**Warranty**

All products sold by Portable Rotation Inc. are warranted against defects in material and workmanship for a period of one (1) year from the date of shipment within North America, and for a period of one (1) year from the date of shipment to outside of North America. If you believe this product you have purchased has a defect in material or workmanship or has failed during normal use within the warranty period, please contact Portable Rotation Inc. for assistance at the contact information listed below. If product repair or replacement is necessary, the Customer will be solely responsible for all shipping charges, freight, insurance and proper packaging to prevent breakage in transit, whether or not the product is covered by this warranty. All shipments of repaired or replaced products by Portable Rotation will be F.O.B. from Roseville, California, USA.

This warranty does not apply to defects resulting from any Customer actions, such as mishandling, improper interfacing, operation outside of design limits, misapplication, improper repair, or unauthorized modification; breaking the Warranty Seal voids all stated warranties. No other warranties are expressed or implied. Portable Rotation liability shall be limited to the actual purchase price of any defective unit to which a claim is made, and shall in no event include the Customer's manufacturing costs, lost profits, goodwill, and any other direct, indirect, special, incidental or consequential damages whether based on contract, tort or other legal theory. Portable Rotation is not responsible for any Damage to or caused by the installed Antenna in any use case.

**Contact Information**

Sales Inquiries: 1-800-366-9216  
http://www.sales@portablerotation.com

Support: 1-800-366-9216  
http://www.support@portablerotation.com

Shipping Address:

Portable Rotation, Inc.  
4010 Foothills Blvd. Ste 103, #118  
Roseville, CA  95747

Website: http://www.portablerotation.com
Introduction
Thank you for the purchase of the Portable Rotation 12 Volt Dual Axis Portable Rotator system, Model 12PRSAT.
This system is designed with a simple to use user interface allowing easy operation while still offering advanced features like ‘Auto Turn,’ ‘Any-Direction Calibration’ and Remote Computer Control. The 12PRSAT is a 12 Volt DC portable dual axis rotor system designed for portable satellite tracking operations. The system is designed to support a dual antenna (VHF / UHF) installation; one antenna on each arm for a total balanced load of 8 pounds.

Key Features and Specifications
- Nominal Az/El rotation speed of 1 RPM, or 6 degrees per-second
- 3 button user interface with backlight 2x8 character LCD and 2 Notification LEDs on the Hand-held Controller and Audio annunciation for Reset and Return to Home conditions.
- Full +/- 540 degree Azimuth rotation with 1 degree minimum movement
- 180 degree Elevation movement – Limited from 0 to 180 degree. 1 degree minimum movement / resolution
- Pulse-width modulation two speed motor control
- 3 Modes of operation:
  - Manual antenna movement
  - Automatic antenna movement
  - Remote computer controlled movement
- Integrated Magnetometer/Accelerometer ‘Sensor’ system provides Auto Antenna Calibration and return to Home Position accuracy
- User programmable Vanity Display message
- ‘Any-Direction Calibration’ offering easy antenna system deployment
- Antenna Rotation Jam detection with auto stop
- USB interface supporting the GS232A Az/El Rotator Control protocol.
- 12.0 Volt to 13.95 Volt DC Operation (13.0 Volts DC Nominal)
- 170 mA idle current, less than 500mA normal turning current at 12.5 Volts DC, both axis – Power Supply reserve capacity minimum of 1.5 Amp
- 25 Foot 4 conductor rotor cable – Minimum wire gauge size: 18 AWG – Max length supported: 100 Feet
- 12VDC 200 mA Accessory power out on Rotor Unit
- Optional GPS Receiver module
- Maximum Antenna load of 8 lbs
- Rotor Head weight with 18 inch arms: 7.5 lbs, Controller Weight: 8 Ounces

Limitations
The 12PRSAT Az/El Rotor unit is not designed for permanent outside installation. The system is designed to be used for portable operations with antennas like what is sold by companies like Arrow and Elk Antennas. Non-portable antennas like those offered by M2 can also be used as long as the maximum weight limitation is not reached. Exceeding the specified maximum antenna weight may damage the Rotor Unit and will void all expressed or implied warranties. Using
oversized antennas will cause tracking failures. It is not designed to withstand long term harsh and extremely wet winter conditions or extreme hot conditions.

