Initialise" button in the "Joystick Configuration" sub-panel.

The user can define which Joystick buttons map to which EQMOD_ASCOM functions. The following image shows the default settings.



OPERATION:

1. In EQMOD, click the [Setup] button (if necessary) to display the expanded EQMOD window.
2. Open up the Joystick configuration dialog via the [Configure] button on the main (expanded) EQMOD_ASCOM window (in the "Joystick Configuration" sub-panel).
3. In the "Joystick Configuration" window, select a function by left clicking and then press the button **on your game controller/joystick** that you wish to use. If you are changing the button for a function, it is not necessary o clear the previous setting first.
4. To clear the button setting from a function, simply right click on the current assignment.
5. Click the [Clear All] button to clear all assignments.
6. Click the [Load defaults] button to load the default assignments.
7. After all changes have been made, click the [Assign Changes] button – the dialog will then close.
8. Click the [Cancel] button to close without updating or changing the current assignments.

Notes on Defining Joystick/Game Controller Buttons

1. The same button can be assigned to more than one function and if this is the case any duplicates are highlighted as a warning. This allows you to combine RA and DEC rate adjustments to use only two buttons (increment and decrement) if you so desire.

2. While the joystick configuration is in progress the joystick buttons no longer control the scope – **this includes any button currently defined for the emergency stop function**. On closing the configuration dialog control is returned to the joystick.

3. A particular function can only be assigned to a single button and so there can now only be one button that performs *"Emergency Stop"*. However, as described above, one button can invoke more than one function (see 1. above).

4. It is advisable to verify that button assignments perform as expected under simulation prior to using them to drive the mount. You should then verify (again) that the buttons drive the mount as expected.

5. If on first run of EQMOD, the *joystick.ini* file does not exist, the code attempts to read each parameter and, upon failure, will fail assign default values. These default values are written to the *.ini* file and the file gets created as part of this process.

6. The read of mappings is performed on EQMOD main form load. This means the default behavior will be assigned without the need for any user configuration.

7. Any buttons that form part of the default mapping that are not applicable to the actual controller being used (perhaps the controller has fewer buttons) will be ignored.

8. If you wish to assign one or more buttons to select slew presets, you should read the section of the manual on slew presets.

9. The function-button mappings are stored in a *joystick.ini* file in the `C:\Documents and Settings\YourLoginName\Application Data\EQMOD` folder. If you want to move your joystick mappings from one PC to another, copy this file. Because of its location each windows account (if you login as a different user to your Windows computer) will have their own mapping file. You can edit the *joystick.ini* file with *NotePad* or some other text editor. This would enable you to change a single button code.

Calibrating the Joystick

Typically a joystick will send values of a minimum of 0 and a max of 65535. These are the limits that EQASCOM always used to apply internally. If Joysticks are auto calibrating or can be calibrated from their driver then these are the typical values.

Some game pads however don't quite seem to make it to the absolute min and max values (perhaps their centre position isn't set exactly at 32767 or perhaps their hardware doesn't have full 16 bit resolution, hence the calibration screen where the actual range can be determined. The data is stored in the joystick .ini file so the values could be edited manually (perhaps to make the trigger points well within the current limits).

The calibration routine also lets you calibrate the right hand joystick (if you have one) i.e. Z and R (Rudder) axis. In future it's likely that other features such as LX200 focuser options will be available on the game pad using the right hand joystick.

Slew Presets

EQMOD can use preset rates for slewing The rates are read from the *EQMOD.ini* file and are defined as multiples of sidereal rate (same as slider bars use). The presets apply the rates to both RA and DEC.

The preset rates may be selected via the drop down list situated between the two rate sliders. A pair of joystick buttons could be assigned to increment and decrement the current preset number (*Increment Preset/Decrement Preset)* or you could set buttons to select specific presets (*Rate_1, Rate_2 etc.)*. Note that joystick buttons are not assigned by default and you will have to do this via the joystick configuration dialog.

If the beep checkbox has been checked then each time a preset is changed via buttons EQMOD will issue a short "click". This is to provide some feedback as joystick scanning is relatively slow and fast changes can be missed (keep the button pressed for a short while and you'll have no problems). When the first or last preset has been reached, further button presses will issue a "beep" to let you know you've reached the min/max rate.

By default 4 preset rates are defined: sidereal x1, x8, x64 and x800. These can be can changed, and added to by editing the *.ini* file. The number of presets can be increased up to a maximum of 10 by changing the *COUNT*. For example

```
[slewrates]
InitalPreset=1
rate_5=800
rate_4=400
rate_3=64
rate_2=2
rate_1=1
COUNT=5
```

Slew Presets (continued)

The value for *InitalPreset* determines which rate will be used as the default rate at startup. The software will only read in the number defined by *COUNT*. If *COUNT* is set to a number larger than there are presets, then the software will create the extra preset and assign a rate of 0 to them. Presets with a rate of 0 do not affect a change in slew rate.

EQMOD.ini can be found in:

```
C:\Documents and Settings\YourLoginAccount\Application Data\EQMOD
```

You may have to set your explorer to view hidden files.

Four additional functions (r*atebtn_1, ratebtn_2, ratebtn_3* and r*atebtn_4*) allow direct mapping of four slew rates presets to gamepad/Joystick buttons. The mapping is defined in the *EQMOD.ini* file as follows.

```
[slewrates]
ratebtn_4=5
ratebtn_3=4
ratebtn_2=3
ratebtn_1=1
InitalPreset=1
rate_5=800
rate_4=400
rate_3=64
rate_2=2
rate_1=1
COUNT=5
```

A *ratebtn_x* (such as *ratebtn_2*) variable is assigned to a preset number *(*such as *rate_3)* rather than an explicit rate since there are only 4 rate buttons but there may be many more preset values. Typically, you will choose to assign 1, 2, 3 or 4 of the possible preset buttons. Default mappings are assigned on an initial run of v112f and use the first 4 rates presets. This means you can just use the Joystick editor to assign buttons to the any one (or more) of the first 4 presets without needing to edit the *.ini* file.

Only if the defaults are not suitable, edit the *.ini* file to change the mapping in the following fashion:

1. In the Joystick editor window assign a button of your choice to (say) *Rate Button 2*.
2. Using Notepad, you set *ratebtn_2* to point at the appropriate rate setting variable (say) *rate_3*.
3. Using Notepad, set the value of *rate_3* to the slew rate you wish.

In summary, the following shows how the button you have assigned points to preset slew rate of 400 x sideral.

```
Game controller button (you choose) -> ratebtn_3 -> 4 -> rate_4 -> 400
```

Note: The above example is not the default setting for the *.ini* file

Ways of Controlling Slew rate

There are three options for controlling slew rate:

1. Pure analogue variation via increment and decrement. RA and DEC (the RA Rate and DEC rate sliders in the slew controls sub-panel). Separate buttons can be assigned to the increment and decrement for DEC and RA (a total of 4 buttons. You could use just 2 buttons where the increment button increments bot RA and DEC. Similarly, one button could be assigned to decrement bot RA and DEC. or can be combined on to two buttons.
2. Assign a button the increment the preset # and another button to decrement the preset #. RA and DEC rates are always linked when using presets.
3. Assign individual buttons to each of the presets so you jump immediately to a particular preset. RA and DEC rates are linked

If you like to use lots of different slew rates then option 1 is probably the best. If you just use three or four rates then it may be more convenient to use option 3.

Leveling the Mount

Although it is not obvious, it turns out that precise leveling of the tripod/pier/mount is not all that important. Of course you want to have reasonable values here (there's little point in having your pier tilted way off vertical). However, any discrepancies are easily compensated for by the algorithms used in the N-Star alignment process.

A level mount can facilitate polar alignment because adjustments are made left, right up and down instead of at slight angles. Do not worry about leveling the mount with great precision.

What is important:

- good polar alignment (using the mounts polarscope will result in results that are adequate for many cases. There are additional techniques that can improve on this setting if you have demanding imaging).
- A good home positioning of the mount in order to improve the accuracy of initial GOTO's to alignment stars. Even this is not absolutely essential if you recognize the alignment star and are prepared for a significant slew.

If you are doing only a 1-star alignment, you may find that setting the home position and leveling is more critical.

Polar Alignment

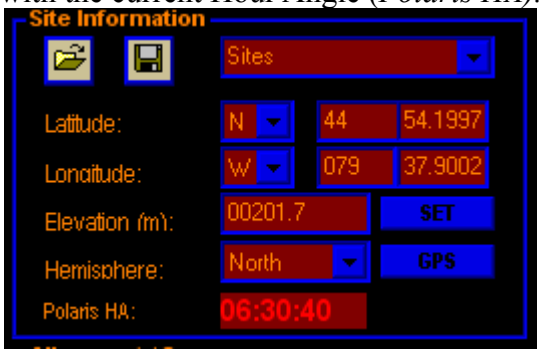
Polar alignment is the process of aligning the mount so that it points at the NCP (the North Celestial Pole) or the SCP (South Celestial Pole). This means that the axis of the mount will then be aligned parallel to the earth's axis. It should be noted that Polaris, although being accepted as the North Star, is not quite at the the NCP. For polar alignment in the northern hemisphere, it is necessary to offset the mount a fraction of a degree from Polaris.

An accurate polar alignment is essential for long exposure imaging. It will also have some effect on alignment.

Mounts with a polarscope usually have a reticle that is visible as you look through the polarscope. The reticle will typically have a circle that is the correct distance from the NCP. Positioning the mount by adjusting the physical adjusting bolts so that Polaris appears on the circle will align the mount. It is important to know where on the circle to position Polaris. For some mounts the reticle lighting is so bright it may be hard to see Polaris. Try with the power off as there is no reason to have the mount powered up for polar alignment (except for the light on the reticle) although you can't turn off the power if you're using the motors to align the hole in the shaft for the polarscope (unless you are prepared to reset home position etc.)

The position of Polaris on the circle is described by its Hour Angle.

- The most recent version of the hand controller firmware will give you the hour angle of Polaris once the hand controller has been initialize with time/date location.
- EQMOD provides you with the current Hour Angle (*Polaris HA).*



- Many planetarium programs will also give you this information.
- A freeware program know as *PolarFinder.exe* will also give you the required information. You may have to search the internet for this program. One page that might contain the link can be found http://arnholm.org/astro/polar_alignment/index.html . The page also has an interesting description of the process of polar alignment.
- Remember that the view of Polaris is usually inverted through the polarscope. The *PolarFinder.exe* program shows you the view you should expect to see with most polarscopes.
- Count the hours in the hour angle CCW starting at the bottom of the clock as 24h/0h, remember that it there are 24 hours in the full circle (not 12).
- many reticles have a small circle on the larger circle used for positioning Polaris. Set this small circle according to the hour angle.

Setting the Home position of the mount

The home position of the mount is the position where the telescope is pointing at the NCP (north celestial pole) or SCP(south celestial pole). This is accomplished by setting the mount with the balance (counter-weight) bar pointed downwards and the scope aimed north or south (as appropriate).

This is quite difficult to do with any real accuracy and it is not essential except that it helps with GOTO's for the alignment stars. A future feature that stores alignment data will reduce the dependency on accurate home position for alignment GOTO's since the mount will be essentially already aligned at power up (although it may still need small adjustments).

Once the mount has been aligned the accuracy of the home position becomes irrelevant.

Technique 1 for setting the home position (from Mon)

To accurately set your mount to the Home position, you need a leveler (digital or bubble both work adequately).

1. Position the counterweight shaft horizontally and level it using the bubble level on the counterweight shaft.
2. Set the RA setting circle to read 6 hours.
3. Lock the RA setting circle.
4. While the counterweight shaft is in the horizontal position, level the DEC side (dovetail and scope) horizontally using the leveler on the dovetail (or on the telescope).
5. Move your DEC setting circle to read the exact degrees as indicated on your mount's altitude indicator (your site's altitude). Choose the DEC degree setting such when you move the scope to 0 Degrees DEC circle (cw shaft still in horizontal position), end of tube should move up).
6. Lock the DEC setting circle.
7. Set the mount to the RA Home Position by moving the RA shaft until it points to 0 Hours. (counterweights should now be pointing down).
8. Set the mount to the DEC Home Position by moving the DEC shaft until the DEC setting circle reads 0 degrees.
9. Scope should be pointing at NCP/SCP (North Celestial Pole/South Celestial Pole) at this point.

Once you have found this position, you may be able to find places on the mount that are level so that you can reset the mount, if necessary, without repeating the above procedure.

Technique 2 for refining the home position

This particular method may or may not work for you. You may just want to experiment with it. The major difficulty may be the subtle movements of the mount that are required while it is unclamped. It is certainly difficult compared to slewing under fine motor control but is no more difficult for most installations than the initial setting of the home position. A future feature that stores alignment data will reduce the dependency on accurate home position for alignment GOTO's and this method would be redundant.

Assumptions:

- You're using a fixed pier installation... although this technique might be useful for portable installations if you have to re-align during the observing session.
- You have a good polar alignment
- When the scope is unclamped and moved it does not move the ring counters.
- Alignment does not change the setting of the home position with respect to the ring counter

Procedure:

1. set the mount in the home position by eye to the best of your abilities. (no need to use technique 1).
2. Start alignment and slew to first alignment star (chances are it won't be in the FOV).
3. Unclamp the telescope and use your finder to align on the star. Moving the scope manually in small increments is difficult but get as close as you can. You might actually be able to get the alignment star onto the CCD or within the FOV of the main scope.
4. Clamp the scope.
5. Continue with 1-Star or N-Star alignment procedures.
6. Typically future power up first alignments will be much closer to the FOV than rough home positioning of the mount.

To prove out the adjustment:

1. Park the scope.
2. Unpark the scope.
3. Start alignment (you should find that the first alignment star comes very close to your FOV).

One Star Alignment

Some users of EQMOD find that alignment on a single star is sufficient... particularly if used with a permanent installation.

Assumptions:

- you have carefully polar aligned the mount.
- you are not concerned about precise GOTO's.
- there is minimal cone error.
- the mount is reasonably level.

Procedure

1. Unpark the mount.
2. Click the [1 Star] alignment button. The EQMOD Alignment Tool window will appear.
3. Using your planetarium program, select an appropriate alignment star... typically any star from eastern or western side at least 45 degrees from the ground.
4. GOTO that star using the planetarium program.
5. Accurately centre the star in your FOV using the slew buttons in the EQMOD Alignment Tool window (or other mechanism such as a joystick).
6. Click the [Accept] button or appropriate button on the joystick.

Once the 1-Star alignment is complete, you will find that the 1-Star & N-Star buttons are disabled. If you wish to repeat the alignment process or you wish to use N-Star alignment, click the [RESET ALIGN Data] button first.

N-Star Alignment

What is "N" Star Alignment?

EQMOD driver supports the 3-star and N-Star Alignment algorithm.

3-Star and N-Star basically is a mount stepper coordinate to sky coordinate affine/taki matrix transformation process. The driver internally plots the sky using a minimum of three alignment star (anchor stars) as reference points. Pointing accuracy is increased by simply adding more anchor stars on different parts of the sky automatically compensating for any mount alignment errors (polar, cone, etc.) yielding more accurate pointing.

Think of the coordinate space of the mount+EQMOD as a rubber sheet with the star database marked on its surface. You place the rubber sheet on top of a star map (your sky) and align the stars on the sheet with the ones on the map. You then lock the sheet with push pins on top of the map. The push pins are now your "anchor points" or "alignment stars" in the real world. To align the markings on the rubber sheet with respect to the catalog points on the map means stretching/ rotating/ scaling specific areas of the sheet and locking them to the star map using the anchor stars (push pins).

The affine/taki matrix coordinate transformation routine is actually the one implementing the "stretching/rotating/scaling" functions and needs at least three stars as anchor points to define the process.

When you have aligned on more than 3 stars, the EQMOD driver dynamically selects 3 anchor points or alignment stars from the list of anchor point stars (N-star) to apply in the coordinate transformation during a GOTO process.

