GET STARTED WITH THE XERXES VARIABLE TRACKING RATE ASCOM UTILITY

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WARRANTY AND DISCLAIMER AND TERMS

PURPOSE OF THIS SOFTWARE

The purpose of this software is to allow users of high quality telescope mounts to utilize their variable tracking rate capability when a telescope model is created from a third party tool (not this tool). This software is intended to operate IN PARALLEL with other telescope control software such as sequencers (e.g. NINA, MaximDL) and planetarium programs (e.g. Stellarium, PRISM, TheSkyX), and guiding programs (e.g. PHD). This is accomplished because the telescope connection occurs via a hub or, preferably, ASCOM Remote. Once this program is configured, the mount continues to operate transparently to other users. It acts ONLY as an ASCOM Client "device", it cannot act as an ASCOM server (meaning it never intercepts and modifies commands to the mount, it only adds commands to the mount).

PREREQUISITES

You need an equatorial telescope mount that can do the following:

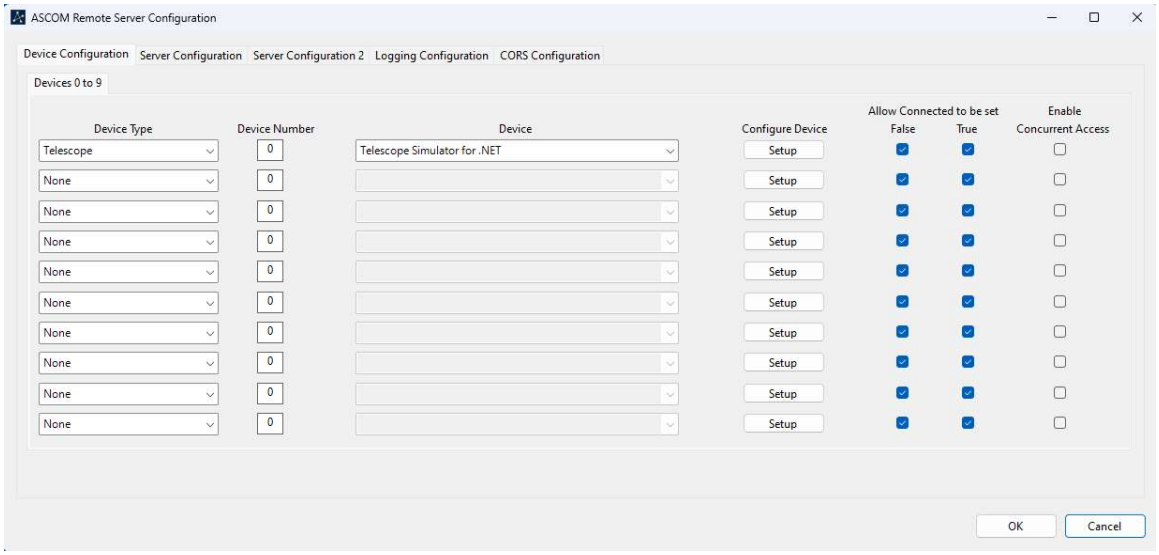
- track accurately in both RA and declination
- ASCOM driver that implements vaiable rate tracking
- At least one Windows computer somewhere, which can host ASCOM Remote

- Know your location and time. You do not need extreme precision on location and time for this application since time and longitude errors are only offsets.