Don’t:
- Install antennas heavier than 8 pounds
- Operate with off-center loading; make sure the antenna is balanced at the rotor mounting points. Excessive off-center loads may cause Elevation tracking errors
- Leave Rotor in extreme wet environments for extended times or in high wind conditions
- Manually force the movement of the antenna system, you will damage the mechanical system

Included Items
The following items are included as part of the Portable Rotator system:

- 1 - 12PRSAT Portable Antenna Az/El Rotor Controller
- 1 - 12PRSAT Portable Antenna Az and El Rotor Mast Units
- 1 - Magnetometer/Accelerometer Sensor unit and mounting hardware
- ‘U’ Bolt hardware to attach Rotor Unit to antenna mast
- 2 – 18 Inch-long fiberglass cross-bars
- 1 - 25 Ft - 4 conductor shielded cable with screw-type connectors
- 4 – 6 Inch Hook and Loop (Velcro™ type) cable ties
- 1 - 6 Foot Pigtail Power cable (2.1mm x 5.5mm, Center Pin Positive) terminated with Anderson Power Pole connector
- 1 - 3 Foot USB Type-B Cable
- 1 - Small Magnetic Compass
- 1 - Extra Set of water seals (in small bag)
- 1 - User’s Manual

Before First Use
Inspect the contents of the box and verify that the contents of the box match the above list.

Rotor System Power
You will need to attach a 12 Volt DC power source to the ends of the provided cable. The cable ships with a 15 Amp Anderson Power Pole connector already installed. If you are going to make your own power cable the Positive lead on the provided power cable has the White Stripe.

Note: The controller electronics will work at a voltage as low as 9 Volts DC, but that is not enough voltage to operate
the Rotor’s DC motors. The controller senses the power supply voltage and will not operate below 11.5 VDC or over 14.0 VDC.
The Rotor System power connections are reverse polarity protected and include a thermal resetting fuse. The 12 Volt DC accessory port is not reverse-polarity protected but includes a 240 mA thermal resetting fuse.

**Rotor System Assembly**
The Rotor System is shipped disassembled to keep the shipping size as small as possible. Note: See Quick Start Guide at the end of this document.
Assembly is straight forward:
- Place the Elevation Unit on a table or other surface with the mounting plate and set screws facing up (unit upside down).
- Place the Elevation unit on top of the Elevation unit aligning the set screws with the notches in the drive shaft.
- Make sure water seal is seated properly.
- Pressing down with light pressure tighten the set screws
- Attach the 18 inch arms in a similar manner with slight pressure on the arms towards the Rotor Housing. A light application of White Lithium Grease can be applied prior to the arm installation.  
- The Position Sensor (magnetometer/accelerometer) can be mounted on either arm though the notches on the sensor mounting plate is made to allow a tight fit on the Left hand Side when viewed from the back. See Appendix A for more details on Sensor installation and calibration.  It is mounted facing forward, opposite direction to where the 6-Pin cable exits the enclosure.  
- DO NOT over tighten the set screws.

**Installation**

Installing the Rotor system for portable use is not difficult.

---

<table>
<thead>
<tr>
<th>Before starting the installation VERIFY that the site is in a safe location to erect an antenna system of the size you are using. <strong>Make sure there are NO overhead power wires nearby.</strong> Also make sure there are NO buildings, structures, or trees that the turning antenna could strike causing potential damage.</th>
</tr>
</thead>
</table>

Eye protection should be worn when installing the antennas. Large antennas with crossing elements can be an eye danger especially when installing them at eye level.

Even though this is a low power 12 Volt DC device, the high gear ratio of the mechanism could cause damage if rotating your antenna into fixed objects.
Use the provided hook-and-loop fastener to attach the feed line Coax and Rotor Cable to your tripod or mast in a few locations to keep the cables from dragging on the ground or moving in the wind. It is recommended to attach the cables to the mast in the opposite general direction of the satellite to be tracked, reducing the amount of cable wrap for your feed line. Remember to include a service loop in the Coax to allow for the rotation and to account for the weight of the feed system when balancing the antenna.
If using a heavy and stiff feedline such as LMR400 or similar, use a small section of a flexible and light feedline like LMR200 Ultra Flex for the antenna to mast portion of the cable run.
There are multiple connections on the Azimuth or lower rotor unit. Each connector has a different pin count, so it is impossible to make the wrong connection. Connect the Elevation unit (Top Rotor) to the Azimuth unit (Bottom Rotor) with the 6 conductor cable. Once the antenna(s)/tripod/mast are erected, connect both the 5 Conductor Sensor Unit and the 4 conductor rotor cable to the Rotor Controller and connect 12 Volts DC to the Hand Controller using the provided power cable. If using the optional GPS unit, connect it before turning on the system. Once the controller is turned on, the following start up messages are displayed with the final display showing the user configurable 8 character top line and the last known antenna heading; A single beep is provided at system start up:

