The EQMOD PROJECT

EQASCOM & AutoGuiding

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EQASCOM AutoGuiding

Guiding control of the mount can be accomplished in 2 different ways.

- ST-4 based guiding
- ASCOM Pulse Guiding

For EQASCOM to provide PulseGuide support the associated checkbox on the “setup screen” must be checked. By default the the PulseGuide support is enabled.

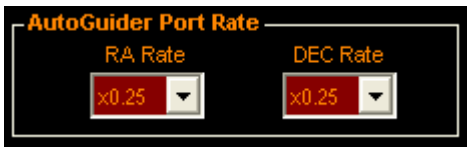
This option was provided due to one particular guiding application that would disable its own ST-4 guiding support if it detected the presence of a driver with ASCOM PulseGuiding capabilities.

ST-4 Guiding

ST4 guiding works using a hard wired interface from connecting you PC/switch box/guide camera to the mount's Autoguider Port. The interface consists of control lines (RA+ RA- DEC+ DEC-) to control each direction the mount can move. When the mount sees a signal on one of the control lines it starts to move in the associated direction at a fixed rate. In the absence of a guiding signal the RA axis will moved at whatever the tracking rate has been previously selected. The DEC axis will stop.

The guiding application keep the mount tracking an object by monitoring the apparent movement of a guide star and using the ST4 control lines to either command the Ra and DEC axis to move faster or slower than their nominal tracking rate.

For ST-4 guiding EQASCOM plays no active part in the guiding process. You can however set the rate at which each axis will move when the associated guiding signals are present.



Possible rates are x1.0, x0.75, x0.50, x0.25 of the Sidereal rate.

Selected EQASCOM RA Rate	ST-4 RA+	ST-4 RA-
x0.25	1.25 x Sidereal	0.75 x Sidereal
x0.5	1.50 x Sidereal	0.50 x Sidereal
x0.75	1.75 x Sidereal	0.25 x Sidereal
x1.00	2.00 x Sidereal	Stopped

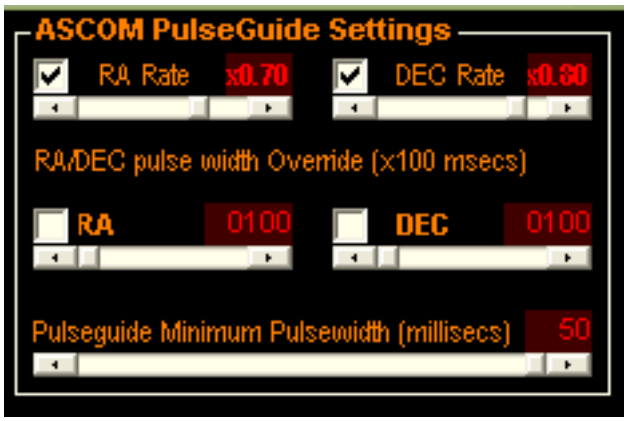
Selected EQASCOM DECRate	ST-4 DEC+	ST-4 DEC-
x0.25	0.25 x Sidereal	-0.25 x Sidereal
x0.5	0.50 x Sidereal	-0.50 x Sidereal
x0.75	0.75 x Sidereal	-0.75 x Sidereal
x1.00	1.00 x Sidereal	-1.00 x Sidereal

ASCOM Pulse Guiding

One of the benefits of using EQASCOM is that correction commands and be sent from the guiding application through EQASCOM to the mount using the EQDirect (or PC direct if using the Syncan) serial interface. This method of guiding requires no additional interface boxes or cables .

An ASCOM PulseGuide message contains two parameters, a Direction to move and a Duration. On receiving such a message EQASCOM will instruct the mount to move at a pre-configured rate for the requested duration. Once the duration expires, the RA axis DEC Axis are returned to their nominal tracking rates - so if tracking at sidereal rate the RA Axis is set to sidereal rate and the DEC axis is stopped. If Lunar, Solar or custom rates are in effect then it is those rates that are applied.

Pulse Guide Settings



Guiding Enable

The Checkbox associated with each Axis Pulse Guide Rate enables (checked) or disables (unchecked) guiding on the associated axis.

Pulse Width Duration Override

The “Duration Override” option allows the user to specify a fixed duration correction regardless of that supplied by the guiding application. This override is only applied if the associated tick box is checked. Typically the duration override is not used and the autoguider application is allowed to dictate the maximum length of guiding pulse.