Accuracy is best within the bounds of the 3 anchor points and degrades dramatically (due the centering errors) as it goes outside the three points. However, if the stars are centered dead-on, even the GOTO's outside the area of the three anchor points should be accurate. N-star basically solves the 3point bound limitation by simply adding more 3-point bounded areas across the sky.

It is best to use stars in the area where you most likely to do your GOTO's. If you imagine one big triangle formed by the 3 stars, GOTO's will be most accurate within the triangle area.

Using N-Star Alignment

Average User Settings
The average user will probably want to use the following settings

- Sync Behavior = Append to N-Star List
- Alignment Behavior = N-star + NearestStar

With "Append as N-Star" selected, any stars that you sync using your planetarium program will be added to the N-Star alignment data. The “Sync Behavior” options are describe in more detail on the “Using Sync” documentation page.

The Alignment Behavior options.

- *N-Star* will use the three nearest alignment points to your target to refine a goto.
- *Nearest star* is treated as a list of one star alignments with the point nearest to your target being used to correct pointing.
- *N-Star+NearestStar* is the best of both worlds. If your target falls within an alignment point triangle it will use N-Star, if it outside the available triangles it uses Nearest Star.

There are two ways to add alignment stars:

Method 1

1. Click the [N-Star] button on the EQMOD window. The align window will pop up. If you have previously done a 1-Star alignment, this button will be locked out. Click the [RESET ALIGN Data] button first.
2. Initiate the GOTO the alignment star using your planetarium program.
3. Centre the star in the FOV and click the [Accept] button.
4. Goto the next star and centre and accept. Repeat for the third star.
5. Click on the [END] button to complete the alignment process (unless you want to use more than 3 stars)

After 3 stars have been aligned EQMOD automatically goes into three star mode of operation. You could have continued adding additional stars beyond the required 3 stars and you can click the [N-Star] button latter to add more stars.

Method 2:
This method uses the SYNC command of the planetarium program and is described on the “Using Sync” documentation page.

Other Information about N-Star alignment

- avoid syncing or aligning stars at the meridian itself as the driver will block such operation. At least 5 degrees away from the meridian is recommended. If the star is too close to the meridian, alignment will be aborted and a message displayed.
- in theory, the driver can handle up to 1000 alignment stars
- you can click the [N-Star] button later, in order to add additional stars to the alignment data. This works really well when you need more accurate pointing for a hard to find object. Adding a near-by star to the N-Star set greatly improves the local pointing accuracy.
- alignment stars should be distributed on both side of the meridian or, at the very least, separated as far as possible in the area of the sky you plan to observe.
- an option to save the alignment data will be added to EQMOD at a later date
- the [Map] button displays a screen with graphical information about N-Star alignment stars

Using SYNC command and an Alternative Technique for Alignment

Sync and Align work side-by-side. You can think of the Sync function as a means of fine-tuning alignment.

There are 2 “Sync Behaviour” options. “Append to N-star list” and “ASCOM Standard sync”. The differences between the two sync modes are as follows:

ASCOM Standard sync:
When a sync command is received by EQASCOM the current pointing model is shifted so the it is aligned with the sync star. No changes are made to the model itself.

Append as N-Star:
When a sync command is received by EQASCOM a new point is added to the pointing model.

Both options will result in the reported coordinates changing to match those of the sync object but one retains the model whilst the other changes it.

Average User Settings
The average user will probably want to use the following settings

- Sync Behaviour = Append to N-Star List
- Alignment Behavior = N-star + NearestStar

With "Append as N-Star" selected, any stars that you sync using your planetarium program will be added to the N-Star alignment data.

For planetarium programs with a SYNC function
The specific mechanism varies from program to program. Essentially the steps are:

1. Execute a GOTO using the planetarium program.
2. Centre the object using the slew buttons/joystick.
3. Select the SYNC option within the planetarium program (this is quite often invoked by right clicking the object).

Simply initiate the GOTO on the planetarium program, center the star, then activate the SYNC command in your planetarium program.

The driver operates in the 3-Star alignment mode after the 3rd SYNC if you are start from 0 alignment stars.

Special Instructions for HNSKY:
In order to accomplish a SYNC with HNSKY

1. Right click the object (this centres it on the screen).
2. Left click the object to perform a GOTO.
3. Click the icon that “Matches the telescope's coordinates to the center of the window”. It is the icon just below the planetarium menu and to the right of the “hand” STOP icon.

For planetarium programs without the SYNC function

If your planetarium program does not have a SYNC command, you can achieve a similar result by using the N-Star alignment process. You will have already (probably) used the N-Star procedure with at least 3 stars when you completed the initial alignment. To emulate the SYNC function you will simply add another star to the "collection" of aligned stars.

1. initiate N-star alignment by clicking the [N Star] button. This opens the EQMOD Alignment Tool window.
2. Execute a GOTO from the planetarium to the appropriate star.
3. Then use the slew buttons in the Alignment Tool Window to accurately centre the star.
4. Click the [Accept] button in the Alignment Tool Window.
5. Either click the [End] button or repeat the above process with another star.

As you add more alignment stars, each star that is added is automatically SYNCED on the associated object found in the planetarium display. You will find that GOTO's near the alignment stars are very accurate.

The D.xSA/DxSB data fields

- These data fields display the offset data in stepper steps for the SYNC Command. They show the discrepancy from the current stepper value computed Catalog coordinates (planetarium database coordinates converted to Stepper data) vs the one that was read currently on the stepper motors.

Using Spiral Search Feature

This feature is useful when the required object is not within the FOV.

1. Open the detailed setup panel by clicking the [SETUP > > >] button
2. In the “Other Settings” sub-panel, click and hold the [Spiral] button. The mount will start a spiral outwards search until you release the [Spiral] button.
3. Alternatively, click on the [Joy] button in the EQMOD navigation sub-screen and then press and hold button [1] on the game controller.

Hint: Since EQMOD starts a new spiral search from the current location whenever you press and hold the [Spiral] button, you can optimize the slew to the object by uses successive spiral searches.

1. Press and hold the [Spiral] button (or button [1] on the game controller).
2. After the spiral has been generated for a number of cycles (getting closer and closer to the object), release the button when the spiral is on the side closest to the object.
3. Press and hold the [Spiral] button (or button [1] on the game controller), starting a new spiral.
4. Repeating the above sequence gives you a method of zeroing in on the object since each spiral starts off relatively small.

Notes:

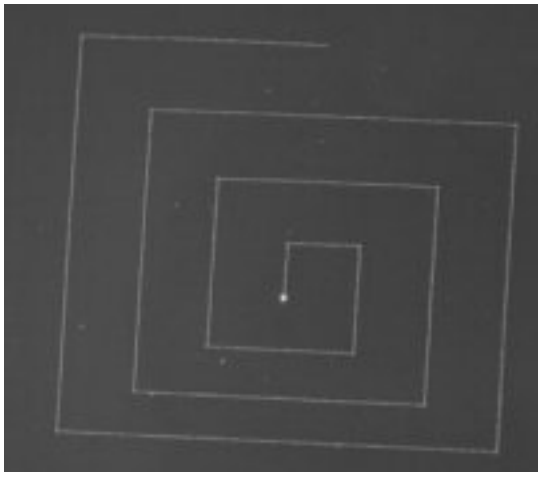
1. The slider can be adjusted to control how much the mount slews on each leg of the spiral.
2. The spiral search will always follow the current tracking state of the mount. That means you can implement the spiral slew with 'tracking on' and EQMOD will implement the slew with sidereal/Lunar/Polar/custom drift compensation.
3. EQMOD will not implement any compensation if the spiral slew is activated and the mount is not tracking.

Using Spiral Search Feature

Here are sample slew patterns when there is no sidereal tracking and with sidereal tracking with small and large microstep settings. The images were provided by Andrew Wall using a Canon 400D on an EQ6 mount using version 109e.

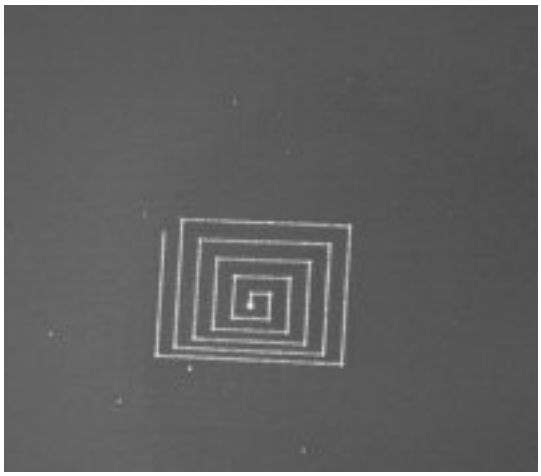
This image used step size of 1029 with no tracking:

This image used step size 4000 with tracking:



Using Spiral Search Feature

This image used step size 1020 with tracking:



Edit Star List

It may be desirable to delete one or more stars from the stars that have been used for alignment without completely resetting all the alignment data or you may simply want to verify the alignment for the stars that you have used for alignment.

Clicking the [EDIT STAR LIST] button on the setup screen will open up the "Alignment Star List Editor" window. The editor displays all of the current stars that have been used for alignment. If the editor window is already open, you should close and re-open the editor in order to display the current alignment information.

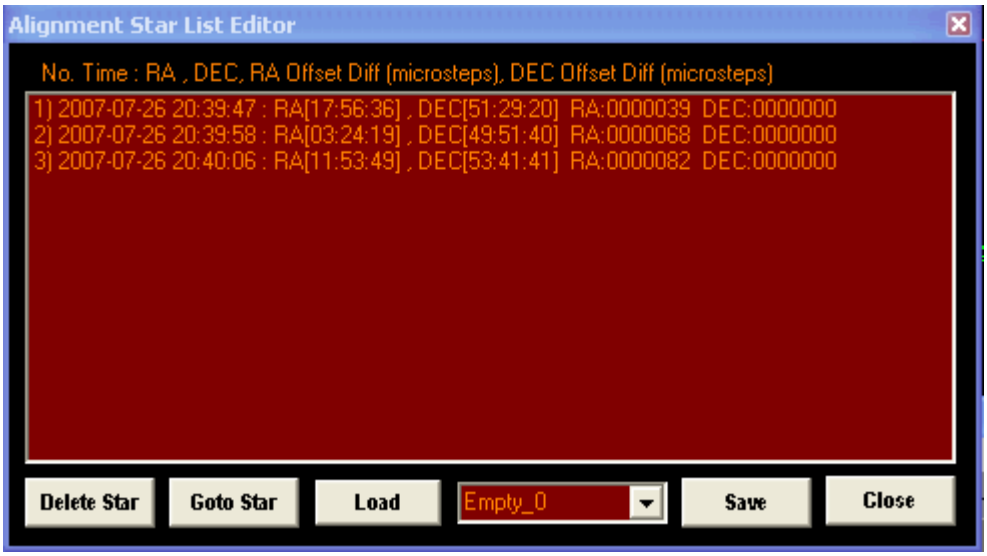
If the alignment appears faulty, you can click the [Delete Star] button to remove it from the list. If the number of alignment objects drops below 3, EQMOD will revert to 1-Star alignment mode.

Using Edit Star List as a Bookmark

The "Alignment Star List Editor" window could also be used as a means of bookmarking objects.

1. Select the "Append as n-Star" option.
2. Slew to the object and centre.
3. Using your planetarium, "Synch" the object. It will be added to the list of alignment objects in the "Alignment Star List Editor" window. Remember to close & open the window (if necessary) to refresh the content.
4. Remember the number of the object in the editor window.
5. Later on you can click on the object in the editor and then click on the [Goto Star] button.

Note: An even better method of bookmarking objects is made possible by an add on application called EQTour.



Saving n-Star Alignment Data

As of EQ_ASCOM V112a, it is possible store and load n-Star alignment data.

Procedure for saving data:

1. Perform n-Star alignment as usual. (you can also synch on stars with the “Append to n-star list option)
2. Open the “Alignment Star List Editor” window by clicking on [Edit Star List] button. See the image in the “Edit Star List” section of this manual
3. Click on the preset drop down list and select a preset.
4. Click on the preset name to rename it
5. Click the [Save] button to save the alignment data. (There is an option to save the data on park documented later in this manual)

Procedure for loading data:

1. Click on Edit Star List
2. Select the preset you want to load
3. Click the [Load] button – new alignment is applied immediately. (There is an option to automatically load alignment data on unpark documented later in this manual).

Loading & saving alignment data can be done automatically by selecting the appropriate options(s). See the “Other Comments” below concerning using presets as backup of alignment data.

Automatic Saving and Loading of Alignment data

On the “Edit Star List” there are 2 check box items. You can select either or both options as of 1.14g. Previous versions may only allow one option to be selected.

You can choose to automatically save the data when you park the mount. This is an excellent option for those of us who forget that the alignment data will not be saved unless you do save it manually or use this option. You should know, however, that if you use the automatic save option, the alignment data will be saved in the currently selected preset and it will replace the previous contents. See the "Other Comments" below about keeping copies of your "good" alignment data as a backup..

You can choose to automatically load the alignment data from a previous session when you unpark the mount. In most cases, this is probably what you want. Starting a new evening session, automatically loading up your previously stored alignment stars means your 'scope will probably be able to centre on objects with the same accuracy as the previous session immediately with no further alignment required.

However, you may wish to “goto”several objects and tweak the positioning followed by a “synch”. If you have the “Synch behaviour” set to “Append to n-star list” the new synchronization will be added to the star list. If you then determine that each of the synchronizations for the current session need significant adjustment (you decide what's significant) from the “go to” position, you may want to delete

alignments that have been stored from previous sessions. Simply click on the star alignment data line and click the [Delete Star] button.

Other comments:

It's always a good idea to use at least two presets particularly if you use the save on park option. This is probably the most common application of using the star list presets. Use one as a backup of a known 'good' set. The other would be the current working set. Using duplicates is also quite handy if you when editing your alignment sets as well as it effectively gives you an undo if you accidentally remove the wrong star/point. It can be useful when playing with the polar alignment where you align on a quite a few stars either side of the meridian and then pick those that give you the best 'matching' triangles and delete the rest.

To save an alignment set as a duplicate, first load it then switch the preset and click the [Save] button. You can then select another preset and click the [Save] button again creating as many backups as you wish.

Different presets can be used to store different alignment datasets based upon the following:

Presets may be useful for observatory mounts where, for example, preset 1 uses one set of N-star data, preset 2 uses a different set of n-Star data.

Perhaps preset 1 is a set of n-Star data gathered at the north-eastern side of the observatory while preset 2 is a set of star data on the western side. Preset 3 could be a combination. Preset 4 could be the entire sky. Preset 5 could be just three stars, and so on.

If we consider for example mount/scope/dovetail flexures induced due to extra equipment mounted on the scope in the data gathering, preset 1 could be settings for DSLR body camera (or bigger camera) setup and preset 2 could be settings for a "small camera" such as webcam. It may not be advisable to maintain a single N-star database if the user keeps on swapping/replacing the hardware options mounted on the scope due to the different flexure mechanics induced by these add-ons (which is also different depending on where the scope is pointed at). Each (from a high accuracy standard) should have a dedicated N-star database.

Star List And Pointing Accuracy

If you create a list of alignment stars using an eyepiece and later create alignments with a CCD you should probably keep the alignments in separate lists. Generally speaking CCD centered stars have an accuracy higher than those manually centered using an eyepiece. It is OK to mix them but the ones centered by the eyepiece (depending on the way it was centered) would slightly 'degrade' the overall accuracy.

If you are planning to populate the list using a CCD camera as a centering tool, make sure the camera is not moved during the entire alignment process.

If you are planning to keep the list for a long period of time, the following points must be considered.

1. The list is heavily "time-accurate" dependent. There is a small amount of variance with regards to the PC Time (where all timing data is based) over a specific time period. Any timing "skew" on the PC clock would degrade the accuracy of the entire list after some time period. To overcome this, your PC has to be synchronized always with a more accurate clock prior to populating the Star list. This is where the GPS will come in. With a GPS device on EQMOD, the time data is "normalized" based on a common reference time (the atomic clock). Now assuming you have already a list of stars centered/populated on a GPS-Synchronized PC, the accuracy of the list will still degrade over a time period from the last GPS synchronization, to regain back the accuracy, simply re-synch the PC again using the GPS.