New Deployment Configuration
After erecting your portable antenna system (including Tripod, Rotor Head, Antennas, Feed Line and Rotor Cable) you will need to calibrate the antenna Azimuth and Elevation, and make any changes to the 8 characters of user programmable message. Using the Antenna Auto Calibration feature of the controller, you can erect the antenna system and not worry about the antenna heading at that time. This saves time and the effort of trying to align the antenna to its proper azimuth and elevation by adjusting U-Bolts and clamps. Using a compass, smart phone application or other navigation device, make note of the current heading of the antenna. Again, you do not need to have the physical antenna heading set to North when first erecting the antenna system; you will set the initial heading of the antenna into the controller during the power on initialization process or use the Heading Sensor feature. Make sure to position your feed lines such that you minimize antenna mast wrapping.

Set the Initial Heading and Azimuth
A compass points to Magnetic North. Due to the varying magnetic fields of the Earth, ‘Magnetic’ North and ‘True’ North are not always the same. When tracking satellites, True North is used. You will need to adjust your Heading entry based on both the Magnetic North reading and the Declination for your area. There is a lot of information on the web that can be referenced to further understand Magnetic Declination:

Next go to the controller and turn the system ON, when the Initial “Portable Rotation” messages are displayed press and hold the MODE button [Middle Button]. Continue holding the button until the “Select / Az Bt El” message is displayed. Release the button.

Select Az Bt El
Selecting Bt for both you will now enter both initial headings.

PTNL RTN
A123E045
Initial Az and El values now set to Azimuth=123 degrees and Elevation of 45 degrees
You can now choose to set the Initial Azimuth, Elevation or both. Press the CCW button to select Azimuth, MODE button to set both or the CW Button to set the initial Elevation value.

```
Enter Az
Az:000
```

Using the 3 buttons
Enter the initial Azimuth heading

```
PTBL RTN
A123E000
```

Notice the 100’s place value has an underline cursor to identify the active location to change. Use the CCW [Counts Up] and CW [Counts Down] buttons to count up or down to set this value. You are allowed the value 0 through 3 in this location for Azimuth and 0 or 1 for Elevation. When the first value is set, press the Mode button, the cursor moves to the next location; the 10’s place. Using the same procedure as before; select the value with the CCW and CW buttons and then press the Mode button when the correct number is displayed. The 1’s place value is now selected; select the value and press the Mode button. The current heading is now saved to memory and the new heading is displayed. If you make an error, just repeat the process by Power Cycling the controller.

The Antenna Auto Calibrate function can also be used to align the antenna system for operation. The Antenna direction must be within +/- 30 degrees of true north and up to +/- 10 degrees of level for this operation to function. See the section on Antenna Auto Calibrate below for details.

**Configuration Settings**

There are 3 Power-On Configuration Setting Areas:

- Antenna Configuration
- Sensor Configuration
  - Set Declination
  - Set Sensor Pitch Offset
- Baud Rate

To change any of the 3 Power-On Configuration values, press and hold the “CW” button and turn ON the controller. A menu choice will be displayed. Press the button that corresponds to the function for which you wish to make a change.

**Antenna Configuration**

The Rotor controller will stop the rotation on the degree position requested when turning in the Automatic Mode and the Remote Control Mode. If you notice turn inaccuracies you can adjust the system response by setting the Antenna calibration to 1 of 3 different timing modes. Small turning errors can occur due the nature of a small, low power system. Differences in the antenna systems mass and cabling load can cause motor stop and start times to vary. These errors are less than 1/10 of a degree, but over time, errors of a degree or more can be seen based on external environmental influences. When using the External Sensor these errors are automatically corrected for after each return to home operation.