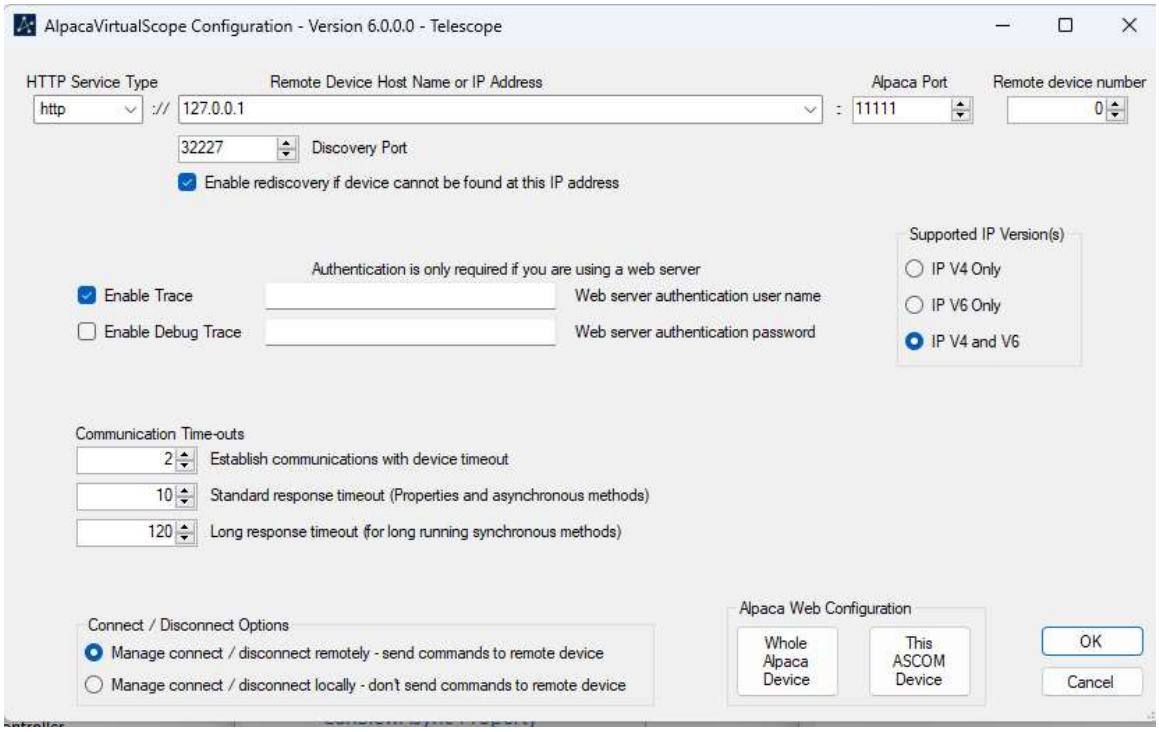
STEP 1 - START AND CONFIGURE ACOM REMOTE

Download & install ASCOM remote from GitHub. ASCOM remote lets multiple computers (including non-Windows devices) connect and control multiple astronomical instruments such as focusers and telescope mounts. ASCOM remote also acts like an instrument hub.

Go to the "device configuration" tab and select "telescope" for device type, and make it 0.

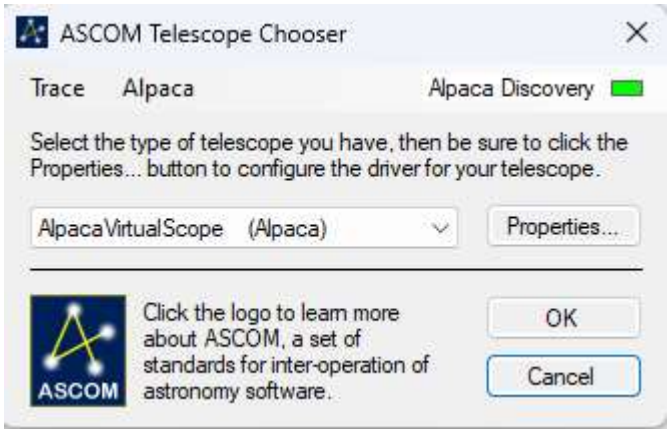


The pull down menu for "Device" will list all the existing ASCOM drivers you have on your machine. The first time you use ASCOM remote, you want to make an Alpaca Virtual telescope, which shold have a configuration properties that looks like this:



Once you have the virtual scope created, you can communicate with it either using conventional ASCOM (COM) methods or using http client messaging (for example from Python).

You can then select the virtualized telescope via the Windows ASCOM chooser function in any Windows program as shown below