2. The accuracy of the star list is also dependent on the mechanical configuration and inherent flexure of the mount (specially the heavy ones). You lose the accuracy of the list if you;
   a) moved the mount to some other location.
   b) You loosened the RA and DEC clutches.
   c) You removed or replaced the scope.
   d) Something in the scope has moved such as re-collimating your optics (mirror shifts), or changing the focuser tube, etc.
   e) added or removed an accessory to the entire assembly (the added weight would contribute to flexure).

Detailed description of how alignments are processed

As explained before, you can actually use the same star all over again in populating the N_star table as it traverses across the sky.

What N-star basically does is it converts all RA and DEC coordinate values into stepper values and uses the stepper values themselves in the transformation process. If we use the equatorial coordinates in the transformation, we need to utilize a third parameter which is the time of measurement. Including time data in the transformation actually complicates the conversion.

In this case, the time data is only used during the equatorial to stepper conversion and the converted stepper values are the ones stored in the N_star table. The time component is not stored (although we store them for window display reasons).

The good thing about this method is that the same RA/DEC Equatorial coordinates of sky object which is fixed have different stepper values as it traverses across the sky after a given time period. Since we are using the stepper values in the transformation process, we can actually align on the same object again on a different time and use the generated stepper motor values as a separate N-star entry.

The Stepper values are actually ALT/AZ coordinates in nature in which you can "map" a stepper count value (RAx, DECy) as a fixed point ALT/AZ coordinate in the sky.

N-star Data processing uses several different different components:

Download a jpg image here:
http://www.welshdragoncomputing.ca/eqmod/images/N_StarDataFlowDiagram.jpg

Equatorial Coordinates to Stepper Motor Counter value converter

This converts the RA/DEC coordinates to its equivalent stepper value using the current time as the 3rd parameter in the conversion. This means you will get different results as you execute this function on the same RA/DEC values as the time parameters vary. Also take note that the nutation is also accounted here.

Polar to Cartesian.

The stepper coordinates are not linear and are spherical/circular in nature. In this case we need to convert them from a vector based coordinate representation to cartesian to allow us to transform them using TAKI or AFFINE Matrix conversion.

If you remove this module from the system, computations will be more complicated as you will have to introduce the vector coordinates within the affine/taki matrix. This was actually the original approach of the the TAKI.bas routines where a matrix cell has sine and cosine functions in them.

AFFINE / TAKI Coordinate Transformation Module

(This was explained a lot on various threads on the news group).

Use matrix conversion/computations for coordinate transformation. It accounts for the 3 basic transformation operations; rotation, shift, magnification/reduction

Cartesian to Polar

Reverse computations from Cartesian back to Polar

Stepper Motor Counter values to Equatorial Coordinates converter

(as explained)

Referring to the legend, it shows colored boxes that represent operations performed within the N-star module;
- ALIGNMENT
- GOTO
- Current Scope Position COORDINATE DISPLAY and ASCOM Coordinate Presentation

The yellow colored boxes/arrows represent the data flow during a goto execution. The green ones are those used to obtain the current position of the telescope. The Light Blue ones are those used during the alignment process.

The diagram also shows the effect of using the same star all over again as an alignment data. As the star moves across the sky, you can actually create a separate N-star when you align on the same star lets say after 2 hours of movement. That point where the star is located is converted to stepper values; Eqmod simply gets the current stepper count (Measured) and The Catalog Stars supposed to be stepper count at time(t) or time of measurement. These four values (ra stepper catalog, ra stepper measured, dec stepper catalog, dec stepper measured) are stored in the N-star table. The 2nd measurement which is already located at a different position can now be used as one of the Affine anchor point of the transformation triangle.

Other Information About Alignment

Should the mount be tracking while aligning?

Yes, the mount should be tracking, although the only difference is that it's easier to centre a star at high magnification (if you weren't tracking the star would drift out of the FOV pretty quickly). When you click [Accept] button EQMOD uses the current ring counter stepper values and that has nothing to do with tracking being on.

Do I have to complete the alignment of a star quickly?

There should be no concern about the time it takes you to slew the alignment star to the middle of your FOV.

Measurements are made right after the [Accept] align button is clicked. It is not a problem if it takes a long time to zero-in (center) on the alignment object. Once the [Accept] button at the alignment window is clicked, EQMOD will read the current stepper values of the mount (RA and DEC) and compute what the stepper values should be on the catalog object at this precise moment based on the Local Sidereal Time (LST).

These four values (mount RA ring counter, mount DEC ring counter, catalog computed RA ring counter, catalog computed DEC ring counter) are then stored as a N-star entry in the N-star in-memory database.

Parking the Mount

Before powering down the mount, it is desirable to return the mount to a known position (the park position).

If you have set some mount RA limits, parking the mount properly before power down is essential in order to record the limits for the next power up. It will also be important for a future release of EQMOD that stores alignment data from one session to the next.

You have basically 2 options for parking:

- the home position
- a customized position very useful for installations where a roof of an observatory would not clear the telescope upon close-up. A common customized park position is with the balance/counter-weight bar horizontal and the telescope itself horizontal.

Note:
You should park only if the alignment is complete. Do not park an unaligned scope or you will be unparking using invalid data creating an invalid alignment table with respect to 1-star alignment. In addition, there will be an issue with the future release that will store/recall N-Star alignment data. Currently EQMOD defaults to 1-star mode in an unpark sequence.

If you have a mount setup with invalid park data, you can get a fresh start by the following procedure: (You will know that you have invalid RA/DEC park ring counter values if you execute a "Park to Home" and mount does not end up at the home position)

1. Unpark Scope from EQMOD driver.
2. Shutdown EQMOD **then** power down the mount. **Don't** use park for this step.

The above steps will reset park settings of EQMOD.

Now do the following:

1. Loosen Clutch and manually position mount at home position.
2. Run your planetarium program if not already running.
3. Check the Latitude/Longitude/Hemisphere settings of your planetarium program.
4. Confirm PC time.
5. Check the planetarium time and date (remember to check daylight saving, if applicable).
6. Connect to the mount (this activates EQMOD). EQMOD should start in an "unparked state" with the Dec And Az set at values for the home position.
7. Check the EQMOD Latitude/Longitude/Hemisphere settings. The Alt value in the EQMOD window should correspond to your Latitude.
8. Perform 1-Star or N-Star alignment.
9. GOTO's should be accurate at this point.

Setting Slew Limiting to Prevent a Collision with the Mounting Pier or Tripod

Version 1.07h (and later) has a RA Limit function. Note: Version 1.14d (currently as of 2008-06-30 in beta) has a much more sophisticated limit control. See the following documentation.

The button [Set Shaft Limit to Current RA Pos] allows you to define the RA shaft limit on both sides of the Pier.
Note: You use the same button for each side of the pier.

1. Manually slew/position your mount to a point before telescope contacts the mount/tripod.
2. Click on the [Set Shaft Limit..] button.
3. Move to the other side of the pier to a point before telescope contacts the mount/tripod.
4. Click the same button.

Notes:

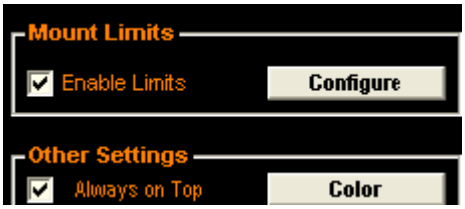
- EQMOD automatically detects the ring counter position on each side and records the value in the appropriate place.
- Any GOTO or tracking past this point will automatically stop the mount. **Caution:** Manual slews made with the buttons/joystick will be ignored by this function.
- The slew limit Values are saved and automatically restored during a PARK/UNPARK function.
- If the mount is stopped by the limit, the mount still remembers the alignment. Just slew the mount away from the pier and click on the appropriate [Track Rate] button.
- A value of "0" on the stepper position (set by the [Reset] button) will disable this function.
- The second button [RESET] clears the limits.

This function is enabled by default and assumes a limit with the RA shaft parallel to the ground.
Caution: If the EQMOD driver is restarted without parking the mount, it will assume the default RA limit values. Click on the [Reset] button to disable the RA limiter.

EQASCOM Mount Limits (version 1.14d and later)

Mount Limits provide a way to restrict mount movement perhaps to correspond to a physical horizon or to help protect equipment from possible pier collisions. It is important to understand that limit detection is performed within the EQASCOM driver and not by the mount motor controller itself. In common with all other PC based mount control applications, if you intend to leave the mount unattended you should carefully consider the potential risks to your equipment that may be caused by Windows crashes, restarts, or failures to applications and/or hardware failures.

Limit detection is optional and can be enabled/disabled via the associated check box. EQASCOM provides detection of limit conditions for both the meridian and horizon. The meridian limits dictate how far the mount is allowed to track past the meridian and it is recommended that Meridian limits are always defined when horizon detection is desired.



Operations that are subject to limit detection are:

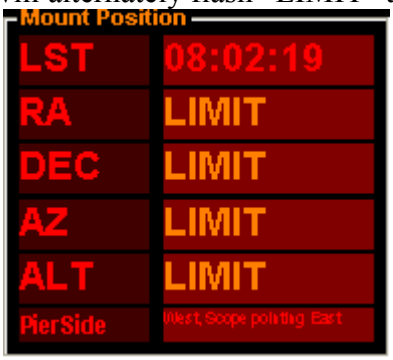
- Tracking
- Gotos

Operations to which limits not applied are:

- Park
- Unpark & Goto (*new feature)
- Manual slews initiated by the EQASCOM direction pad or external gamepad

When a limit condition is detected the following actions are performed

- Both RA and DEC motors are stopped
- Tracking is stopped.
- The Mount position display will alternately flash “LIMIT” and the current coords.



- If desired the mount can be automatically moved to a park position on limit detection.

These actions are continually re-applied until such time as the limit condition no longer applies. To remove the mount from the “limited” state use the direction pad or gamepad to slew the scope away from the limit point or execute a Park operation.

Limits Configuration

Meridian Limits.

These limits apply when the scope has moved past the meridian (usually through tracking) and has been a part of EQASCOM since V1 .07. By default the limit is set to trigger when the RA axis is horizontal but most folks will want to allow some degree of tracking past the meridian. To set the limits simply slew the scope to the limit position and click the “add” button. You will need to do this for both East and West sides of the pier.

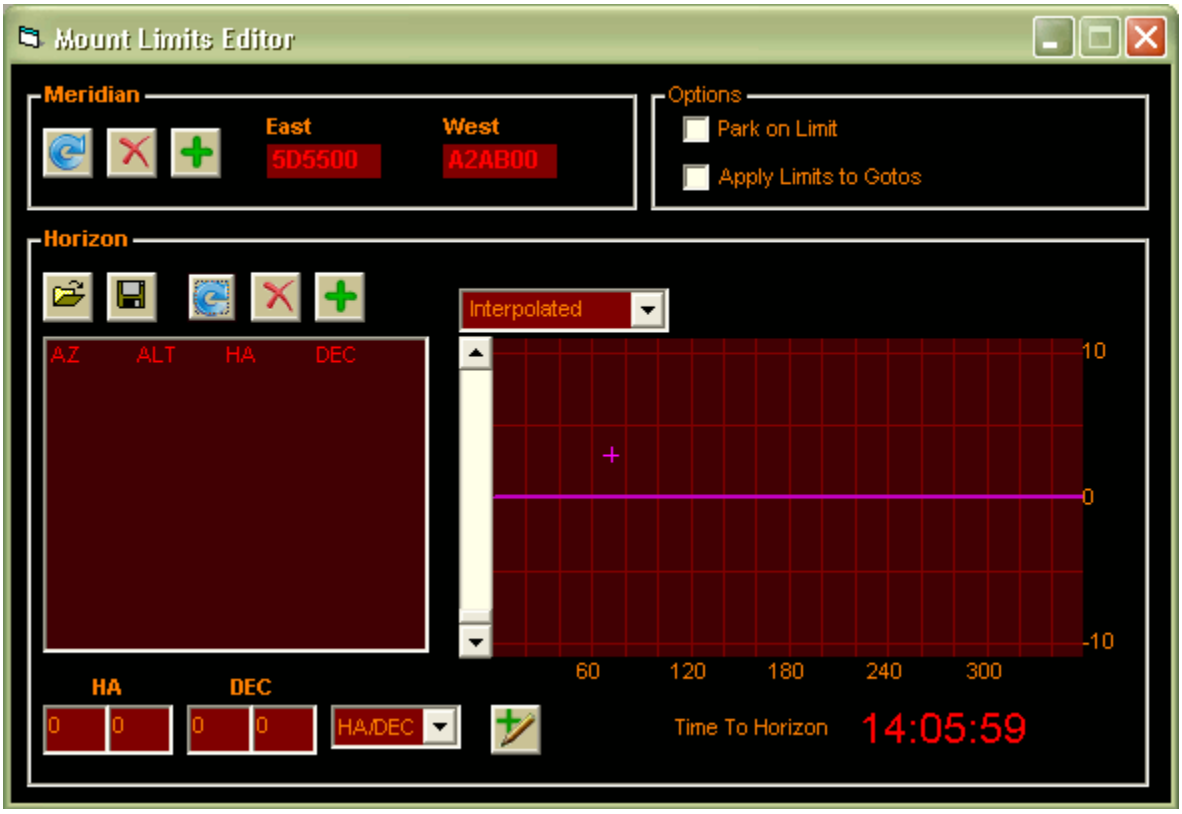
As these limits use encoder positions they can only be applied properly if the mount is parked and unparked. On start-up the default ‘horizontal’ limits are applied and on unparking any user specified limits are restored.

The default ‘horizontal’ limit can be restored by pressing the [defaults] button. Meridian limits can be removed altogether by pressing the [delete] button.
Horizon Limits.
This detects when the mount is pointing below a specified horizon profile. By default a horizon is applied of Alt= 0 degrees.
There are three ways to create a horizon profile.

1. Slew the scope along your horizon using the “add” button to add points.
2. Manually enter points, either in Az/Alt or HA/DEC (i.e. useful if reading setting circles).
3. Edit a text file with your horizon points (in Alt/Az)

The horizon profile is stored in a text file that is the same format as CDC’s horizon file. This allows both applications to share the same file if you wish.

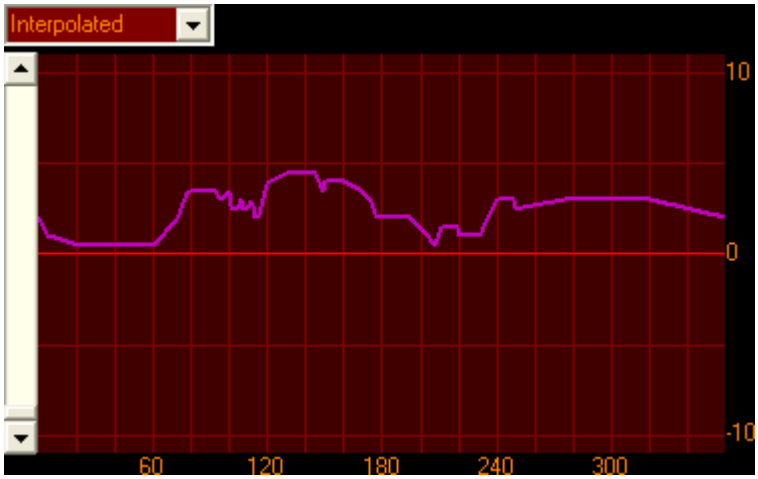
EQASCOM provides a plot of the current profile and the mounts current position is marked with a cross. Points can be individually deleted if required. The [defaults] button removes all points restoring the Alt=0 horizon.