To set the Controller to one of the 2 optional timing modes, do the following; turn ON the controller and when the “Portable Rotation” message is displayed, hold down the CW button [right
button]. Continue holding the button until the “Config / AC MD BR” message is displayed then release the buttons. When using the Sensor Unit option, it is recommended to use the Default setting.

Then press the CCW button to select the Antenna Calibration option. The 3 choices displayed are:

- "DF" – Default and overall best fit
- "01" – Slightly smaller timing delays for smaller antennas
- "02" – Slightly longer timing delays for larger antennas

Select the timing option by pressing the corresponding button. The Controller will display your choice for a few seconds, then return to the previous operating mode prior to the power cycle.

**External Sensor Configuration**

The external sensor consists of a Magnetometer/Accelerometer Sensor system and has two power on user settings; Declination and Pitch Adjustment.

The Declination is set to match the values for the area of operation and needs to be set so the system will align to True north. The Pitch adjustment function is used to calibrate the mechanical sensor element to a 0 degree pitch.

**Magnetometer Declination**

The power on Magnetic Declination function is used to set the magnetic declination for the location of the installation and must be set for accurate automatic antenna positioning. The data is stored in memory between power cycles. Using the declination for your area of operation, enter the data. Remember to set the ‘+’ or ‘-’ value along with the declination. Note that the US East coast is negative and the West coast is positive. Use the same method as setting the initial heading to set the declination. The controller will make the adjustment to True North automatically.

**External Sensor Pitch Calibration**

The Sensor units may have a slight mechanical pitch misalignment that cause the system to auto align such that the sensor is pitched up or down a few degrees when measured with a bubble level. Even though they function properly, they look a little odd when calibrated to level but with a slight pitch up or down in relation to a level antenna.
This feature allows for the adjustment of the physical sensor so it looks level after the antenna system is reported level. The adjustment allows for a + or – 5 degree pitch adjustment. This feature is designed to align the mechanical sensor to level, you still need to make sure the system as a whole is level for proper tracking.

Select “SC” by pressing the Mode button and then select “PT” by pressing the Right hand button. As with all other functions use the “CCW” and “CW” buttons to set the value and the “Mode” button to select the change. The Pitch is set as ‘+’ or ‘-’, and then the amount in degrees range from 0 to 5.

Change Baud Rate
The default USB to serial configuration is 9600/1/N. The controller supports 2 optional baud rates; 4800, and 19,200 baud. To change the power on default, while pressing the CCW button, turn on the controller. Release the button after the power on messages are displayed.

Setting your Call Sign / Vanity Text
The 12PRSAT Rotor Controller allows you to set and will display during idle time where the controller is not turning the antenna, 8 Characters of your choice on the top line of the display. This can be your call sign, antenna information, or any other message you want displayed. This information can be changed as often as you like.

The process of setting the text message is similar to setting the initial antenna heading. Turn on the controller and when the “Portable Rotation” message is displayed, hold down the CCW button [left Button]. Continue holding the button until the “Ent Call” message is displayed, then Release the button. The bottom line will now display the current message text and the first character position will show that it is ready for input as it will be underlined. Use the CCW and CW buttons to go forward or backward through the Letters and Numbers, pressing the MODE button after the correct character is selected. You must do this operation for all 8 character positions. If no change is needed, just press the MODE button to move to the next character.
After entering all 8 characters the display will refresh showing the new user selected text on the top display row and the current antenna heading on the bottom.

**Normal Operations**

Once the initial configuration is complete, the 12PRSAT Az/El Rotor system is ready to manage your antenna azimuth and elevation movements. As with most portable VHF/UHF beam type antennas that this system is designed to work with, exact degree accuracy is not really needed as the antennas are not that exact or narrow in aperture. The system design is accurate to 1 degree with a minimum of 1 degree increments.

A simple-to-use menu system is provided to select the turning mode and to control the system. There are three modes of operation:

- **Manual Turn Mode** – Used to make manual changes in azimuth or elevation. Not a practical solution for satellite tracking but very useful for system setup.
- **Automatic Turn Mode** – Used to make a turn by entering the azimuth and/or elevation and letting the controller manage the movement of the antenna.
- **Remote Control Mode** – Standard mode of operation using an external computer system with tracking software.

