PstRotator ~ Antenna Rotator Software Application for Radio Astronomy
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1. Introduction

This article describes the PstRotator application software {PstR}. PstRotator is a Windows program used to control antenna rotators (also called rotors) in azimuth and elevation or just azimuth (figure 1). PstRotatorAz is an almost identical program for users with an azimuth-only rotator; it has a slightly more compact user interface. PstR costs about US$20 and has built-in celestial tracking features and interfaces of interest to radio astronomers.

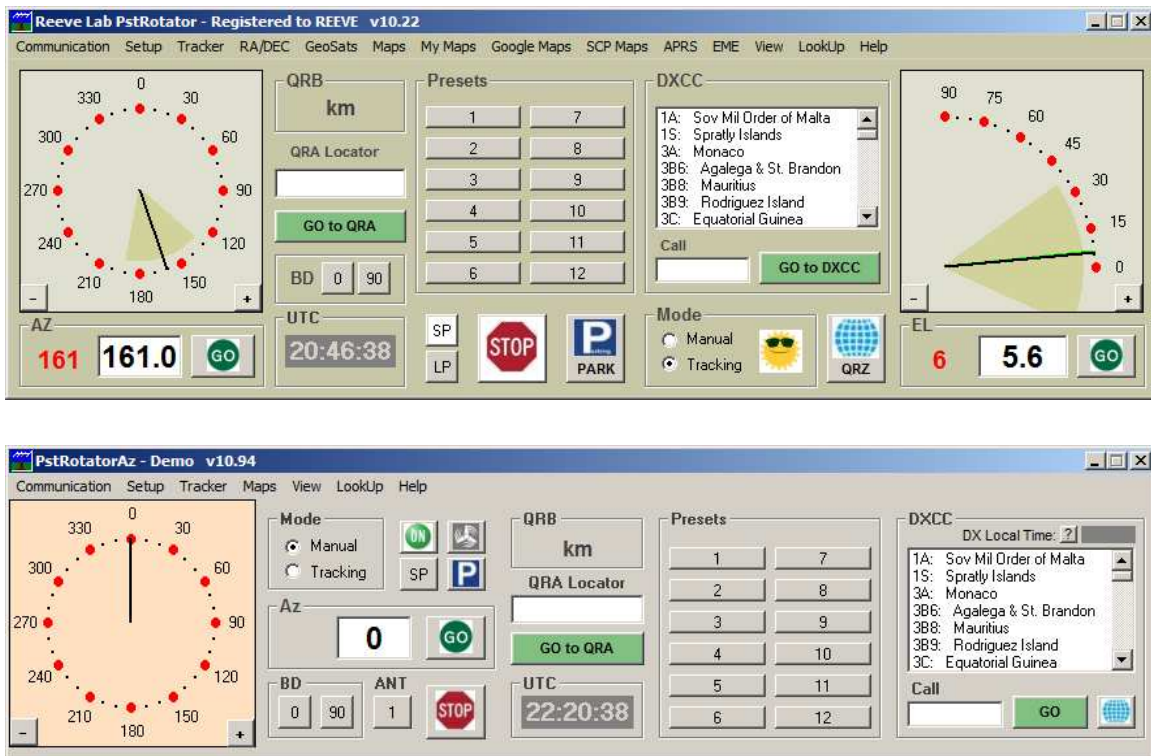Note: Links in braces { } and references in brackets [ ] are located in **section 9**.

Figure 1 ~ PstRotator (upper) and PstRotatorAz (lower) main user interfaces. Most functions and features are designed for amateur radio but both programs have functions specifically incorporated for radio astronomy. A compact window can be selected (shown later). The main differences between PstRotator and PstRotatorAZ are 2-axis (azimuth and elevation) versus 1-axis (azimuth only) control and relay control functions (see text).