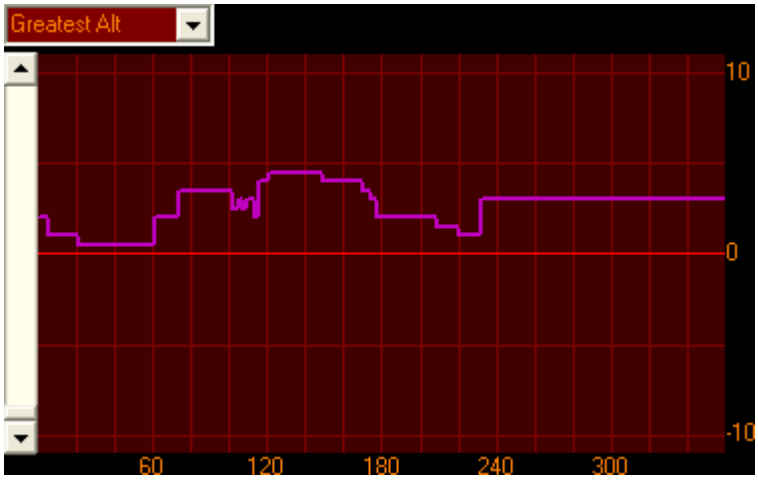
Adding a single point will give a 360 degree horizon at the associated Altitude

As you add more points the horizon profile is built.

There are two algorithms that determine how EQASCOM uses the points list to calculate an Altitude limit.



Using Interpolated mode EQASCOM calculates a straight line between the two points and then establishing the point on the line that corresponds to the current Azimuth.



Using “Greatest Alt” mode EQACOM finds the two points on either side of the scopes current Azimuth and uses the one that has the greatest Altitude.

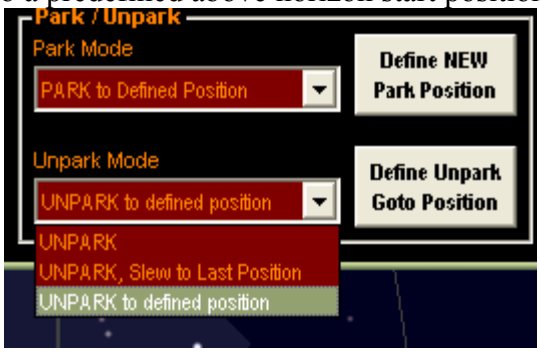
Limits File Load/Save & Startup

On startup EQASCOM will attempt to reload the last opened horizon definition file (the filename was stored in the EQMOD.ini file). To make any changes permanent then you must save the file otherwise they will apply only for the current EQASCOM session.
Time to Horizon
The time it will take the scope to reach the current horizon is display. If the mount is at a position such that it will never “set” then --:--:-- is displayed.
Options
If “Park on Limit” is checked the mount will automatically Park (using the currently selected park mode) when a limit is reached.
If “Apply Limits to Gotos” is checked the Limit detection is active during a goto slew. This may be inconvenient if your slew patch crosses a visual obstruction when moving from one above horizon point to another as shown below.

However if the horizon file represents physical mount movement obstructions you will want to ensure this option is checked.

Limits Park and Unpark.

As mentioned previously Park operations are excluded from limit detection so the Park position can be below the horizon limits. A new Unpark mode has been added, “Unpark to defined position” which allows the scope to be moved to a predefined above horizon start position on unpark .



Other EQMOD Settings

RA Reverse and Dec Reverse

These 2 options allow you to reverse the function of the associated slew control.

"Local to Pier" radio button (enabled by default).

When enabled, the effect of the AFFINE 3-point coordinate transformation data one side of the meridian is not passed on the other side. If disabled, a 3-point cross-meridian is allowed.

This function is ignored if there are only three stars. Should have at least four.

Previous versions of EQMOD use purely "Local to Pier" on setups with more than 3-alignment stars. You can actually visualize the effect of the "Local to Pier" function via N-star mapper display. Just modify the radio button setting and click on the N-star mapper's "Show Transformation Map" button.

This function should be enabled if the setup has SEVERE cone errors. You can disable this if the mount has minimal cone errors and the user wishes to play around with only a few alignment stars as you will be sharing the same alignment stars on both side of the meridian.

Always on top option

This option controls whether the EQMOD window stays visible when you click on another program such as your planetarium program. If it is not selected, the EQMOD will disappear when you click other programs. This is helpful if you're working with a smaller screen. You can always cause the window to reappear use the [Alt-Tab] keystrokes or clicking the appropriate reference in the task bar at the bottom of the screen.

Color option

The [Color] button allows the change of the various default colors. It also allows the change in the message font size although increasing the font size causes messages to be partially displayed since, with a larger font, the message will not fit into the message window.

AFFINE_TAKI+POLAR ENABLE option

If the check box is enabled, it will turn off all affine/taki/polar coordinate transformation routines. The alignment stars will be treated as multiple "localized" SYNC stars. The number beside the “Local to pier” shows which alignment star is currently being used as a localized sync data. The SYNC command will then treat the SYNC Command data as a fine-tune alignment for the N-star SYNC data.

Beep

A function that will produce a beep sound at the end of a GOTO or PARK slew, and Align Accept command has been added as of version 1.09g. This will serve as a remote notification (for those using wireless joysticks) for star alignment.

See also: The beep option also activates sound for the slew preset buttons. See the section on slew presets.

The PC BEEP option is disabled by default. You need to enable it manually.

1. Open the detailed setup panel by clicking the [SETUP > > >] button
2. In the “Other Settings” sub-panel, click the “beep” check box

Using the EQMOD simulator

It is important to distinguish between the ASCOM simulators and the EQMOD simulator. When you use the EQMOD simulator you are not using the ASCOM simulator. In fact, ASCOM “thinks” that you are working with a "live" mount!

Preliminary Check

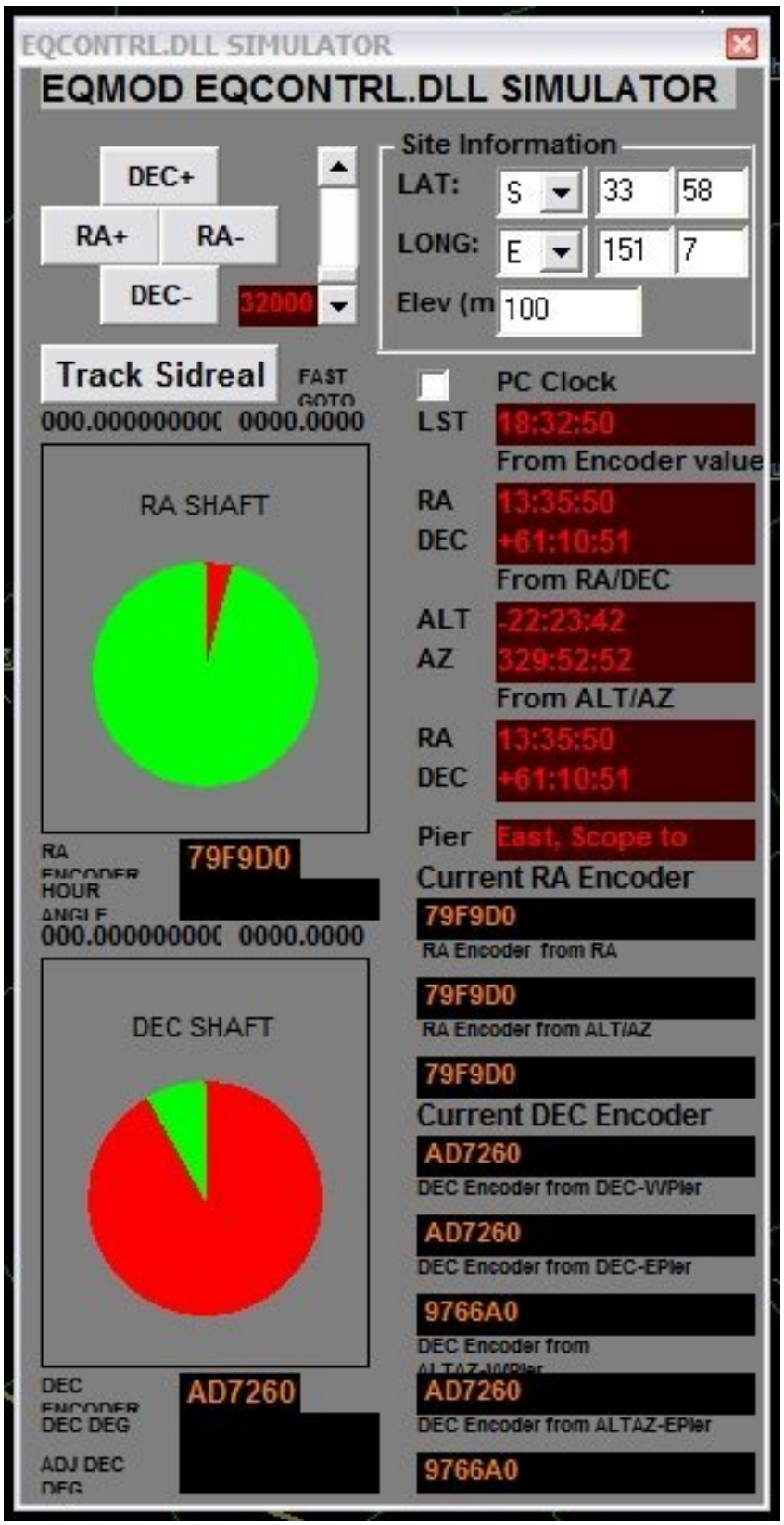
In order to successfully use the simulator, a file called *mschrt20.ocx* must be installed. Open the folder c:\windows\system32 and look for this file. If it is not there, it will have to be installed:

1. Download *mschrt20.ocx* from the Internet or get it from http://tech.groups.yahoo.com/group/EQMOD/files/A 20EQMOD Release/EQASCOM/
2. It is typically stored in a .zip file
3. Extract and copy the .ocx file to *C:\WINDOWS\system32* folder.
4. Run the command prompt (Start | Run | Cmd) and type *cd C:\WINDOWS\system32* .
5. Press the <Enter> key.
6. Then type in the command *regsvr32 mschrt20.ocx* .
7. Press the <Enter> key.
8. It should respond with a “succeeded” message.

Installing the EQMOD simulator

As of V112, the simulator version of EQMOD is installed at the same time as the regular driver version (see the installation instructions earlier in this manual).

1. When you connect from your planetarium program select *"EQMOD ASCOM Simulator"* .
2. The first time you try to use the simulator driver you may find that the [OK] button in the ASCOM Chooser dialog is not enabled. In that case, select the [Properties] button. Fill in:
   Port
   Baud
   Timeout
   Retry
   Values don't matter. Then the [OK] button will be enabled.
3. When connected to the simulator version, an additional window appears displaying shaft position. If this window does not appear or you get a message such as *"ASCOM driver not found"*, you haven't installed the *mschrt20.ocx* file or you are running the non-simulator version of EQMOD.
4. You will have to manually set the site information if you are planning to do accurate simulations. You will also find that setting the “Fast Goto” option will speed up the simulator slews. (See the following image for both of these items).


EQCONTRL.DLL SIMULATOR
EQMOD EQCONTRL.DLL SIMULATOR
DEC+
RA+
RA-
DEC-
32000
Site Information
LAT:
S
33
58
LONG:
E
151
7
Elev (m
100
Track Sidreal
FAST GOTO
000.00000000(0000.0000
PC Clock
LST
18:32:50
From Encoder value
RA
13:35:50
DEC
+61:10:51
From RA/DEC
ALT
-22:23:42
AZ
329:52:52
From ALT/AZ
RA
13:35:50
DEC
+61:10:51
RA SHAFT
Pier
East, Scope to
Current RA Encoder
79F9D0
RA Encoder from RA
79F9D0
RA Encoder from ALT/AZ
79F9D0
HOUR
000.00000000(0000.0000
DEC SHAFT
Current DEC Encoder
AD7260
DEC Encoder from DEC-WPier
AD7260
DEC Encoder from DEC-EPier
9766A0
DEC Encoder from
AD7260
DEC DEG
AD7260
DEC Encoder from ALTAZ-EPier
ADJ DEC
9766A0

Guiding

Guiding control of the mount can be accomplished in 2 different ways. The guiding signals can be sent to the dedicated ST-4 port on the mount or they can be sent to the regular control port on the mount.

ST-4 Port and ST-4 Autoguider port rate

For the ST-4 port, the signal could come directly from the guide camera (if the camera supports that option) or the signal could come from a separate port on the computer using a relay or electronic switch box.

If user intends to use the ST4 based Autoguider port found at the faceplate of the mount's stepper controller, the "Autoguider Port Rate" sets the correction applied on the RA and DEC motors if any of the four ST4 lines (RA+ RA- DEC+ DEC-) are activated. Possible values are x1.0, x0.75, x0.50, x0.25 of the Sidereal rate.

ASCOM pulse guide settings

For guiding through the regular control port of the mount, the guiding signal uses the same cabling as the signals used for slewing and GOTO's. The ASCOM POTH (plain old telescope hub) software allows 2 or more programs to send signals over the same port without conflicts.

Other than ST4 type of autoguiding, EQMOD also provides the "PulseGuide" Method where the correction commands are fed directly through ASCOM. A pulseguide message contains two parameters, the direction and the duration. The Pulseguide message currently does not contain any Guide Rate settings. The correction rate has to be provided by the user by means of two "slider bars" at the EQMOD setup window. Each bar specifies the speed of the RA and Dec motor during the course of the pulseguide correction. The Duration parameter (specified in terms of milliseconds) determines the duration to which the correction speed is applied. Once the duration of the correction expires, the RA speed is restored to the sidereal rate speed (or in DEC where the motor is stopped)

The pulseguide speed rate can be set between x0.1 to x0.9 of the sidereal rate at increments of 0.1 independently on each motor (RA or Dec).

The "Duration Override" option allows the user instead of the autoguiding application to dictate a fixed duration correction.

See further information about EQDIR and pulseguiding in the miscellaneous facts section.

Custom track rate

Other then the standard Lunar, Solar, and Sidereal rate, the user can specify the speed of each motor (RA or DEC) using the Custom Track rate facility. This option is provided at the Custom Track rate portion on the EQMOD driver setup window wherein the user will simply enter the rate in terms of arcseconds/second and then click on the [Execute] button. EQMOD will apply the rate on the two motors right after the [Execute] click. The Default value you see on the RA entry is actually the RA rate in sidereal. Clicking on the [Execute] button using the default RA rate value (15.04157) puts the mount in sidereal Tracking mode.

Periodic Error (EQ)

EQMOD VS-PEC: Q&A

Author: Chris Shillito

1. Documentation for EQMOD VS-PEC can be found on the Yahoo tech group here:
   Files | A EQMOD Release | Documentation
2. Also:
   Files | Debug | EQPEC

Q What is Periodic Error?
A: Periodic Error (PE) is movement in a mount caused by imperfections in the gear train resulting in a very slight 'wobble' about the axis being driven. The most significant contribution to PE is the worm to worm gear transfer. PE can be reduced by mechanical improvements but it cannot be removed altogether, it is an inherent feature of a worm drive.

Q: What is VS-PEC
A: VS-PEC is **V**ariable **S**peed **P**eriodic **E**rror **C**orrection. This is a technique developed for the EQMOD project that varies the mount tracking speed to compensate for Periodic Error. This differs from PEC as applied by the SYNSCAN hand controller which uses constant speed corrections of varying duration.

Q: What are the benefits of using VS-PEC?
A: VS-PEC basically provides an improvement in tracking performance. Typically this is an advantage when using the mount for astrophotography.

Q: How much improvement will I see with VS-PEC?
A: Its difficult to give absolute figures because every mount differs in its periodic error. PEC is most effective if the mount periodic error varies smoothly and is consistent in amplitude over many cycles. If the periodic error appears erratic then you should first consider mechanical adjustments.