Minimum Pulse Width

The Minimum Pulse Width slider specifies the minimum length of time a correction will be applied and overrides any request by the autoguider for a shorter duration. EQASCOM always imposes a minimum pulse width of 50ms as it is not practical to accurately measure shorter periods.

Guiding Rate

The Pulse Guide Rate can be set between x0.1 to x0.9 of the nominal tracking rate at increments of 0.1 independently on each motor (RA or Dec). The rate sliders will determine how quickly the mount can move to correct a guiding error.

Setting the rate “high” will cause the he mount will move much quicker in response to guiding pulses. This may seem desirable however if the error is small the guider will have to issue correspondingly short pulses. If the resulting pulse width is less than the 50ms minimum imposed by EQASCOM there could be an over correction.

Set the Rate to low and corrections will take longer so there is more chance that the guider will always be chasing the error rather than correcting it.

Autoguider Calibration

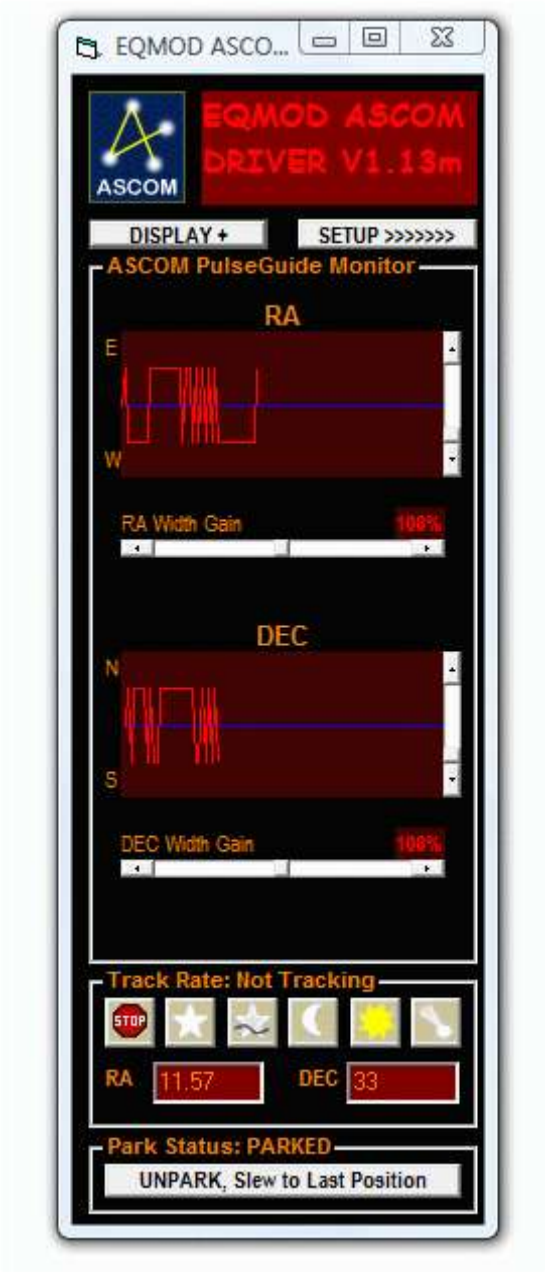
Many autoguider applications include self calibration routines during which a guiding pulse is initiated and the apparent movement of the guide star monitored to determine guide camera orientation and resolution. These calibration routines will typically require a minimum movement to be achieved and will fail if this is not achieved in a given time. This can lead to a potential problem as the optimum settings for guiding my not deliver “fast” calibration.