2. Antenna rotator control

The basic components used to mechanically point an antenna are a motor for each axis, a position sensor for each axis, mounting arrangements and a controller (figure 2). One motor is required for an azimuth-only rotator and two for azimuth and elevation. For a given model, the controller usually is matched to the rotator. The controller provides power to the rotators and has a position indicator and momentary switches or buttons to

control the azimuth motor (horizontal rotation) and elevation motor (vertical rotation). Most rotators have limit switches or a mechanical stop to prevent over-rotation. The motors may be ac or dc depending on the model.
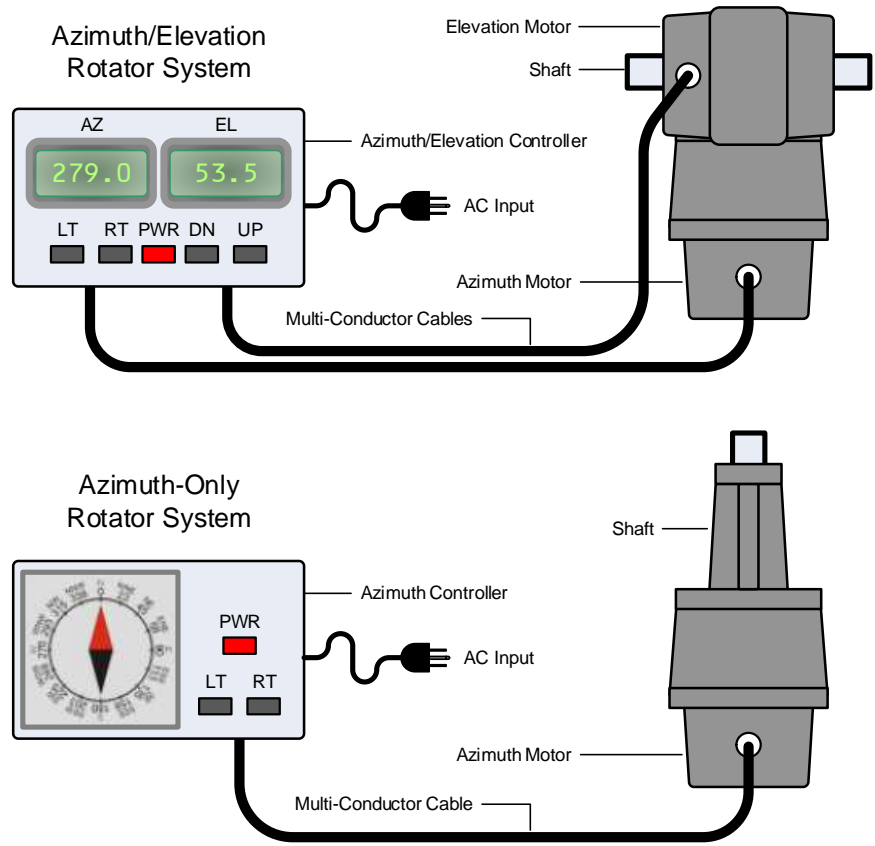

Figure 2 ~ Manually controlled rotator system block diagrams. Some models use ac and others use dc motors. The multi-conductor cables between the controller and rotator motor usually have 4 to 6 conductors, some for position indication and others to power the motor. (Images © 2015 W. Reeve)

To control inexpensive rotator systems with a PC, it is usually necessary to modify the rotator controller to include a communications interface such as serial (EIA-232), USB or Ethernet (figure 3). In most cases, the modified controller retains its original manual control features. Some vendors have a separate (external) EIA-232 interface accessory for this purpose. In my case, I modified stock controllers with a 3rd party interface as described later. More expensive rotator systems usually have a built-in communication interface and no modifications are required. After the PstRotator software is installed on the PC, it sends movement commands through the controller communications interface to operate relays that simulate switch or button operation.
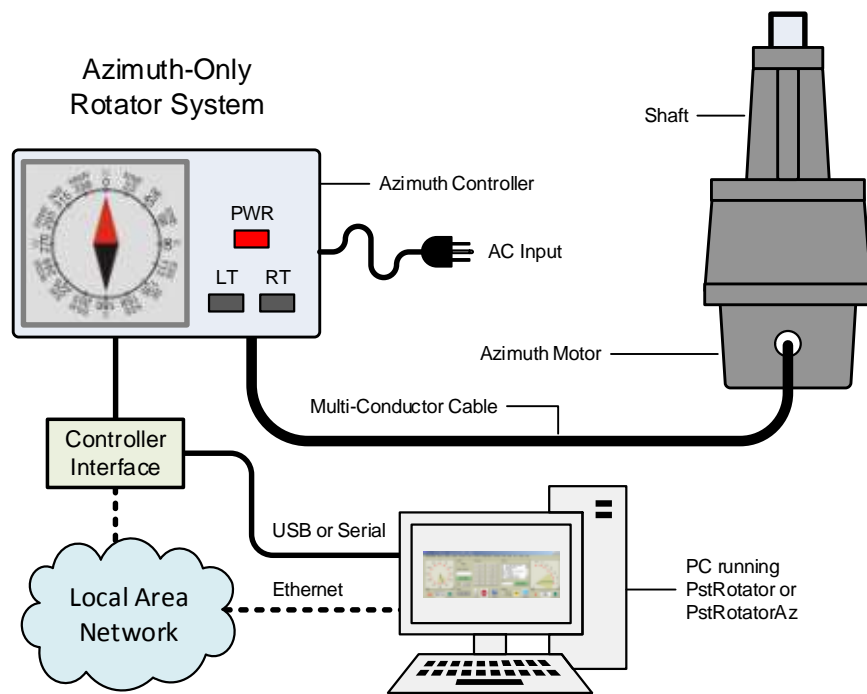
Figure 3 ~ PC-controlled azimuth-only rotator system block diagram; a rotator system for azimuth and elevation is similar. The controller interface may be added as an internal modification to the controller or external as shown here. The controller interface is connected to the PC through serial, USB or Ethernet, depending on its capabilities. PstRotator is capable of remotely controlling a rotator over the internet or through a local area network. (Image © 2015 W. Reeve)