Q: What is the advantage over auto-guiding?
A: A lot depends on the image scale you chose to image at and the magnitude of Periodic Error that your mount exhibits. For instance with VS-PEC it may be possible to reduce the periodic error movement of the mount to a level where for a given exposure time the movement experienced is smaller than the resolution of your imaging system. In this case VS-PEC has an advantage of not requiring a separate autoguider thereby saving weight, less processing
load, less cables etc.

Q: Can ST4 AutoGuiding and VS-PEC be run simultaneously?
A: It is not recommended to use VS-PEC in combination with ST4 guiding it is likely that this will lead to overcorrection. No tests have been performed to verify this, so if you do try it let us know your results.

Q: Can ASCOM PulseGuiding and VS-PEC be run simultaneously?
A: Yes. EQMOD VS-PEC is designed to work alongside pulse guiding and can actually improve guiding performance when tracking on fainter guide stars.

EQMOD VS-PEC: Q&A (continued)

Q: What do I need to record PE?
A: A star, an imaging device and a capture program. The simplest approach is to use the EQMOD perecorder application and a Webcam.

Q: What is pereccorder and why should I use it?
A: perecorder is an application written specifically for the capture of PE data for use by EQASCOM's VS-PEC. It provides automatic calibration to automatically determine the resolution of your imaging system and integrates closely with EQASCOM to record not only the Periodic Error, but also the associated stepper motor position. Perecorder is the most accurate means of capturing PE data for EQASCOM.

Q: What imaging devices does perecorder support?
A: Currently perecorder only supports webcams.

Q: I don't own a webcam, how can I record my PE?
A: If K3CCDTools or PHD supports your imaging device then there is a way to import log file data into PECPrep. This process is slightly more involved than using perecorder.

Q: How long does it take to record PE?
A: For an EQ6 type mount you really need to record at least 40 minutes of data. For an EQ5 mount 55 minutes of data. With brighter stars you can record PE during dusk or periods if during poor seeing when other observation is impractical (the smoothing process is able to remove seeing and wind disturbances in the recorded signal).

Q: How often would I need to record/process PE?
A: You might need to re-record your PE if you change the loading of the mount, or if you fail to park the mount (there are means to resynchronise manually if this happens but re-recording may be the simpler option).

Q: How do I analyse my PE and create a PEC Curve for EQASCOM?
A: Use PECPrep. PECPrep has been written specifically for this purpose and contains a number of analysis and manipulation tools.

Q: What's the difference between a PE Curve and a PEC Curve?
A: There isn't a big difference but the PE Curve is the raw response of your mount, whilst the PEC curve is the data formatted for EQASCOM to apply corrections to the mount.

Q: Where is the VS-PEC data held?
A: VS-PEC data is stored in a text file on your PC and loaded by the EQASCOM driver. EQASCOM uses the file to send rate change commands to the mount. Whilst the mount may continue to track at sidereal rate when EQASCOM has been disconnected, it cannot track using VS-PEC.

FAQs

Tracking – my mount stopped tracking, When I click a tracking icon it flashes briefly and still stays at “not tracking”. What is the probable cause?

One of the RA limits that have been set in EQMOD has probably been reached.

Solutions:

1. Try slewing the mount away from the pier a little and then click the tracking button. You will probably find that it will now track.
2. Expand to the full setup window by clicking the [Setup >>>>] button. You can then change the limits by clicking the [No Limit] button (Caution: the mount is not protected from moving into the pier.).
3. Slew the mount to the position you want to define as a limit and click the [Set Current RA] button. You would also want to repeat the procedure with the mount flipped to the other side as well. You use the same [Set Current RA] button.

Location of ini file

The EQMOD.ini file is typically stored in directory (folder):

\Documents and Settings\USERNAME\Application Data\EQMOD

USERNAME is your windows login username). The Application Data folder has hidden attributes . This means you might not be able to see the folder. Set your explorer options to show hidden files.

Do EQMOD and HC (hand controller) use the same method of parking?

Both EQMOD and HC use the same method of parking.

In HC mode, the mount initializes the ring counter values and assumes the home position (the same position manually pointed by the user to NCP upon power up). EQMOD also uses the same position as the home position. User also has to manually point the mount to the home position which is also NCP. The only condition for the usage be interchangeable (EQMOD vs HC) is to position the worm gear to the same spot where it was found at power up prior to shutting down and this is through the park to home position found both on the HC and the EQMOD driver.

However, if you use EQMOD's user-defined park position (the HC doesn't have this feature in some versions), and then attempt to use the HC after, user will have to disengage the clutch and manually point by hand the mount back to the home position. This disengaging the clutch alone will invalidate any alignment/PEC data on the EQMOD side.

In short, to be able to use both method (HC and EQMOD) interchangeably and at the same time preserve the alignment data, you need to use only the park-to-home feature and not EQMOD's custom park-to-user-define-position.

You can use EQMOD's custom park-to-user-define-position only if you use EQMOD entirely for all mount operations.

Does unclamping and moving mount move ring counters?

Unclamping will not move the ring counters. However you will lose alignment if you loosen the RA/DEC clutches. This can be fixed by:

- initiating a GOTO to a bright object (assuming the 3-star/N-star data is still active)
- manually centering the object through the scope eyepiece FOV after the GOTO by loosening the RA/DEC clutch and pushing the tube to bright object's position.

FAQs

Does Alignment alter the home or park position?

Alignment does not alter the home or park position as the driver uses hard coded park position which is not affected by any alignment/sync data.

How do you pick a good star for 1-star alignment.

Assuming that the mount is polar aligned and there is minimal cone error, choose any star from eastern or western side at least 45 degrees from the ground.

If you click the [Stop] button do you lose alignment?

No, it will not lose alignment. Position computation is time based. If you stop tracking and re-initiate tracking 30mins later, the driver will simply compute the new position and apply the GOTO.

If the mount stops because an RA limit has been reached, does it lose alignment?

No, it will not lose alignment. (see the reference to the [Stop] button above).

RA offset Diff and DEC offset Diff

Q: If I start an alignment and goto a star and accept (without any adjustment) the position, the DEC offset is always 0 (as expected) but the RA offset is not 0.

Mon: That is the difference in microsteps from the computed ra/dec ring counter values of the alignment star goto using the ra/dec equatorial catalog coordinates and the ring counters that is read on the simulator. Ideally the discrepancy should be less than 50 if you are using the physical mount (crystal based counter) than the simulator (pc based sidereal counter).

I forgot to park the mount before I shut the computer. What can I do?

As long as the mount is still powered, you can re-connect EQMOD and the ring counter data will remain intact. The ring counters are being maintained by the stepper board. You will lose the ring counter data only if you remove power from the mount without parking it.

FAQs

EQMOD Connection Issues

Q: When I try connecting my planetarium program to EQMOD the connection fails. If I attempt to connect to a non-existent serial port (say, COM9), the EQMOD config window pops up very briefly and disappears. When I attempt to connect to the correct port (verified through Windows XP's HW manager), the window pops up, but only displays its outline... hangs there for some time and then disappears. What's happening.

A: When you see the EQASCOM "ghost" interface appearing, it means that EQASCOM has found a valid COM port and is trying (in vain) to contact the mount. When you try with an invalid com port EQASCOM quickly detects this so can close much quicker (no comms timeouts or retries etc). So, it would appear that you do not have a com connection to the mount or you have not used the correct port settings... typically 9600, 8-1-N, no flow control.

How do I reset the “Park to Home” position?

If you have a mount setup with invalid park data, you can get a fresh start by the following procedure: (You will know that you have invalid RA/DEC park ring counter values if you execute a "Park to Home" and mount does not end up at the home position)

1. Unpark Scope using the EQMOD driver.
2. Shutdown EQMOD **then** power down the mount. **Don't** use park for this step.
3. Position the mount in the home position.
4. Power up mount
5. Start EQMOD & connect to mount.

The above steps will reset park settings of EQMOD.

How do you use the function "Drift Compensation"

Drift compensation is needed for the motor control boards V1.06 or later. For some reason these boards do not track accurately when issued the same commands as earlier boards and so this additional parameter was introduced. There is a "driftmeter" application

http://tech.groups.yahoo.com/group/EQMOD/files/Utilities/SiderealRateUtil/

that allows you to measure any tracking drift but others have found that for V1.06 boards a figure of 3 is required, for earlier boards set the compensation to 0.

FAQs

What is the purpose of the “Auto RA Sync” setting?

This option has to do with how EQASCOM determines the stepper motor positions while tracking. If it is unchecked EQASCOM simply estimates the position based upon the last known position (as read following a slew or goto) and the elapsed time. With the option checked EQASCOM will regularly poll the mount for the current position and between polls estimate the position.

What's the point of this? Well at one time there was a belief that communications to the mount could affect the tracking speed. By having the ability to turn off stepper polling it was possible to remove the possible impact. In hindsight, it may be that there was never an issue of this sort. Possibly the drift compensation issue for v1.06 mounts may have clouded the issue.
In general, the “Auto RA Sync” should always be selected (checked). Certainly it must be checked if you are using the drift meter otherwise you'll always get perfect results!

How do I determine the board version in my mount?

Once EQMOD has been connected to the mount click the [Display +] button located just below the ASCOM logo. The message centre will appear. Clicking the [Display +] button repeatedly cycles through several displays but you want the message centre for the version information.

The information displayed may be something like

EQ Modded Mount found at COM1: 9600

Mount Version : 000601 DLL Version: 000204

The mount version is displayed in reversed order. In the above example the mount version is 1.06.00

Miscellaneous Facts

Functioning of [Synch As] and 1-Star vs n-Star

Q: This is an interesting feature since it provides a method of moving from 1-star to n-Star without clearing the previous alignment data. Is there any reason, that the [n-Star] button is locked out after a 1-Star align? Unless you use the "sync" option, the only way to move from 1-Star to n-Star is to clear alignment data (or uses the [Sync As] option).

Mon: Thats precisely the reason, to force the user to clear the data for a new set of alignment points.

Q: Couldn't the first star (the 1-Star alignment star) count as the first of the 3 sync/alignment stars?

Mon: Currently EQMOD uses a different alignment routine for the 1-Star and the n-star. The 1-star simply uses an offset value implementation on the stepper motors which is entirely different from the n-star approach. Because of this, they cannot share the data.

Also, this option was done so that EQMOD would have a simple default mode to use upon startup.

Q: If I've done a 1-Star align and then turn on [Append as] and then sync on stars do I move into n-Star alignment. The message window seems to imply this.

Mon: Yes. However you need at least three SYNC commands to activate the n-Star alignment. If there are only 1 or 2 SYNC commands (while append as is activated), EQMOD will continue to function in 1-Star align. If you get the SYNC at the 3rd star, EQMOD will automatically function in n-Star alignment mode and will use the 1st three SYNC stars as the 3-Star alignment data.

Clarification of park/unpark/tracking/power down of EQMOD

Author: Mon

EQMOD gets the equatorial coordinate values (RA and Dec) from the mount itself. If you disconnect the driver while maintaining power to the mount and then re-activate the EQMOD driver, it will continue to operate based on the RA and Dec values stored in the mount's stepper controller. This means that even if you shutdown the PC but leave the mount in a tracking state and then reconnect EQMOD, it will continue to display and report the correct RA and Dec values based on the current position of the mount.

The setup will revert to a home position only if you remove and re-apply the power to the mount. When EQMOD reconnects it will know if the mount was reset or was left in a tracking state.

To allow continuity of operation after a power recycle, the mount has to be parked at a known position (either the home position or a custom park position). When the mount is parked the last RA and Dec values are recorded. Upon mount power up, EQMOD restores the RA and Dec values to the mount. This works successfully based on the assumption that the worm gears remain at the same position as when the mount was shutdown.

Assuming the mount is parked at the end of a session and unpark is performed on mount bootup, and assuming the n-Star data is saved and restored (a future feature), GOTO's will remain accurate even if you use the last n-Star list. Sync data will also remain correct and accurate. Of course, the PC time and coordinate values need to be accurate.

GPS and a n-Star store/restore would be a great combination.

Using Starry Night and PHD

Author: Gerardo

At first I found that PHD was hanging very frequently so I added 1GB RAM to my laptop which only had 256 MB. With this the hangs were delayed up until I was working about half an hour. I realized that it was SNP who, if it is working for this time, hangs. It would be not much problem because it can be killed but the real problem is that it leaves the ASCOM driver in a state that PHD can no longer guide and what is worse if you close PHD and try to connect again the problem remains.

What I do now:

1) Start PHD
2) Connect to the guiding camera (Opticstar PL130)
3) Connect to POTH
4) Then the EQMOD starts
5) Start SNP
6) Connect SNP to POTH
7) Do whatever alignments I want with SNP and EQMOD
8) Goto selected target and frame it
9) Close SNP telescope window
10) Close SNP
11) Start the loop in PHD to look for a suitable guide star
12) Stop looping, select star and start guiding
13) Start Artemis capture, set imaging parameters and start capturing a sequence
14) When ever I want to change target or if I want to park the mount I continue as in point 5 starting SNP. I have no problems in connecting and disconnecting SNP many times. I think the problem happens when I keep it working.

With this I have been able to work up to 5 hours without a problem .

A detailed description of how EQMOD gets the equatorial coordinates

Author: Mon

1. Read the RA and DEC Stepper ring counter values from the stepper board
   - Values are 32BIT Hexadecimal Ring counter values
   - Ring counter center value is 0x800000
   - A single increment (decrement) of the counter corresponds to 0.144 arcsecond of mount movement on each axis

2. Get the PC Local Time and the site's Latitude, Longitude, Elevation
   - data provided by the user or the GPS module and is fed to the EQMOD driver
   - data stored in the windows registry

3. Compute for the Local Sidereal Time/date based on the PC Local Time, Site Coordinate data, and the RA ring counter value

4. Get the Hour Angle based on the LST and date and other factors such as obliquity and nutation.

5. Get the DECLINATION equatorial coordinate based on DEC motor ring counter value

6. Compute for RIGHT ASCENSION equatorial coordinate based on the Local Sidereal Time and Hour angle, RA coordinate and PIER status
   - Notice that the Right Ascension is also dependent on the DEC motor. The Right Ascension values change when the DEC motor moves to the other side of the pier.

7. Publish the values on the display and on the upper application layers such as the Planetarium application

8. Repeat from Step 1

As you can see, the values are still based on the RA and Dec motor ring counter values (Step 1). Even if the EQMOD driver is shutdown and restarted and as long as the power is not removed from the mount, you will be able to continue the operation without starting from the home position.

EQMOD Goto Accuracy - Explained

Author: Mon

The key to GOTO accuracy is basically a two step method;

1. Alignment of the mount with respect to a series of reference point on the sky (alignment stars)
2. Properly Positioning the RA and DEC stepper motor after the GOTO slew to the correct location.

Step 1 is achieved by the N-star alignment.
You can still achieve accurate GOTO's even with a 1-star if the mount is properly polar aligned and have minimal cone errors (we can still overcome cone errors on a 1 star align by choosing stars on the same meridian side on both the alignment and the GOTO). If the final position crosses the meridian opposite where the 1-star alignment is, then you need to do a SYNC first to overcome cone errors on the opposite side.

Step 2 has already been achieved within the EQMOD
It is achieved using the GOTO function codes and through the "Iterative Goto" implementation. Achieving the correct stepper position both for RA and DEC at the same time compensating for the earth's movement and the time the GOTO was implemented were the keys for an accurate iterative GOTO function.

The "iterative GOTO" uses the following two control lines found at
the 'EQMATH.bas' source code;

```
NUM_SLEW_RETRIES As Long = 5retries
gRA_Allowed_diff As Double = 10
```

It says that Goto should not stop until you get within 10 microsteps of the desired position (10 * 0.144arcsecond) or roughly 1 arcsecond. To achieve this you need to at least perform an iterative GOTO retry. Iteration will stop if more than 5 attempts. I have observed that most GOTO's on this mount stops at the 2nd or 3rd iteration. You will notice this on your mount as stepper "clicks" / "bursts" after a GOTO operation and as "Slew Retry" messages on the EQMOD window.

```
CoordSlew: RA[ 06:00:03 ] DEC[ +44:57:00 ]
SlewRetry[ 4]: Diff at : 1444 Target is: < 10
Goto Slew Complete. Diff at 2
```

Using the sample EQMOD message above, without iteration, GOTO will stop at 1444 microsteps of discrepancy (.144arcsec/microstep = 207 arcseconds). A slew retry has brought the mount only at 2 microsteps discrepancy. With good alignment, a 2 microstep discrepancy should put the object dead center on the FOV.