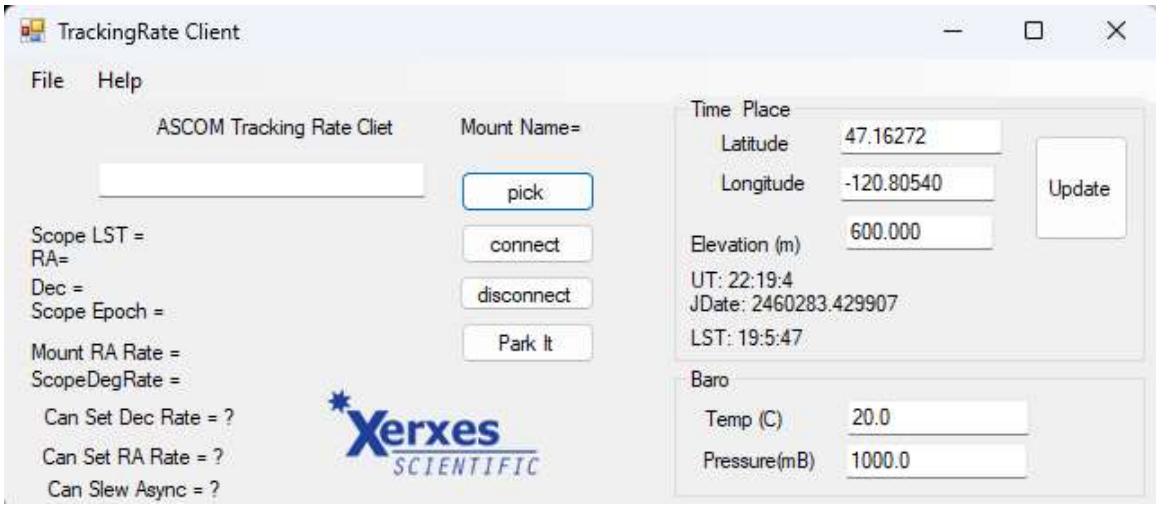


STEP 2 - start the telescope mount and then connect to it from ASCOM Remote via the radio button "Setup" under "Configure Device". Alternately you can make the connection to an

ASCOM hub program.

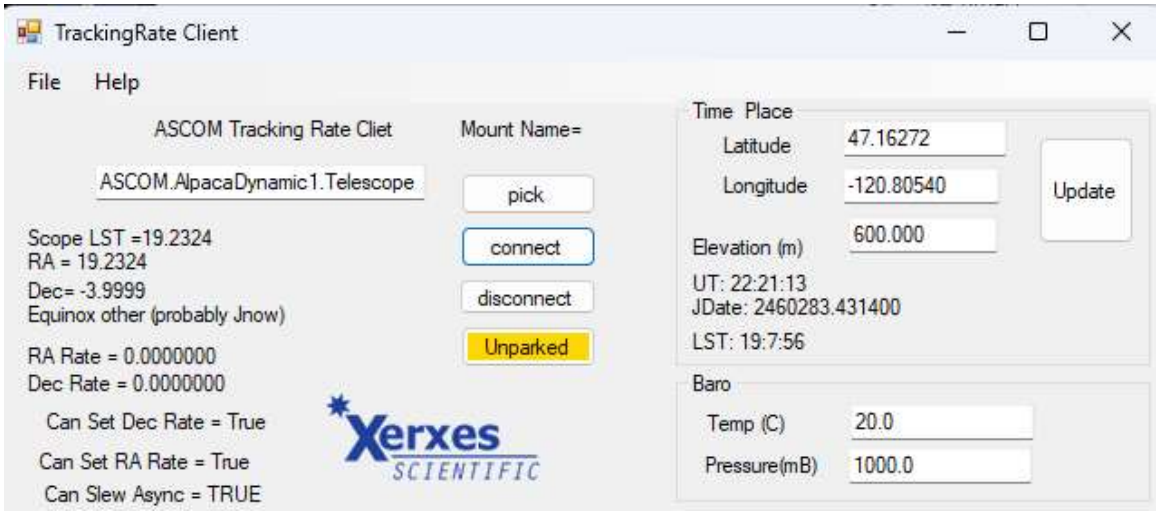
STEP 3 - Start the Xerxes Scientific ASCOM tracking rate client utility program on the SAME computer that is running ASCOM remote. It will show two forms, the main control form and the pointing form.

STEP 4 - Update the latitude and longitude for your location and click the "Update" location in the main control form. NEGATIVE LONGITUDE IS WEST OF THE PRIME MERIDIAN. The location below is near Seattle in the USA so it is -120 degrees longitude.



STEP 5 - connect to the telescope via ASCOM remote: click the "pick" button, which pops up the ASCOM chooser popup form. Select "Alpaca Virtual Scope" and OK te form.

STEP 6 - click "connect" and now you will see the scope properties populated



Look for the following properties:

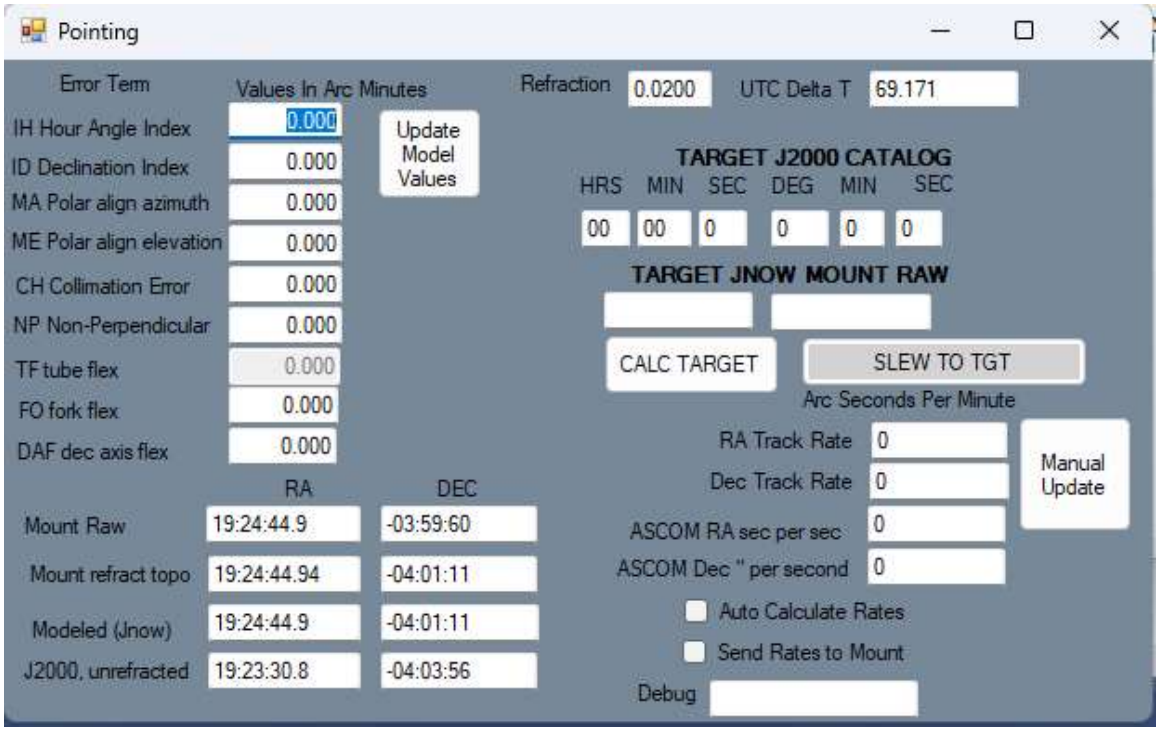
- Scope LST is telescope mount Local Sidereal Time. It's based on the latitude and

longitude and local time you entered into the mount controller. It should be close to the LST reported by this program

- RA and Dec and the decimal valued right ascension and declination from the mount.
- Equinox (or Epoch) is the time equinox of the coordinate system reported by the mount. For this software, we want Jnow, which in ASCOM is "other". We do not want J2000.
- CanSetRARate and CanSetDecRate should both be true. This means that the mount can receive variable tracking rate inputs. For RA, the variable rate is ADDED to sidereal rate. The mount itself should be tracking in sidereal rate and not in solar or King or some other rate.
- CanSlewAsync means that the mount can accept slews from this program. Asynchronous slews are the preferred ASCOM type meaning the ASCOM call will not stall waiting for the slew to complete.

When you are connected, you will see real values for the scope parameters. LST should update about once per second. The program polls the mount (polls the ASCOM driver) for various parameters between more than once per second down to once every five seconds or so.

Step 7 - Update pointing form:



The pointing form shows the "Tpoint" like pointing model terms as values in ARC MINUTES (which is the default for PRISM). TheSkyX reports these in arc seconds so you will hve to

convert.

Along the lower left you will see the following position boxes:

- Mount Raw is the RA and dec reported from the mount, assumed to be with no refraction, Jnow, and with no modeling corrections (it should be a one star sync).

- Mount Refract topo is the position with the effect of refraction removed (position LOWER than the mount apparent position, due to refraction). The refraction is zero when pointed at zenith and increases as you go to the horizon.

- Modeled (Jnow) is the position with refraction removed and the error terms removed.

- J2000, unrefracted is the modeled position with the epoch changed from Jnow to J2000. This is essentially the catalog position of the star. The epoch conversion uses the ASCOM.Astrometry library which is the same as the USNO NOVAS31 library to do this conversion.

Along the right side of the form you see the following text boxes and controls:

- Refraction is the current refraction correction based on the sky position of the mount and the barometric data (pressure and temp).

- TARGET J2000 catalog is where you can enter a catalog star target position in sexagesimal RA and Dec

- CALC TARGET takes the J2000 value you entered, applies the mount model, refraction, and epoch conversion, and converts this to a Jnow coordinate AND pre-loads it into the mount as the ASCOM target value

- SLEW TO TGT sends the ASCOM asynchronous slew command to the mount. The mount will then slew to the specified target if it can or is safe to. The button turns yellow while slewing is in progress.