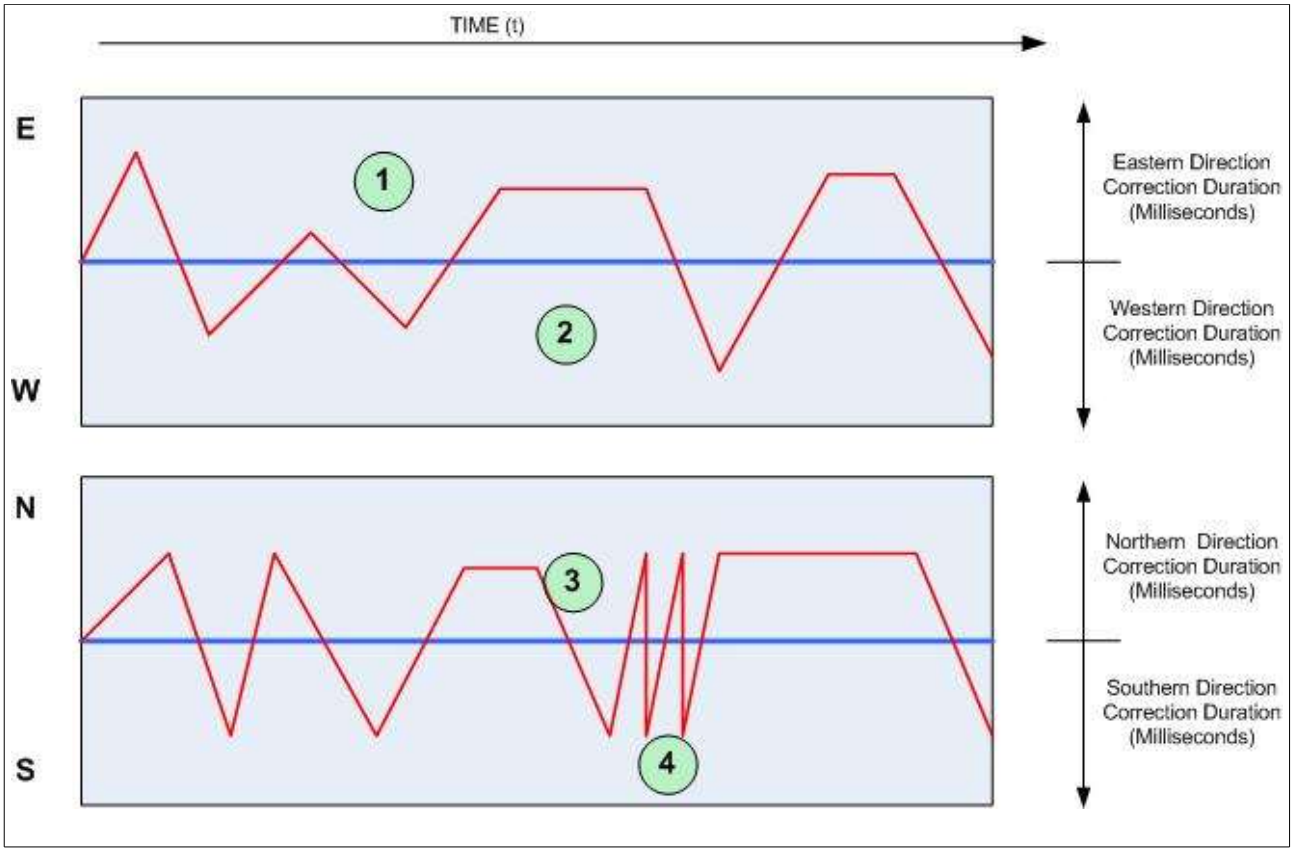
If you do experience “guide star didn't move enough” type errors during autoguider calibration the check your autoguider setup and see if it is possible to either extend the calibration time/ calibration pulse. You could also change the RA/DEC Rate sliders in EQASCOM to a higher value to force quicker movement but please remember that **the rate settings resulting in fast calibration may not be the best for active guiding**.

The PulseGuide Monitor

EQASCOM includes a PulseGuide Monitor tool to help you visualise the effectiveness of your guiding and to allow you to dynamically adjust the strength of guiding being applied if you think it is either under or over correcting.

The PulseGuide Monitor is accessed by pressing the EQASCOM “DISPLAY+” button until it appears.