The driver has to impose a 5 retry limit to avoid any indefinite oscillations in the iteration process. If you get more than 1 arcsecond of stepper positioning error visually on the FOV, then the problem is NOT on the stepper position but on the mount alignment (polar/cone/etc).

Value of using a GPS device

Author: Mon

As long as you have the time and location data consistent and accurate on every imaging or observation session, and as long the alignment data is intact, whether the data came from the GPS or manually entered, you will be able to achieve accurate GOTO's.

Although you can manually define the coordinates and time-of-day of your mount on your hand controller or on the PC (when using EQMOD), having a GPS device handy would allow things be done automatically for you. The location data may be fixed but the time component will not be as you are required to make sure that the time is accurate as the mount driver computes for the Local Sidereal Time (LST) based on the local time. The position of the stepper motor based on the requested RA/DEC Goto coordinates are computed based on the current Local Sidereal Time value.

Any electronic device (Notebook, PC, Watch, Clock, HC, etc) that maintain the current time will not be always accurate. You will have to sync it on a regular basis from a common timing system which can be found on GPS devices which are synced from an Atomic Clock passed to all GPS satellites.

A GPS would come in handy for mounts that are permanently located on a certain location (observatory, fixed pier, etc.). As you park and unpark your mount, the RA shaft position is usually memorized and the absolute position is computed based on your longitude and latitude coordinates and the current time-of-day / Local Sidereal Time.

With the GPS, the "continuity" of your mount "state of accuracy" is achieved. This means the data from any "alignment" operation/calibration done on a previous day can still be re-used on the current day and the days to come as you will be using the same coordinate data and the sky will still be "synced" with the RA shaft because of the atomic time.

If there are inherent discrepancies introduced on the time alone, that means you have to perform the same 1-star, 2-star, 3-star, N-star alignment every night for you to be able to maintain the accuracy on any GOTO operation.

In the EQMOD program code, the GPS data (time and coordinates) is processed even to the seconds/arcseconds portion in order to be able to compute in 0.144 arcsecond accuracy of the stepper motor position,

For mounts "on the go" or mounts that don't have a fixed location, the latitude and longitude coordinate and time-of-day data is usually important on the first alignment star GOTO coming from the initial home position. In the absence of an alignment data, the driver usually uses a "0" offset alignment. To "estimate" the position of the 1st, 2nd, and 3rd alignment star, it has to rely on these latitude/longitude/time-of-day data. This means, the centering process of any alignment operation would be better if your latitude/longitude/time of day are accurate. The GPS info would be helpful for this.

Some of you might ask are we still close to accurate GOTO's even without access to a GPS data. The answer lies on the different "offsets" applied on your goto coordinates. These offset data were derived from the alignment and star centering/calibration operation. The errors from the your latitude/longitude/time-of-day data are easily compensated by the star alignment operation.

However the accuracy may not be constant on all parts of the sky if you introduce errors on your coordinates as the accuracy will vary depending on which part of the sky your scope is pointed at. (unless you have access to an N-star alignment). Usually the correction offset only applies to a certain part of the sky. (This where the N-star and SYNC operation becomes handy). This happens as the mount firmware attempts to compute in a spherical coordinate system the location of the sky object. If your latitude/longitude data is not accurate, the virtual sphere which your mount firmware maintains to which your local sky is part of it will be a little "skewed" on certain sky locations.

At the end of the day, you get to minimize these errors and spare the mount from compensating these errors by simply using a GPS device.

Most mounts usually provide arcminute accuracy. However, with good command on programming, mathematical mechanics and depending on the capability and quality of the hardware itself, it is always possible to increase the accuracy towards the arcseconds level.

The advantage of using pulseguide with EQDIR

Author: Mon

The old hand controller (HC) will not work as it doesn't have Pulseguide support. On the ASCOM-talk yahoo groups, I suggested that the Celestron's ASCOM driver be changed to support a "timer" based simultaneous axis pulseguide. An updated Celestron driver was released last month to support the ability of PHD to implement pulseguide directly to the Syncscan controller.

However, it should be noted, that the EQDIR option should be more accurate due to less delays induced on the serial interface since the pulseguide commands are directly fed to the mount's stepper board controller. This should provide the ability to have better subpixel autoguiding

Without the EQDIR option (using the hand controller) there are two "cascaded" serial interface delays (very critical to mount's reaction time to the pulseguide corrections). One delay comes from the serial connection between the PC and the hand controller (HC). The other delay comes from the connection from the HC to the mount. Since Celestron's Pulseguide commands protocol is entirely different from the Mount's Stepper protocol, the HC does some sort of command translation. This adds to the delay. Pulseguide will be successful using this option (PC->HC->mount), however the accuracy in terms of subpixel guiding would be less.

Problems

Game Controllers

If your game controller is not responding as expected, look for the [Mode] button on the controller. This button switches most game controllers from analog to digital modes. The digital mode should work correctly.

Tracking past Meridian

Q: I would like to be able to set my mount to keep tracking a few degrees past the meridian before any limits are set. Tracking appears to stop right at the meridian which can be quite frustrating when imaging. Is there a setting for this?

A: That is the "RA LIMIT" at the EQMOD setup window. Just click on the [RESET] button. A "0" value disables the RA Limiter function.

Starry Night and PHD

There is a detailed write-up on using Starry Night with PHD under the topic “Using EQMOD with POTH”.

A Starry Night/EQMOD/SN6 problem

Q: I am using EQMOS V112k and aligning either via sync or N-Star. The strange thing is that when I select the command slew to ... in SN 4.02 the EQ6 slews "NEAR" the object but not to the object. And in the display it shows the red cross near the object. If I move manually the red cross via the EQMOD pad or my usb hand controller over the object then the object appears in my CCD camera.

A: You may have an old/stray definition of Sync data or 1-star or N-star in there. Try to clear the data and start fresh from your usual 1-star/nstar session.

Glossary

Affine

There are many detailed mathematical descriptions of affine/taki transformations (check http://en.wikipedia.org/wiki/Affine_transformation for example). The simplest description is to say that it is a mathematical method of calculating the differences between the actual "sky" positions and the mount position. Basically it is used to tell the mount where it has to move in order to GOTO the required object. It uses the star catalog data from your planetarium program and the alignment data from the alignment process you completed at startup.

Encoders (Ring Counter)

This documentation sometimes refers to the “encoders” in the mount. Strictly speaking, the mount doesn't have Optical Encoders, instead, the mount uses 32 bit ring counters to keep track of the stepper motor position. The more appropriate term to describe the stepper motor counters would be "RA position counter" or "DEC position counter"instead of "encoder" (or just "RA or DEC counter").

Home

The home position of the mount is the position where the telescope is pointing at the NCP (north celestial pole) or the SCP (south celestial pole). This is accomplished by setting the mount with the balance (counter-weight) bar point downwards and the scope point north or south.

Park

Before powering down the mount, the mount should be returned to a park position. This position could be the same as the Home position. However, it is possible to define another position for the park position that might be preferable for special installations such as a permanent pier in a roll-off roof observatory. Parking the mount before shutdown means that the mount has a known place to start when power is returned and the mount is "unparked".

POTH

POTH is part of the ASCOM software. Although you must use the ASCOM software itself, POTH is an add on feature to allow several programs to control the mount and other hardware at the same time using the same cable.

Accessories Used with EQMOD

The accessories most commonly used with EQMOD are:

- a game controller/joystick
- a USB to serial converter
- an add-on numeric keypad

A source of specific hardware models and brands that work and do not work can be found on the EQMOD Yahoo site under files or database.

Future Features

This page outlines some the features that may be implemented at some future date.

Backlash Compensation

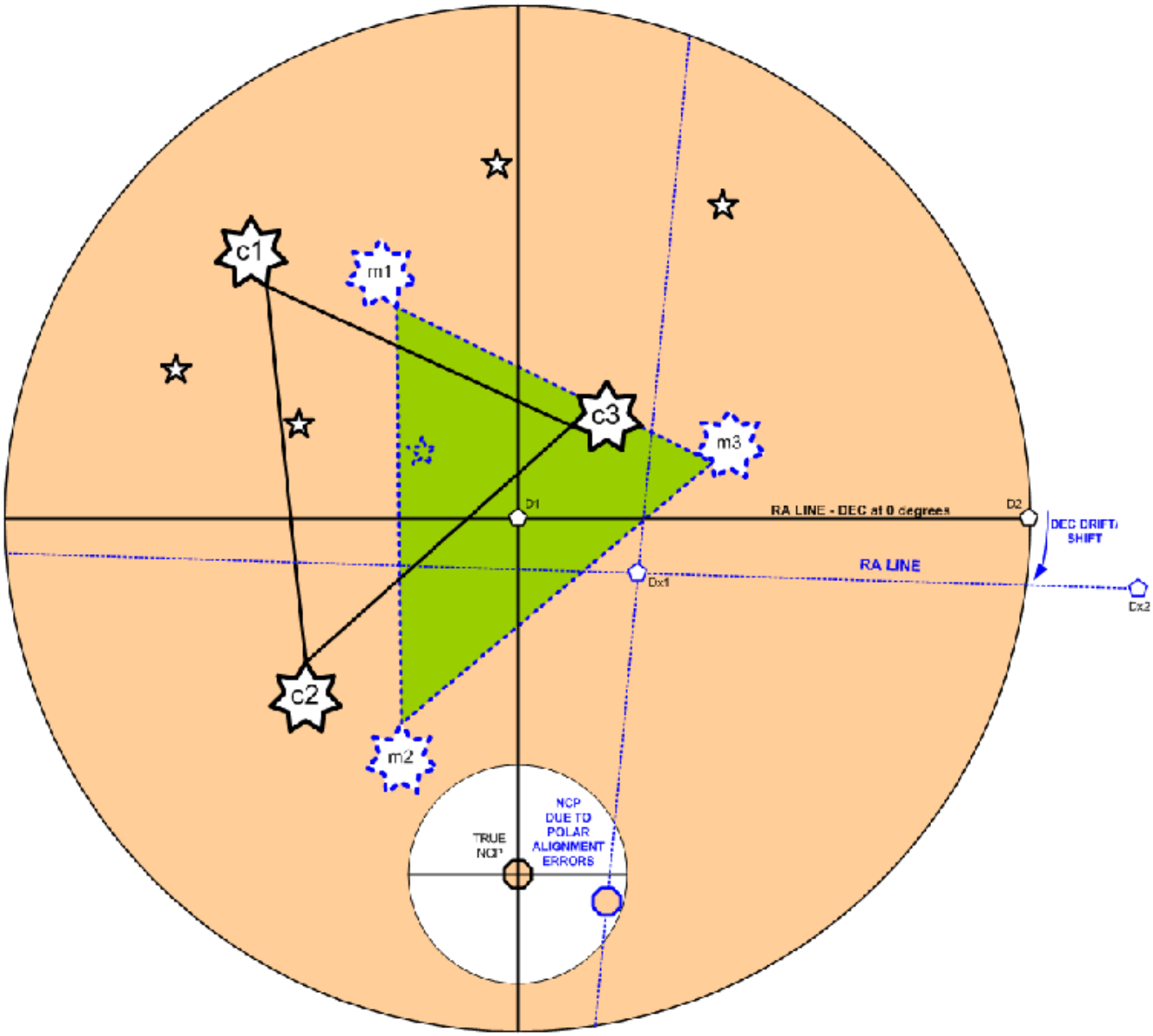
Currently not active since most of the EQ designs do not require backlash.

EQMOD - Polar Alignment Checking using 3-Star Coordinate Transformation

The AFFINE/TAKI coordinate transformation method basically is a SHIFT/ROTATE/SCALE coordinate transformation function. Any SHIFT, ROTATION, SCALING on a given set of catalog points can be computed using the matrix transformation process.

Applying this on the 3-star alignment data (figure 1), we can compute for the mount's polar alignment discrepancy (shift/rotation) using the 3-star transformation matrix data (c1,c2,c3,m1,m2.m3). c1-c3 being the catalog stars RA/DEC data, m1-m3 being the measured stars RA/DEC data captured during the 3-star alignment process. Using arbitrary points (D1, D2) along the RA coordinate space, the coordinates of these points are transformed (using AFFINE/TAKI) to Dx1, Dx2. Using these four points, D1,Dx1,D2, Dx2, we can compute for the polar alignment shift as depicted by the blue NCP marker on the lower part of the image.

The Diagrams show the position of the true NCP and the position that is pointed to by the mount. In simple terms: Once you have complete an accurate 3-star alignment of the mount it would be possible to indicate the polar alignment error.


c1
m1
c3
m3
c2
m2
D1
RA LINE - DEC at 0 degrees
D2
DEC DRIFT/
SHIFT
RA LINE
Dx1
Dx2
TRUE
NCP
NCP
DUE TO
POLAR
ALIGNMENT
ERRORS

Resources

The best place to find supporting resources is the Yahoo special interest group

http://tech.groups.yahoo.com/group/EQMOD

Within that group, you will find a very responsive and supportive group of individulas willing to provide answers to questions that might not have been covered in this manual. Please remember to search the manual and news group before posing questions that might have already been covered.

As part of the Yahoo interest group there are additional resources accessed from the following links.

http://tech.groups.yahoo.com/group/EQMOD/links

http://tech.groups.yahoo.com/group/EQMOD/files/

http://tech.groups.yahoo.com/group/EQMOD/database

http://tech.ph.groups.yahoo.com/group/EQMOD/photos

Additional link:

http://eq-mod.sourceforge.net/index.htm

Add on Software

There are a number of additional applications that have been written specifically to work with EQMOD. These applications use the ASCOM interface and so may also work with other ASCOM compliant telescope drivers. This manual focuses on their use with EQMOD.

Note: ***None of these applications are required for using EQMOD.*** They simply add additional (and useful) functionality. It is recommended that you install and use EQMOD without these applications. Once you have EQMOD fully functional and you are completely familiar with its use you may wish to try the “add on” applications.

EQMOD Mosaic

EQMOD Mosaic is an ASCOM Client Application that integrates with EQMOD.

Note: ***You do not need to install EQMOD Mosaic in order to use EQMOD.***

EQMOD Mosaic is used to facilitate creating mosaics of large objects. The program creates a grid of RA and DEC coordinate points so that the mount can be moved in a systematic manner as the mosaic images are accumulated.

Currently the program is being developed so the latest versions can be found in the files folder at

http://tech.groups.yahoo.com/group/EQMOD/files/A%20EQMOD%20Release/EQMosaic/

The file will have a name such as:

```
EQMOD_MOSAIC_BETA_V106.zip
```

where the version number in the above example is 106. The version you should download will probably have a later version number such as 106a. Eventually an official release will be located outside of the debug folder.

Assumptions:

1. You have setup ASCOM
2. You have setup EQMOD (although EQTour can be used with other ASCOM drivers).

ASCOM Server Connection

Connection must be made to an ASCOM telescope driver and this is achieved via the [Connect] Button. If no connection has previously been made then the ASCOM “Chooser” dialog is shown, otherwise connection is established to the server currently set as the current default. The default server is set via the [Choose Scope] button on the extended window. EQTour can be set to automatically connect to the current ‘default’ ASCOM server on start up. Typically you will choose "EQMOD ASCOM Scope Driver".

Download EQMOD Mosaic

1. Download the latest version into an appropriate folder from: http://tech.groups.yahoo.com/group/EQMOD/files/A%20EQMOD%20Release/EQMosaic/
2. Unzip the the file. It will typically create a sub-folder with the project files. For non-developers the *.exe* file is the only file of interest.