3. PstRotator evolution

When I first installed PstRotator, I was very surprised by several things – ease of setup, ease of use, reliability and accessibility of the software developer, Codrut Buda. Prior to using PstRotator I had tried several other rotator control programs and none of them worked well or had any measurable level of software support. With PstRotator I finally had software that worked and was well supported. It did not take me long to realize the high support level, so I decided to ask Codrut for some celestial tracking features including Sun tracking for solar radio. I was surprised when these features were added within a couple weeks of my request.

Although PstRotator originally was designed for amateur radio applications, it clearly has evolved to support radio astronomy. It now includes built-in tracking for Sun, Moon and all planets as well as pointing to any celestial coordinates by specifying right ascension and declination. In addition, Codrut interfaced PstRtoator to Jim Sky's Radio-Eyes {RE} program so that any celestial object can be tracked. PstRotator can be setup to work with Radio-Eyes in two different modes, one simple and one using the more complex Radio-Eyes Telescope Control Point Program (TCPP). I have extensively tested the simple mode, but discussion of the Radio-Eyes interworking will have to wait until I have time for further investigation of the TCPP.

Over time, at user request, Codrut added control over LAN and internet (using TCP/IP), satellite tracking and interworking with just about every radio amateur logging program and rotator under the Sun. Also added to PstRotatorAz is local or remote control of several types of relay modules figure 4). The relay control feature is

not yet implemented in PstRotator as of this writing (January 2015). I simultaneously run several different installations (instances) of PstRotator. Some operate a Yaesu {Yaesu} rotator through an EIA-232 interface using a USB-Serial adapter and some through my local area network (LAN) using an Ethernet-serial port server. PstRotator co-exists with itself and all other programs that I have ever tried running at the same time.

Figure 4 ~ PstRotatorAz can be used to remotely or locally control relays used for power control or other station control functions. The relay units shown here are KMTronic units compared to an HP calculator. The KMTronic units have 8 relays, each with Form C contacts (Normally Open, Normally Closed and Common). PstRotataor does not yet have the relay control feature. (Image left © 2015 W. Reeve)

The PstRotator user interface has changed a little over the years as features were added. To reduce the clutter of unused features, Codrut added a compact view (figure 5). The user also can customize the "skins" and color schemes. From an operational standpoint, it is only necessary to setup PstRotator for the user's location, type of rotor controller interface (protocol) and communications method and then specify the type of tracking. The user must specify geographical coordinates so that Sun, Moon and planet tracking will work as expected.

Figure 5 ~ PstRotator user interface compact view. Only the azimuth and elevation are shown.

There are several ways to control a rotor from the PstRotator user interface. These include entering the desired azimuth and elevation into boxes on the main window or clicking on the displayed compass. For terrestrial radio communications, there are several mapping options available and the user only has to click on a map location and the rotor is commanded to point at the appropriate great circle path (both long and short paths are supported).