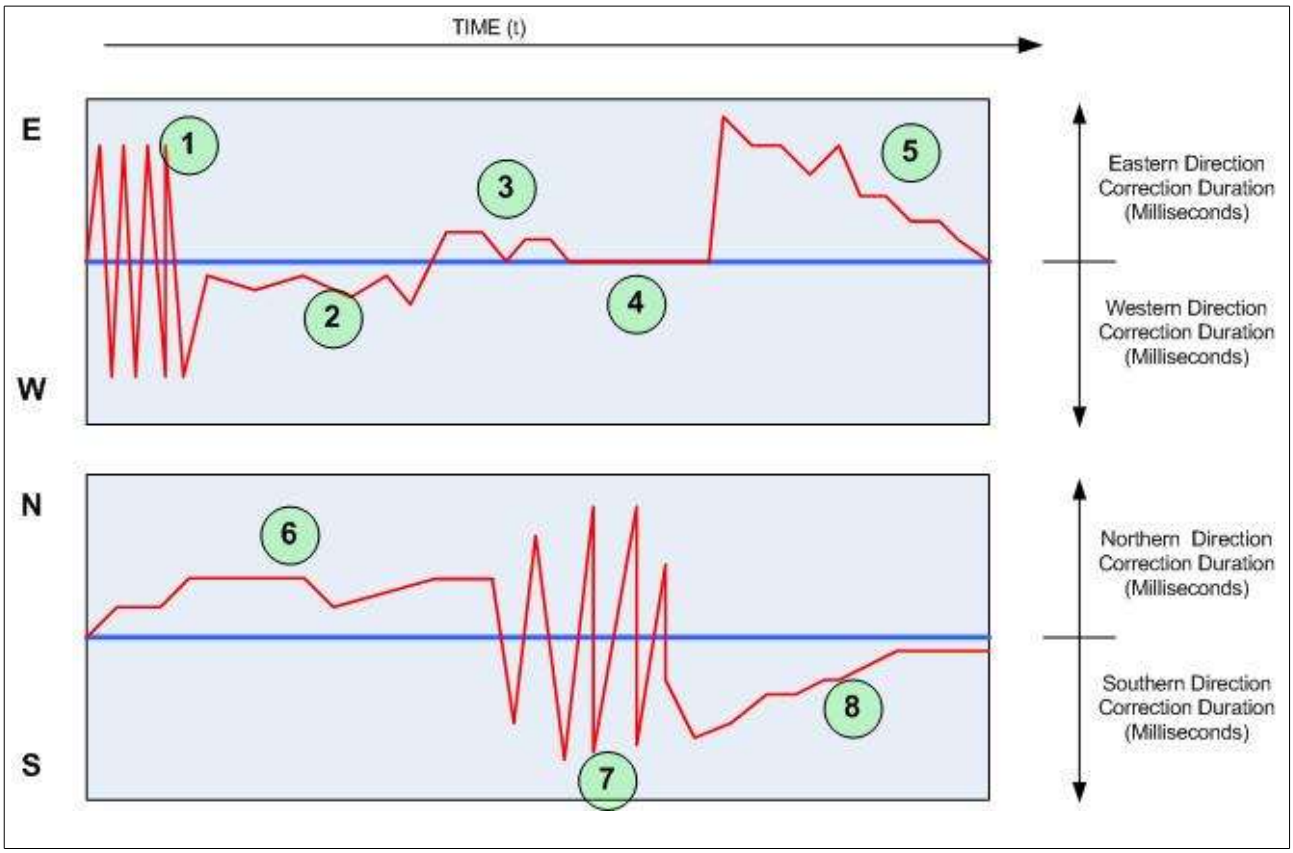
The upper graph shows the PulseGuide commands issued to EQASCOM on the East and West side (RA Corrections). All East-wise correction (1) corrections are plotted above the centre line, West-wise corrections (2) are plotted below the centre line.

The lower graph shows PulseGuide corrections for North and South side. (DEC Corrections). North-wise corrections (3) are plotted above the centre line, South-wise corrections (4) are plotted below the centre line.

The distance from graph centre to the plotted curves is proportional to the duration data in milliseconds of each correction. This means a higher plot peak value equates a correction with a longer duration. Good guiding performance would therefore show plots concentrated close to the centre lines.

The vertical slider bars at the right side of the graphs allow the users to adjust the plot's peak to peak display.

Interpreting the PulseGuide Monitor Graphs



1. PulseGuide Oscillations on the RA side. It basically means that there are correction overshoots. To fix this, user has to lower the RA Width Gain settings.

2. Purely west side corrections. This means that there is a small amount of RA drift towards the east - may need to RA drift compensate.

3. Purely East side corrections. This also means an RA drift towards the west. - May need to RA drift compensate.

4. ZERO Duration corrections - MAXIMDL usually issues this kind of commands. It simply means a correction abort which is perfectly normal.

5. Eastward drift correction. - In cases like this, multiple corrections are issued only on one direction with duration value getting smaller at each correction instance. It means the duration value issued by the autoguiding software is very small. User may have to compensate by increasing RA Width Gain settings.