Basic Operation of EQMOD Mosaic

1. Double click the file *EQMOD_MOSAIC.exe* . Depending upon your computer setup the *.exe* extension may not be visible.
2. Start your planetarium program (optional) and connect to POTH in the “ASCOM Telescope Chooser” dialog (not EQMOD). EQMOD will start up. This assumes that you have already setup POTH to use the EQMOD driver.
3. In the EQMOD Mosaic window, click the [Connect] button. EQMOD Mosaic will then connect to an ASCOM driver. If none has previously been selected then the “ASCOM Telescope Chooser” dialog will appear. Choose POTH not EQMOD. You could connect to EQMOD if no planetarium program or other programs will be used to control the mount. (see note about auto connect option). On successful connection the center cell of the mosaic grid is automatically synchronized with the scopes position and will appear highlighted.
4. Use your planetarium program or the EQMOD slew controls (joystick etc.) in EQMOD to move to the object of interest.
5. Double click a new grid position (or [Spiral] button) to slew the mount a precise amount for each subsequent image. When the scope finishes slewing the target grid cell will be highlighted and the grid cell label will be displayed (if option enabled).
6. If at any point you wish to resynchronize the grid center with the current scope position, click the [Get Position] button. The grid will be reset and position F6 (row F, column 6) and will appear highlighted.

Summary of Using Mosaic

1. Startup Mosaic and Planetarium program.
2. If auto-connection hasn't been enabled press [Connect].
3. Find object, slew to it.
4. Verify current FOV and overlap settings are giving reasonable slews by using Mosaic to move in RA, then DEC visually noting features in the overlap zones.
5. Frame the Mosaic by performing a Mosaic slew to the 'edges' of your subject, adjust using manual slews (joystick, keypad etc.).
6. **Mosaic** slew to first grid of your mosaic and start imaging.
7. **Mosaic** slew to next grid, image - repeat till done.

Using the [Spiral] button in EQMOD Mosaic

1. The first click of the [Spiral] button initializes the spiral slew
2. Subsequent button clicks slew the scope in a “circular” pattern of grid positions
3. When all grid positions have been covered the process starts again. Provided your target is roughly circular/square and doesn't span the meridian during your imaging session, this provides a simple one button approach to mosaic building.

Note: The [Spiral] button only becomes active once a scope is connected its position read. Also the [Spiral] and [Slew] buttons are disabled until the slew is complete.

Mosaic can also be used as a spiral search where it is necessary to pause to take an exposure. This works well for finding dim targets where you need a long exposure image.

EQMOD Mosaic Settings

1. To change the default settings of EQMOD Mosaic, click the [> > >] button.
2. In this extended window, you can set the frame size that corresponds to your imaging setup. This setting only needs to be approximate although it should typically be equal or smaller than the actual camera image size. The frame size is used by the grid navigator to calculate the amount of slew.
3. There is a drop down that allows you to save and recall the frame sizes
4. There is a setting to allow you to specify the amount of overlap between frames.
5. There is an option to warn you if the slew will cause a mount flip.
6. There is an option to automatically connect to the default ASCOM driver on program start.
7. There is an option to keep EQMOD Mosaic on top of all other desktop applications.
8. The current default ASCOM driver is displayed and there is a [Choose Scope] button that allows a different default driver to be selected (perhaps a driver other than POTH or EQMOD).
9. You can save and load sessions.

Setting the Framesize Default in EQMOD Mosaic

Q: I am using a 6" Schmidt Newton F/5 with a (modified) Canon 350D, my FOV is about 2 x 1 degrees.

However currently the maximum framesize is 60 arcmin (1 degree). Is it possible to make the framesize bigger than 60 arcmin, say 150 x 150 arcmin?

Chris: Yes it is possible to increase the maximum frame size but you'll need to do a little bit of text editing.

First make sure the mosaic program isn't running then find the EQMOSAIC.ini file. Under XP it can be found in ....

```
C:\Documents and Settings\USERNAME\Application Data\EQMOD
```

where USERNAME is your windows username.

(You should also see an EQMOD.ini file in this directory if you're using the latest version of EQMOD.)

Note that the Application Data folder has the hidden attribute set so you may have to make sure your file explorer is showing hidden files. If you open EQMOSAIC.ini file you'll see some lines like

```
DEC_MAX_FOV=60
RA_MAX_FOV=60
```

You can set new values as required but obviously the bigger numbers you use the less resolution you have on the slider's that change the FOV in the mosaic program itself - so you may find yourself having to use the [nudge] buttons rather than the sliders to get an 'exact' value.

EQMosaic and Meridian Flips

If the Meridian flip warning option has be enabled, Mosaic will issue a warning if it thinks the next slew is on the opposite side of the meridian from last slew position. Mosaic itself doesn't make the mount flip, the driver actually controls the flip. The mount may not actually flip when you click the [OK] button because, in the time it takes you to make the decision, the target position may have drifted back to the mounts current side.

When doing a mosaic of an item that starts spanning the meridian, a recommendation would be to start on the western side and move through the grid by doing columns of common RA. In this way you spend the maximum amount of time at the same RA. If the second column is on the other side of the meridian when you start, then by by the time you've finished imaging the the first column, the second column may well have drifted across the meridian and so no flip would be needed.

If you do get the meridian flip warning in mosaic you can always cancel the slew, wait a short until the object moves onto the current side of the meridian.

Mosaic Sessions

It is possible to save and load sessions. Up to 10 separate sessions may be saved and recalled. The following information is saved as part of a session definition.

```
RA field of view
DEC field of view
RA overlap
DEC overlap
RA & DEC coordinates of grid centre.
X,Y grid coordinates of Cell to be slewed to.
Status of all grid cells.
```

On session load the grid will be restored to the condition it was in on saving and a slew is initiated to place the scope at the last slew position. RA and DEC skip values are recalculated using the current coordinates.

This feature makes for easier mosaic compilation when imaging spans a number of observing sessions as the mosaic program is able to pick up from the exact point it was previously saved.

Notes about EQMOD Mosaic

1. As of v106, the grid navigation pad has been removed - All grid navigation is now via mouse clicks. This feature is merely hidden from view at the moment and can come back if there are sufficient requests.
2. The settings for EQMOD Mosaic are stored in a file *EQMOSAIC.ini* in folder:

   ```
   c:\Documents and Settings\YourLoginName\Application Data\EQMOD
   ```

3. The [Get Position] button synchronises the grid to your scope. The object does not have to be in view when you [Get Position] - when you slew the grid moves with you where ever you go. Key to mosaic operation is to realize the difference between 'external' slews (planetarium, tour, joystick) and Mosaic slews. External slews will move the entire grid around, Mosaic slew move within the grid.
4. **Tracking:** EQMOD Mosaic can only control the scope to accurately cover an area of sky if the mount is tracking. The tracking status is checked whenever the [Get Position] button is pressed and/or at completion of a slew. If the mount is found not to be tracking then a warning message is displayed in the message center and an attempt is then made to start tracking. If this fails a “Scope will not track” message is displayed.
5. **Non-sidereal tracking:** Imaging the Sun and particularly the Moon needs special consideration Mosaic places a grid on the celestial sphere but objects such as the Sun and Moon move across that grid with time i.e. move at a nonsidereal rate. Mosaic incorporates an algorithm that will automatically compensate for this provided the mount is able to track the objects accurately . Currently EQMOD only does solar and lunar tracking in RA - the Moon & Sun both move in declination as well so over time will slip over mosaic grid. Clearly these are bright objects and imaging times will not be extended so the effect should be negligible unless there are long pauses between image captures.
6. Prior to initiating a slew Mosaic, checks the scopes current position (both RA and DEC) and subtracts the position it thinks the scope should be at (i.e. the position used for the last slew). This gives a drift compensation in RA and DEC that is then applied to the grid centre coordinates, from which all other grid cell coords are calculated.
7. If you use Mosaic session save/restore and your imaging target is the Moon, the initial session restore slew is unlikely to get you to the right place as the Moon will have moved on across the sky. The session save/load feature is really only practical for Deep Space Mosaics.
8. Before starting your Mosaic sequence of images, you can adjust the alignment of the grid over your object by using the scopes slew controls.

For example: Whilst imaging the moon, try centering the moon and click the [Get Position] button to lock the grid in place. Then double click around the grid to find the frames the will constitute the boundaries of the mosaic. If any frames on the edge have an unacceptably small amount of moon in them, simply use the telescope slew controls to get more of the moon in the cell and the drift compensation code will automatically move the grid centre to compensate. Then check that the other extremity is satisfactory. This way, you can ensure that you capture the object with the minimum number of images.

About Mosaic FOV settings:

2 deg,54 min x 1 deg,34mins is 174 arcmins x 94 arcmins

The field of view needed is that of your imaging device when applied to your scope. Obviously there are a wide range of FOVs we need to cover when you consider the various options folks have in terms of scopes, barlows, reducers, CCDs, webcams, DSLRs, SLRs etc. You don't have to be deadly accurate with setting the FOV values just err on the 'smaller' side and all that will happen is the mosaic will be slightly more overlapped.

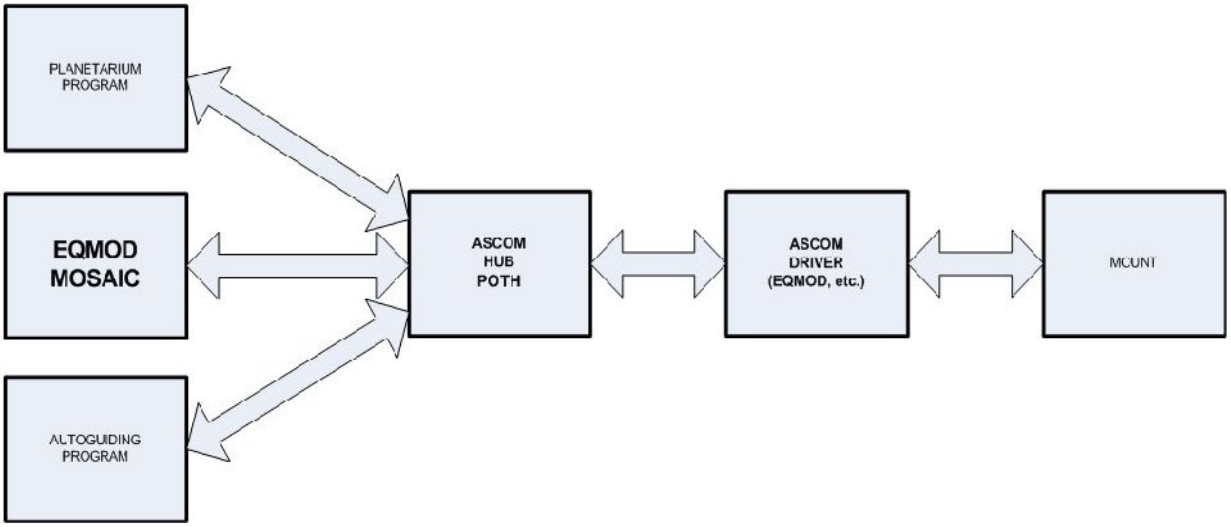
For an imaging device at prime focus the FOV dimensions may be calculated as follows:

```
FOV (arcmins) =   3.438 * ChipDimension / FocalLength
```

Where ChipDimension and FocalLength are in mm. FocalLength should take into account magnification effect of any barlows/reducers in the imaging setup.

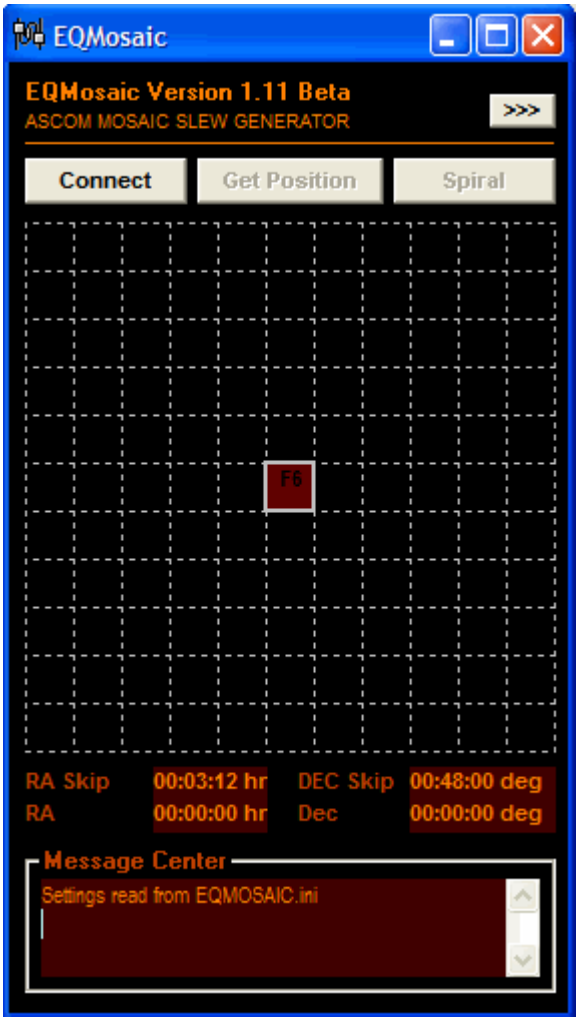
Note that the mosaic program assumes your imaging device's FOV is aligned in RA and DEC - so movement in RA moves stars horizontally across the image - adjusting the frame overlap should compensate for small errors in alignment.

An Overview of typical EQMOD Mosaic setup



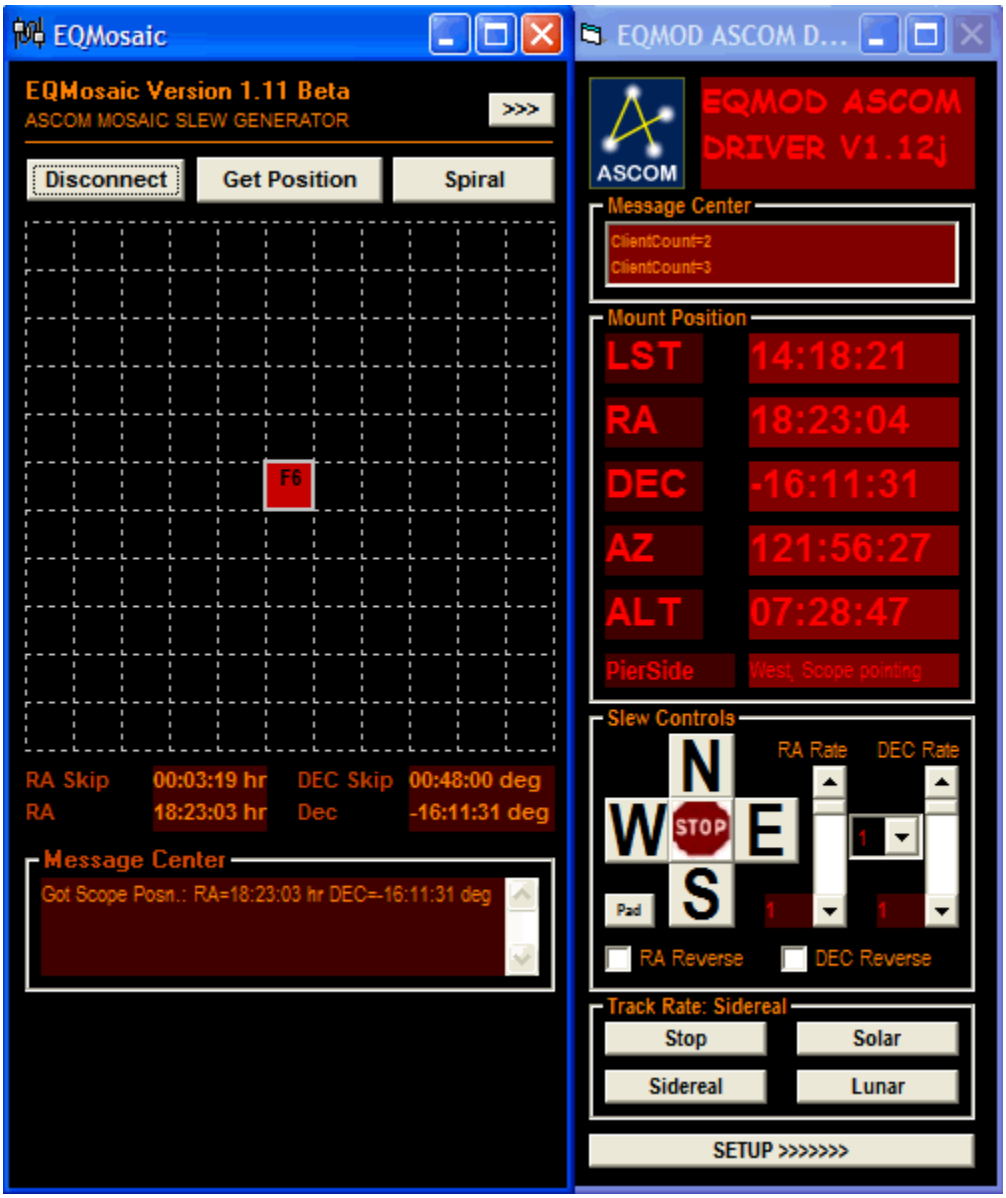
EQMOD Mosaic – Interface Images

This is the start up window of EQMOD Mosaic. Click the [Connect] button to connect to the mount. (see below about auto-connect option)