4. Software upgrades

Upgrades are free and the user may install as many instances of the program on as many PCs as desired without additional license fees. Support for PstRotator is through the PstRotator Yahoo group {Yahoo}, and Codrut regularly publishes a "To Do" list of feature requests from users. Some new features require a couple weeks but most often a couple days. When I started writing this article in early 2014, PstRotator was updated to allow automatic turning of the antenna into the wind or any other preset azimuth when the wind reaches a preset

speed threshold. This feature queries the Weather Underground website {WX} to determine wind speeds. If the user has a weather station that sends data to Weather Underground, then that can be selected or the user can select a nearby weather station. This is a useful feature for unattended operation to reduce the chance of wind damage to an antenna. Of course, internet access is required for the weather feature to work.

PstRotator is progressively developed – new features are released immediately. Sometimes this leads to almost daily updates. However, updates are as simple as clicking *Check for Updates* in the Help menu. This automatically updates all instances of PstRotator that have been setup using the *Multiple Instances* feature. Updates are manually initiated by the user and all previous settings are retained so there are no surprises. If there are bugs in PstRotator, I am not aware of them after about six years of use. Occasionally, a new feature has a minor problem but these usually are fixed within 24 hours of a trouble report.

5. Rotor controller interfaces

Most of my rotatable antennas use an azimuth-only rotator. I modified the factory controllers with the Easy Rotor Control (ERC) controller interface designed and sold by Rene Schmidt {ERC}. The ERC was another nice revelation in reliability and product support. The ERC is a small printed circuit board (PCB) with a microcontroller and several relays (figure 6) that can be installed in many of the Yaesu controllers. Because the Yaesu controller power supply is isolated from the metal chassis and ground and the ERC is not, I also installed a small 12 Vdc power supply and transformer for the ERC, making a simple self-contained installation.
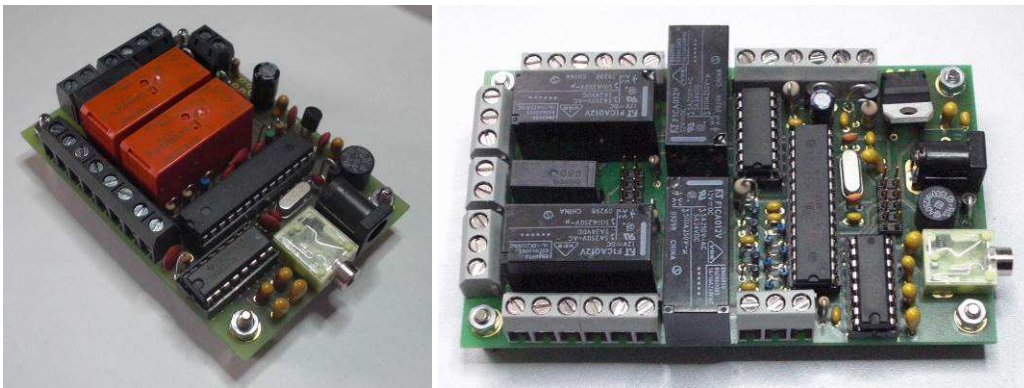

Figure 6 ~ Easy Rotor Control printed circuit boards. The model ERC (left) and ERC-3D (right) are installed in Yaesu controllers at my observatory. Since my installation, the vendor has upgraded the two models to ERC version 4 and ERC-M, respectively. The ERC board dimensions are approximately 79 x 54 x 20 mm. (Images © 2014 Ing.-Buero Alba de Schmidt, www.schmidt-alba.de, used with permission)

I have installed the ERC in Yaesu G450-A and G800-SA enclosures (figure 7). I also have a Yaesu G5500 controller used for azimuth and elevation. For this I used the ERC-3D, which is similar to the ERC but is external and has two control channels and an optional digital display. The ERC-3D is no longer available and has been replaced by the ERC-M, which provides azimuth-only, azimuth and elevation or dual-azimuth functions. I also use the SPID Alfa RAS rotator {SPID} but it has a built-in communications interface.
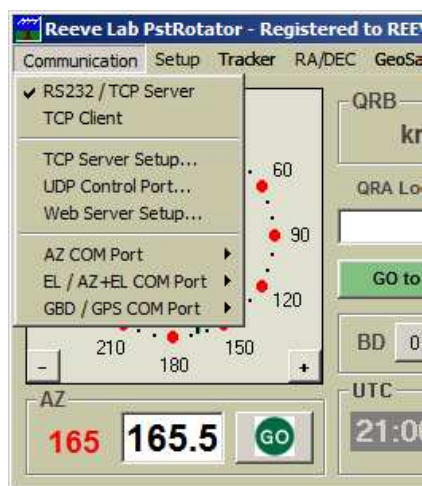
6. PstRotator Setup

When setting up PstRotator it is necessary to select the correct communications protocol. There are fewer rotor control protocols than rotor types – for example, a popular protocol is the Yaesu GS-232, and it is used by many non-Yaesu rotor controller interfaces. The PstRotator setup menu lists controllers by name so the user does not need to know the actual protocol, only the controller type.