- RA and DEC Track Rate are the calculated tracking rate offsets in arc seconds per minute. If you selected the checkbox "auto calculate rates" then these are re-calclated once per second.

- ASCOM RA sec per sec and ASCOM Dec " per second are RA seconds per second and arc second per second floating point rates to be sent to the mount per the ASCOM spec. A value of 1 ASCOM RA sec per second changes the RA tracking rate from 15.04 arc seconds per solar second to 16.04 arc seconds per solar second, so these are normally tiny values whch is why the arc second per minute value is more useful. 1 arc second per minute means that after one minute, the mont will have tracked to a location one arc second different from ideal.

- Auto Calculate Rates checkbox tells the program to use the current mount reported position and automatically calculate the corcrected tracking rates but does not send

them to the mount.

- Send Rates to Mount checkbox sends the updated rate to the mount every three seconds.

- Manual Update allows you to manually enter values in the RA Track Rats and Dec Track Rates window and then these will be sent to the mount of Send Rates to mount is checked.

STEP 8 - closing and disconnecting

It is highly recommended to disconnect prior to closing the program. Click the "disconnect" button on the main form to disconnect from ASCOM remote.

STORING VALUES IN THE CONFIG FILE

Xerxes mount control software uses a plain text XML file to store telescope mount configuration entries such as sync points, home position, mount tuning parameters, latitude, longitude, and communications parameters. A subset of these parameters are used here to store the latitude, longitude, altitude, and mount pointing model terms. The file should be in a directory called Xerxes immediately under the C root (C:\Xerxes\default.xml for the default startup file)

The only terms used by this program are:

<obslat> observatory latitude

<obslong> observatory longitude in degrees

<obsalt>observatory elevation in meters

<ihpoint> hour angle index offset in arc minutes

<idpoint> declination index offset in arc minutes

<nppoint>non-perpendiculatiry term RA axis to dec axis mechanical in arc minutes

<chpoint>collimation non-perpendicularity dec to optical axis term in arc minutes

<mepoint> polar alignment elevation error term in arc minutes

<mapoint>polar alignment azimuth error term in arc minutes

<tfpoint> tube flex error term " " " (currently disabled)

<fopoint>fork flexure point error term

<daf> dynamc axis flop term

In encoder mounts, the harmonic "swash" terms can be significant and may be added in a future release. These are caused by runout between the encoder read head and the true mechanical axis of the mount.

With a good polar alignment (< 5 arc minutes error> you should be able to get good tracking results with exposures of 30 seconds to five minutes, using a mount with quality encoders. Tracking errors always increase as you go closer to the celestial pole.

SAMPLE XML FILE

```
<?xml version="1.0" encoding="utf-8"?>
<XerxesDoc>
  <mountname>"My Mount"</mountname>
  <obslat>46.20200</obslat>
  <obslong>-120.5</obslong>
  <obsalt>600.00000</obsalt>
  <focallen>3.9</focallen>
  <aperture>0.4</aperture>
  <raslewvpgain>150</raslewvpgain>
  <raslewvigain>10</raslewvigain>
  <raslewppgain>2500</raslewppgain>
  <raguidevpgain>400</raguidevpgain>
  <raguidevigain>60</raguidevigain>
  <raguideppgain>4000</raguideppgain>
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  <decslewvigain>30</decslewvigain>
  <decguidevpgain>400</decguidevpgain>
  <decguidevigain>30</decguidevigain>
  <decslewppgain>1500</decslewppgain>
  <decguideppgain>1500</decguideppgain>
  <home1dec>-172</home1dec>
  <home1ha>244</home1ha>
```

```
  <decsafelimit>0</decsafelimit>
  <hazeroencoder>0</hazeroencoder>
  <deczeroencoder>0</deczeroencoder>
  <ihpoint>0.00</ihpoint>
  <idpoint>0.00</idpoint>
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  <chpoint>1.16</chpoint>
  <mepoint>-0.68</mepoint>
  <mapoint>0.76</mapoint>
  <tfpoint>0.0</tfpoint>
  <fopoint>0.0</fopoint>
  <dafpoint>0.0</dafpoint>
  <home1dec>-172</home1dec>
  <home1ha>244</home1ha>
  <rasync>0.5550</rasync>
  <decsync>-1.8045</decsync>
  <remoteipaddr>172.20.10.5</remoteipaddr>
  <remoteport>15001</remoteport>
  <localipaddr>172.20.10.2</localipaddr>
  <localport>15001</localport>
</XerxesDoc>
```