6. Northside corrections - Successive corrections on the North side would mean a DEC drift towards the south.

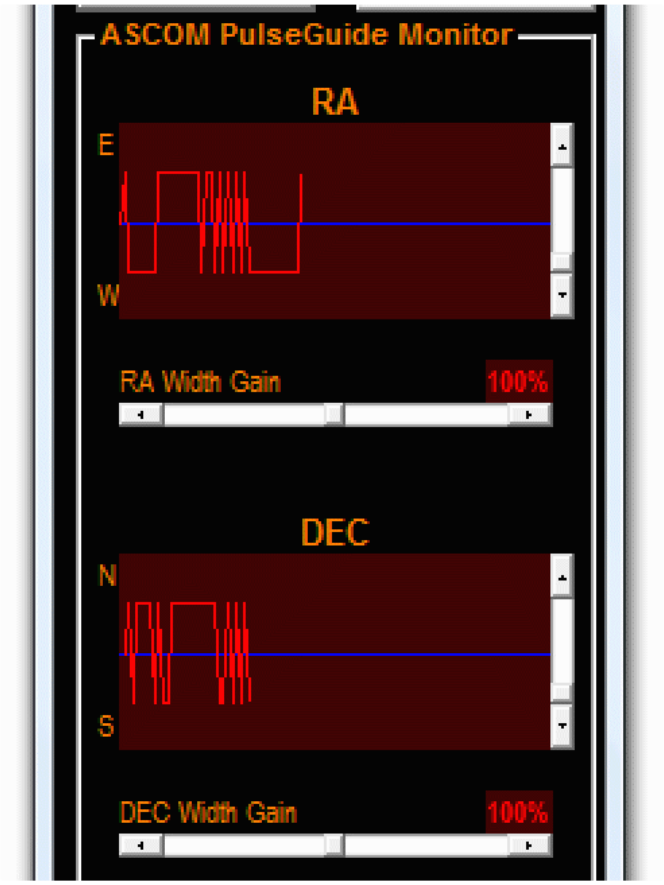
7. Pulseguide Oscillations on the DEC side - Definitely a must to lower the DEC gain settings.

8. Southward Drift Correction - Just like in #(5), user may need to increase the DEC width gain settings

as the autoguiding application is issuing very small corrections.

Of the above 2,3,and 6 (single side corrections) should be OK as long as the fluctuations are very small. Some users even induce drift to boost the performance of the autoguiding setup.

Adjusting the PulseGuide Gain Slider bars



The horizontal slider bars labelled "RA Width Gain" and "DEC Width Gain" adjust the correction durations as issued by the autoguiding as a percentage of their original values. 100% here means the duration values are processed as is without any changes. A setting of 50% would mean only half of the requested correction duration is applied.

For example at 50% RA Width if EQASCOM receives a PulseGuide command at the East side with duration of 150 milliseconds, EQASCOM will execute an Eastwise correction with 75 milliseconds.

By using the sliders you can dynamically change the guiding response whilst guiding is active. This is useful when using guiding applications that do not permit the changing parameters once guiding has started.

Please note that autoguiding calibration should always be performed with the sliders at 100% gain settings. Adjustments on the gain values should be done only during the actual autoguiding process and NOT before any calibration process.

General Discussion Points

ST-4 v. ASCOM Pulse Guiding

Some instinctively believe that ST-4 guiding must deliver more responsive control than ASCOM Pulse Guiding because it is a “direct” hardware override of the mount. The reality is that if you want to consider the responsiveness of a control system you need to look at all lags present in that system. Typically an autoguiding set-up will involve:

- The capture of a star image,
- processing of that image
- Centroid calculations made to determine star movement
- Application of a control algorithm to determine corrective action
- Correction of the mount.

The greatest time lags in this control loop are related to image capture and processing by the autoguiding software. The method of initiating a correction to the mount, be it ST-4 or Pulse guiding, is not a major factor.

Also just because a mount can take a direct ST-4 input doesn't mean that it will instantly respond to that input. The firmware in the mount controller may be fully occupied in supervising motor control and those inputs may have a relatively low priority.

Equally the implementation of ASCOM Pulse guiding is driver dependent and there may be differences in the methods of implementation between different vendors.

Some folks believe that because their guide camera has an ST-4 output this makes for more responsive guiding. However this would only be the case if the camera itself is performing the autoguiding algorithm. If the ST-4 port on the camera is simply controlled by the camera's driver and that the PC must first communicate with the camera to initiate ST-4 signals then there really is no advantage other than possibly tidier wiring.

In summary there is no reason why ST-4 guiding should offer any significant performance increase compared to ASCOM Pulse Guiding. However the implementation of both methods is highly vendor specific. For the Synta mounts using the EQASCOM driver and a PC based autoguiding program you are unlikely to notice any difference in the responsiveness of ST-4 and ASCOM Pulse Guiding.

Autoguiding + PEC

PEC is an open loop method of control and simply seeks to correct for repeatable mechanical error in the RA drive by “playing' a fixed correction signal. PEC is therefore predictive and seeks to correct error before it occurs. Autoguiding on the other hand is a closed loop control method that works by measuring an existing error and calculating an appropriate corrective action.