Figure 7 ~ G450-A controllers (upper-right and lower-left) and G800-SA controller, all modified with internal ERC modules and in active service. Only the G800-SA is shown tracking the Sun. Also seen in this picture is the 5-port Ethernet switch that handles LAN traffic for the equipment. (Images © 2015 W. Reeve)

During setup it also is necessary to specify the communication method and associated port. For example, a PC serial port may be used and it is necessary to specify the associated COM port number. For TCP/IP it is necessary to specify the IP port number (or use the default port). The various settings are grouped under the Communications menu (figure 8).

Figure 8 ~ Communications setup dropdown menu reveals the various communication methods supported by PstRotator.

PstRotator can be setup in Server and Client modes to allow remote control over a LAN or the internet. For the client/server configuration, PstRotator is setup on one PC to run as the server (the PC to which the rotor controller is connected) and on another PC as a client. The client then controls the rotor through the remote server PC. Instead of a PC, the remote server can be a terminal server or Ethernet-serial port server such as the B&B Electronics VLinx ESP900-series Ethernet Serial Servers. This is the configuration I use in Anchorage to control an HF log periodic antenna rotor over a wireless LAN.

7. Celestial Object Tracking

My installations use only a fraction of PstRotator's capabilities. The ones I use are all related to celestial tracking, so the remainder of this review will describe only my applications. As mentioned earlier, PstRotator can track the Sun, Moon and all planets and it also works with Radio-Eyes. For its built-in tracking to work properly, PstRtotator needs an accurate time-of-day clock and the station's geographical coordinates. There are many

programs available to synchronize a PC's clock (for a description of some programs, see [Reeve]). Station latitude and longitude are easy to obtain using Google Earth or online calculators.

In my Anchorage observatory, I mainly use PstRotator to track the Sun. During mid-summer, the tracking spans true azimuths from about 34° to 325° and elevations up to 52° (figure 9). During mid-winter the Sun is tracked from as little as about 145° to 213° true azimuth with a maximum elevation of 6° around the winter solstice. PstRotator's built-in Sun tracking is enabled by selecting *Sun* on the Tracking menu and then selecting the Tracking Mode radio button on the main window. PstRotator can remember the tracking mode and will resume tracking if it is restarted.
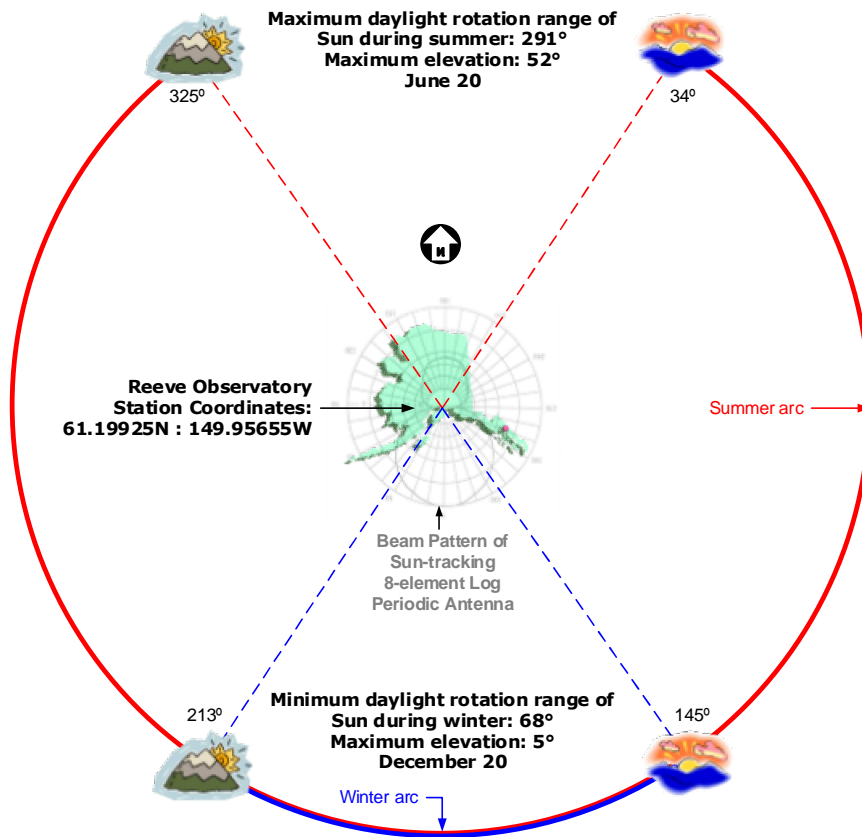