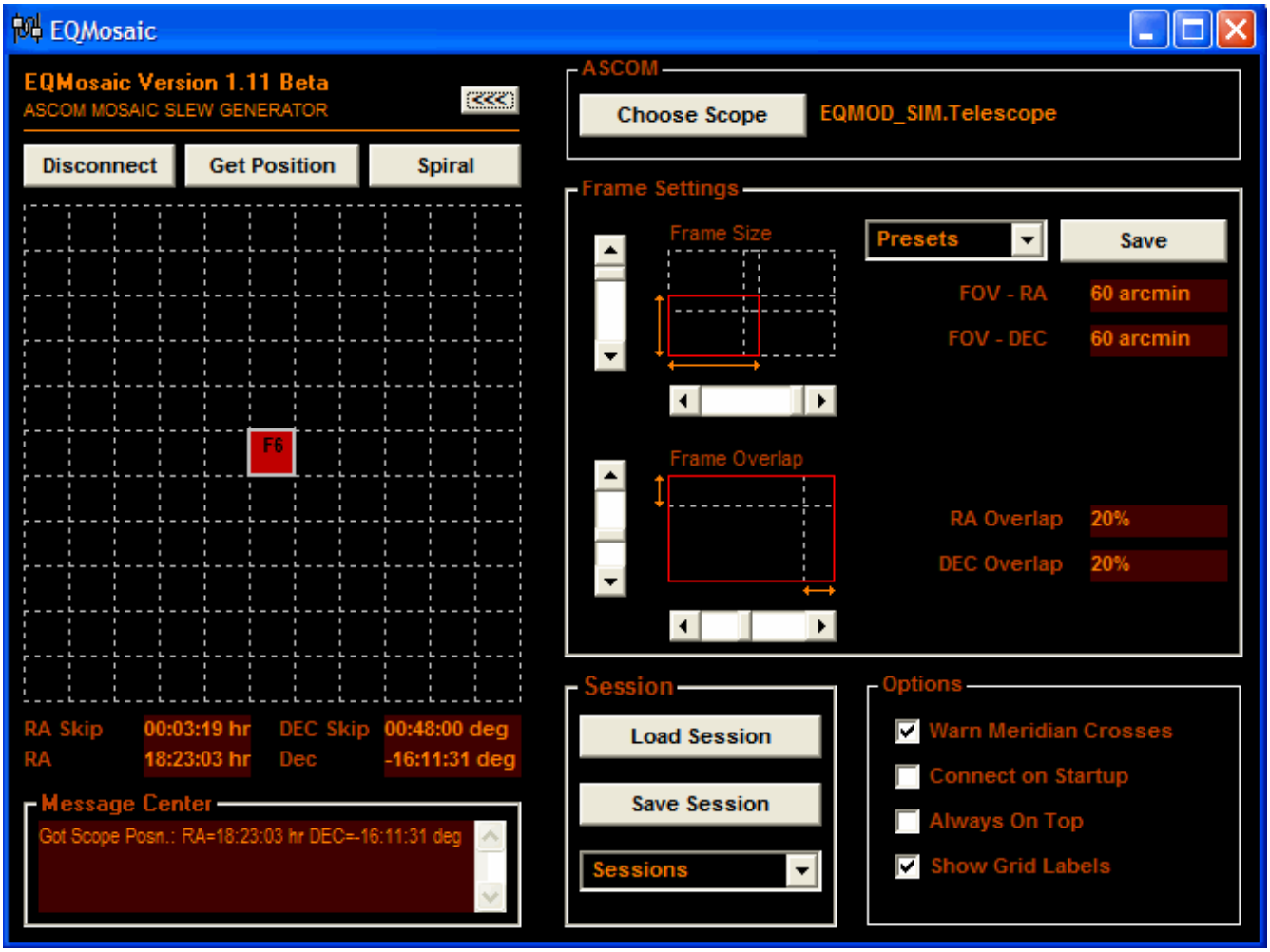


The ASCOM Telescope Chooser appears.

Select [POTH] and click the [OK] button. If you have set the "Auto-connect" option, Mosaic will attempt to connect to the last driver that you have used. In this case the [Connect] button will be replaced with a [Disconnect] button.



EQMOD will activate.



In order to set EQMOD Mosaic options, click the [> > >] button. Here you can

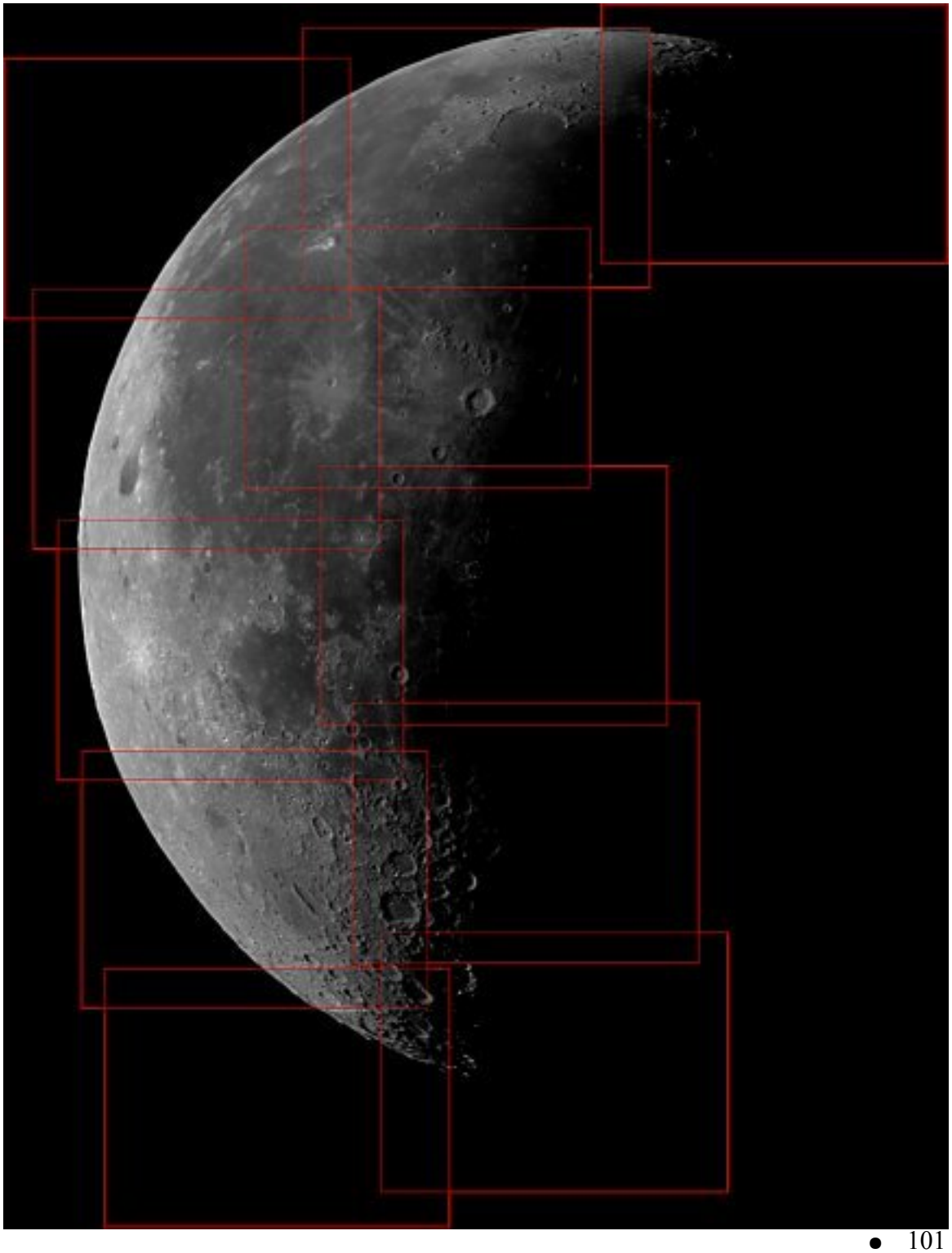
- adjust the frame size and overlap.
- save several different combinations by using the “Presets” drop-down.
- save and load sessions

The other options are”

- choose to be warned if the slew will cause a meridian flip
- automatically connect when Mosaic starts using previously used driver
- keep Mosaic on top of all other applications
- display grid labels for easy identification of images

EQMOD Mosaic – Moon Images

The staggered nature of the grids shows the effect of not having the camera RA aligned and that despite this, given sufficient overlap, an acceptable mosaic can still be achieved (each frame being overlapped by six other frames rather than 4 for optimal alignment)



EQTour

EQTour is an ASCOM Client Application that integrates with EQMOD.

Note: ***You do not need to install EQTour in order to use EQMOD.***

EQTour is a lightweight, small footprint application that provides users with the capability to create their own Sky Tours of objects. This may prove be useful as a "bookmarking" facility during or spanning observing session when objects need to be regularly revisited. By using *EQTour* in combination with Planetarium software and the EQMOD simulator, it is easy to build up lists of sky locations for later observation/demonstration sessions.

Currently the program is being developed so the latest versions can be found in the files folder at

http://tech.groups.yahoo.com/group/EQMOD/files/A%20EQMOD%20Release/EQTour/

The file will have a name such as:

```
EQMOD_TOUR_BETA_V102b.zip
```

where the version number in the above example is 102b. The version you should download will probably have a later version number. Eventually an official release will be located outside of the debug folder.

Assumptions:

1. You have setup ASCOM
2. You have setup EQMOD (although EQTour can be used with other ASCOM drivers).

ASCOM Server Connection

Connection must be made to an ASCOM telescope driver and this is achieved via the [Connect] Button. If no connection has previously been made then the ASCOM "Chooser" dialog is shown, otherwise connection is established to the server currently set as the current default. The default server is set via the [Choose Scope] button on the extended window. *EQTour* can be set to automatically connect to the current 'default' ASCOM server on start up. Typically you will choose "EQMOD ASCOM Scope Driver".

Downloading EQTour

1. Download the latest version into an appropriate folder from: http://tech.groups.yahoo.com/group/EQMOD/files/A%20EQMOD%20Release/EQTour/
2. Unzip the the file. It will typically create a sub-folder with the project files. For non-developers the *.exe* file is the only file of interest.

EQTour - Tours & Object lists

On start-up *EQTour* automatically scans its install directory and populates a drop down list of available Tours. Each Tour simply consists of a list of sky objects. Several samples have been included as part of the installation zip - these have not been fully verified as to accuracy but should give a fair selection of Northern and Southern hemisphere objects.

The *MyTour.lst* file is provided as an empty tour which effectively replaces the bookmark feature of earlier *EQTour* versions (See below for adding Object entries).

Select a Tour via a drop down list. Changing the tour will generate a list of objects in the Tour object window that are currently above the horizon. Note that object list can only be populated when an ASCOM connection has been established (via the [Connect] button) as the application must read Local Sidereal Time and Observing Site coordinates from the scope driver in order to determine which objects are visible. The list of currently visible objects is not dynamically updated but can be refreshed at any time by clicking the [Refresh] button.

EQTour - Slewing to an Object

Clicking on a Tour Object Item will result in the "Object Position" settings being changed to those associated with the object. Double clicking will slew the scope to the object position. If an object has passed below the horizon its coordinates will be displayed in RED and slews for that object will be disabled.

EQTour - Adding and Deleting Object entries

Objects can be added to the current Tour Object List. Usually you would add objects to the *MyTour* list.

1. Start EQTour and connect to the POTH interface.
2. Start your planetarium program and connect to the POTH interface.
3. Using your planetarium program, slew to the object to be added.
4. In EQTour, click the [Add] button.
5. Enter an appropriate description. Press the [Enter] key on your keyboard in order to record the description. The list will be refreshed and the new entry will appear.
6. If an empty description is entered then the process is aborted.
7. Objects are removed from the current list by first selecting them then pressing the [Delete] button.

EQTour - Tour Files

Tour definitions are stored in text files (*.lst) located in the same directory as *EQTour.exe* These files can be freely edited (in notepad for example) to add new entries. The format is as follows :

- Lines starting with a semi-colon are comment lines
- Object definition take the form of RA; DEC; Name RA and Dec are decimal representations in Hours and Degrees respectively.

If you don't require all of the sample Tour files either delete them, rename them *.sav, or move them to another directory. Note that the program needs at least one list file provide any useful functionality!

Additional Notes about EQTour

1. The additional settings are visible only if you click the [> > >] button.
2. The additional settings has an option to set the horizon altitude. Setting this value above 0degrees will hide objects from the tour list below that level.
3. The settings for EQTour are stored in a file *EQTOUR.ini* in folder:
   C:\Documents and Settings\YourLoginAccountName\Application Data\EQMOD

Language Customization for EQMOD and EQMosaic and EQTour

EQMOD and *EQMOD_TOUR_BETA_V105* and *EQMOD_MOSAIC_BETA_V110* support the use of language specific *dlls* where all language specific text is held.

Developers wishing only to translate these products now can do so by creating a separate language *dll* without the need to modify the main body of code.

The code works as follows:
On start-up the applications determine you language automatically from your PC's locale settings. They then attempt to load a *dll* named EQMODxx.dll/*EQTOURxx.dll* / *EQMOSxx.dll* - where xx is an abbreviated form of your language i.e. en=English fr=French etc.

If a suitably named *dll* cannot be English is used by default (an English *dll* need not be present for this).

For testing purposes the language *dll* used can be overridden by editing the *LANG_DLL* entry in the application *ini* file and assigning a filename.

Each time the application requires text data it attempts to retrieve it from the language *dll*. If the particular text doesn't exist, then the English text will be used instead. In this way, if for some reason translated *dlls* lag behind the current English version all that will happen is that English text will appear where new text has been added.

Included in the zips are VB projects for creating the language *dlls*. To start a new translation do the following

1. Copy and rename one of the exiting projects
2. Copy the *EN.res* file from the main project parent directory.
3. Edit the string table of the resource file as needed
4. Build the *dll* , making sure its named according to the convention mentioned earlier.
5. Copy the new *dll* to the parent directory.

An alternative method would be to copy and rename an existing *dll* and use a resource editing program (there are many free ones available) to edit the *dll* directly

Note that ideally translated text should be of equivalent length as the original English to ensure it will fit in the space allocated for buttons, labels, etc.

Included with *EQTour* is a French *dll* that Ange has already provided the translation for (there are a few English phrases that haven't been translated). *EQMOSAIC* contains a French project but it the text has yet to be translated.

There have been only minor changes to the User Interface with these releases (to make a bit more space for translated text) and documentation need not be updated. If anyone fancies having a go at providing a translation (German, Spanish etc) that would be great :-)

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