If your mount exhibits a periodic error signal that is repeatable both in period and amplitude then PEC alone could theoretically serve you very well. However in reality there are likely to be variations in the error signal perhaps due to manufacturing tolerances and the interaction of non harmonic components such that PEC alone is not sufficient for long exposure work. Also there may be non periodic errors that you wish to correct, for instance slight flextures between guide and imaging scopes. The only solution to correct for these is to adopt autoguiding. So if Autoguiding is to be adopted anyway you may well question whether there is any point in using PEC?

The “standard” answer to this is that as autoguiding can only correct errors that already exist your image is potentially “compromised” by the time an autoguiding correction is made. By using PEC you can hope to remove more of the total error before it happens.

Although this sounds a convincing argument in reality things are never that straight forward. It is usual practice for autoguiding measurements to be made at a higher resolution than that of imaging and as a result it could be that this “compromising of the image” never actually occurs as the guider errors occur at a sub pixel resolution to the imaging camera. Also in the real world there are likely to be other more significant errors present such as those caused by seeing fluctuations.

One area where using PEC+Autoguiding can give you an advantage is when using very faint guide stars that require exposures of over 1S to capture. Whilst the exposure is being made the autoguider is inactive so by using the predictive correction of PEC we can seek to keep the mount on track during this period. For many folks however this simply isn't an issue and it probably only is of benefit to those using off axis guiders where the choice of guide star is limited.

One effect you will notice if you run PEC in combination with autoguiding is that the number of autoguiding corrections required drops. Some folks assume that this must be “good” as the autoguider is having to “work less hard”. However, the mount is working just as hard to correct its tracking and the fact that the task is now split between PEC and Autoguiding doesn't in itself lead to better overall control.

So in summary using PEC in combination with Autoguiding does have some advantages in some specific circumstances.

- When using low resolution guiding compared to imaging
- When using faint guide stars
- Where the guiding only error exceeds the seeing conditions

It is wrong to give the impression the using PEC in combination with guiding delivers a guaranteed improvement to image quality.

Do PEC and AutoGuidng fight?

Running PEC and autoguiding simultaneously should, in theory, deliver the best of both worlds. The PEC keeps the mount on track. The only errors observed are non periodic ones which the autoguiding makes corrections for. Many folks are successfully using PEC and autoguiding.

So where does the widely held opinion that PEC and Autoguiding fight come from? The answer lies in how ST-4 and/or PulseGuiding has actually been implemented for your particular mount – here's why:

> Consider the case where PEC is doing its job and keeping the guide star centred. To do this PEC is overriding the mounts tracking rate. The Autoguiding software however is totally unaware of any rate corrections made by PEC it assumes that the mount is tracking perfectly by itself.
>
> Now consider what happens if a “non periodic” error occurs. The Autoguiding software see the error and when it deems it significant will calculate a pulse duration needed to correct it. Remember this correction is being made in response to an error observed with PEC already active and potentially already making a significant correction of its own. The Autoguiding software issues its correction by setting the appropriate ST-4 signal. This is where it all goes wrong. As soon as the mount sees the ST-4 override it moves at a fixed “preset guiding rate”. Any existing speed correction made by PEC is immediately lost and, because the autoguiding software has no knowledge of PEC, the ST-4 correction made will not be sufficient to hold the guide star on track. Effectively we have introduced a step change into the closed loop autoguiding system. In due course the autoguiding software should be able to recover the situation by making further corrections but now it is having to correct for periodic error as well. Eventually the guidestar is brought back on target at which point control passes back to PEC.

Some folks assume that all that is happening is that PEC is lost for a short period whilst autoguiding takes over and that having PEC operating 80% of the time must be better than not having it at all. What they fail to

take into account is the level of disturbance to the control system that occurs whenever ST-4 corrections are made. This can result in a greater error than would have occurred if simply using autoguiding alone.

Although ST-4 is used in the example above the same problem could also apply to ASCOM Pulse Guiding. The key is in the implementation. In order for Guiding and PEC to operate together the guiding rate corrections must be made as relative corrections to the PEC tracking rate rather than as absolute rate overrides.

If your mount/driver cannot provide relative corrections then PEC+Guiding is not a useful combination (those selling PEC applications may try to convince you otherwise, but then they would wouldn't they!).

For those using the EQMOD EASCOM driver the good news is that the Pulse Guiding implementation has been carefully designed to work alongside PEC. I would not however advise the use of PEC with ST-4 guiding for the Synta mounts.