Figure 9 ~ Reeve station solar tracking geometry throughout the year showing the variability in azimuth and elevation at northern latitude. (Images © 2015 W. Reeve)

As the Sun moves across the sky, PstRotator commands the rotor to move accordingly. The Sun Tracking setup menu includes a setting to start tracking at a Sun elevation of −9° to +45° with respect to the horizon. For HF observations I usually start tracking −5° (before sunrise) and stop −5° (after sunset). This has helped me capture several solar HF radio bursts after sunset during summer (the Sun does not drop lower than about 5° below the northern horizon at Anchorage during mid-summer).

Most of the time I use PstRotator's Parking feature to park the antenna at 90° azimuth so that after sunset the antenna automatically rotates back around to the east, making it ready for the next sunrise.

The resolution of the rotor movement can be specified. I have both PstRotator and the associated ERC controller set to 1° resolution. The resolutions can be different but the lowest one determines the system resolution. With this setting PstRotator sends a rotate command every 1° when tracking the Sun resulting in antenna movement approximately every 4 minutes or so. PstRotator is capable of tracking to within 0.1° but this is of little use if the rotor and its controller do not support such fine resolution (the resolution of the Yaesu rotators is around 5°) or the antenna has a wide beamwidth. Earth-Moon-Earth (EME) communications and satellite tracking use very high directivity antennas and high resolution rotator systems, so very fine resolution is needed for those setups. However, I use log periodic antennas with 50~60° beamwidths in my solar radio installations, so even 1° resolution setting is technically farfetched.

Although I use PstRotator to automatically track the Sun every day, I often interrupt this schedule for Jupiter radio observations. However, I use a different strategy. Instead of tracking Jupiter, I use a fixed azimuth. Because of high RFI levels at my Anchorage observatory, I usually determine Jupiter's azimuth range for a predicted pass (enhanced Io-A, Io-B or Io-C) using Radio-Jupiter Pro3 prediction software and then manually rotate the antenna to an azimuth near the middle of the pass but offset as needed to minimize the RFI. In other words, I try to point a null in the antenna pattern toward the RFI source while keeping Jupiter in the main beam. Of course, there are many times when I cannot find a compromise azimuth that both reduces RFI and has Jupiter in the main beam but this strategy has improved my success, especially during summer when RFI levels are lower.

8. Conclusions

PstRotator and PstRotatorAz are application programs used to control almost any type of antenna rotator through a serial, USB or Ethernet interface. Unlike other rotator control programs, PstR and PstRAz are very reliable and have numerous useful functions directly related to radio astronomy.

9. References and web links

[Reeve]   Reeve, W., Maintain Your Time, *Radio Astronomy*, Society of Amateur Radio Astronomers, May-June 2012

{ERC}   Easy Rotor Controller: http://easy-rotor-control.com/
{PstR}   PstRotator and PstRotatorAz: http://www.qsl.net/yo3dmu/index_Page346.htm
(RE}   Radio-Eyes: http://www.radiosky.com/softwarehome.html
{SPID}   SPID Alfa rotator: http://www.spid.alpha.pl/english/01.php
{WX}   Weather Underground: http://www.wunderground.com/
{Yaesu}   Yaesu rotator: http://www.yaesu.com/?cmd=DisplayProducts&DivisionID=65&ProdCatID=104
{Yahoo}   PstRotator Yahoo group: http://groups.yahoo.com/neo/groups/PstRotator/info

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Document information

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