**Manual Turn Mode**

To use this mode of operation, press and hold the “Mode” button for 1 second. A menu of 3 choices is then displayed, “Az AT El”. The 3 controller buttons correspond to the 3 menu choices. Pressing the “CCW” button selects the Manual Turn mode for the Azimuth motor. Pressing the “CW” button selects the manual turn mode for the Elevation motor, and pressing the middle or “Mode” button selects the Auto Turn mode. When using the Manual turning mode the bottom display line shows both the Azimuth and Elevation position. To indicate which axis is selected for manual turn control, the leading letter, ‘A’ for Azimuth or ‘E’ for Elevation is shown capitalized before the degrees value. The non-selected axis is shown with a lower case letter. If an Azimuth move was selected, the letter ‘A’ is shown as upper case, and the letter ‘e’ is shown in lower case. If an Elevation move was selected, the lower case letter ‘a’ is displayed before the degrees of turn and the upper case ‘E’ is shown before the degrees of elevation.

After selecting the Az or El turning option, pressing the CCW (Counter Clockwise) button or the CW (Clockwise) button until the heading on the LCD display shows the heading you want. This will cause a slow speed turn. Dynamic breaking is used to stop accurately on heading. You can do a full speed turn by pressing the mode button and holding it while pressing the CW or CCW button. Releasing the Mode button will return to slow speed movement. During any turn operation the GREEN LED is on, indicating that a turn is in progress.

The controller limits the Elevation motion between 0 and 180 degrees, Azimuth rotation is limited to +/- 540 degrees from North.

As a turn is in process, the new heading value is saved to memory. When finished with your turn, to save on battery power until the next time you want to turn the antenna, you can turn off the
Controller to conserve station power. Turning the power off does not cause a USB connection to be lost, as the USB interface is powered by the attached USB master (the PC).

**Automatic Turn Mode**

This mode for turning to a new heading is useful when you need to make a large antenna heading or elevation change; As an Example: Turn from 010 degrees to 170 degrees, (60 degrees). You can either hold the “CW” button down for the duration of the turn or you can enter the Auto Turn Mode, input the new heading and/or elevation and let the controller manage the turn for you. To enter the Auto Turn Mode, with the control unit on, press and hold the MODE button for 1 second. When you see the message “Az AT El” in the display, release the button. Press the “Mode” button to select Auto Turn. Enter the new heading followed by elevation as explained below.

On the first line of the display the message “Enter Az:” is displayed and on the second line of the display the message “Az:000.” Notice the 100’s place heading value has an underline cursor to identify the active location to change. Use the CCW [Counts Up] and CW [Counts Down] keys to scroll up or down to set this value. You are allowed 0 through 3 in this location. When the first value is set, press the Mode button, the cursor moves to the next location; the 10’s place. Using the same procedure as before; select the value with the CCW and CW buttons and then press the Mode button when the correct number is displayed. The 1’s place value is now selected; select the value and press the Mode button. Using the same process, enter the Elevation values.

If no change is needed for either Az or El, press the Mode button to step over and keep the current value.

The ‘Auto-Turn’ process will start and the controller will automatically turn the antenna to the new heading and/or elevation.

When the turn is completed, the new heading and/or elevation value is saved to memory and you can turn off the controller to save on battery power until the next time you want to turn the antenna.

The current antenna heading and Azimuth are displayed during the turn.

**Aborting an Auto Turn Operation**

At any time during the Auto Turn process, you can abort the turn by pressing the MODE (Middle button). The turn will stop immediately saving the current heading to memory.

**Remote Control Mode**

As explained in detail starting on page 17, this mode is the intended primary mode of operation. This is the mode used for automatic satellite tracking when connected to a host computer.

**Operational Features**

There are three additional operational features built into the 12PRSAT dual-axis Rotor System. They include:

- GPS Data Capture from optional GPS receiver
- Built in Voltage monitor
- Automatic Antenna Calibration Sub Menu
By pressing and releasing all 3 buttons when in the Non-Remote Control operating mode you will be given 3 choices.
GP – Display GPS position and Altitude data (Optional)
VO – Display input voltage, accurate to 10 mV
CA – Displays a Sub-Menu for the Automatic Antenna Calibration functions

**GPS Data**
If the optional GPS unit is installed on the Azimuth Unit the GPS position is captured along with elevation and the current Fix time.

If the GPS unit is not installed, a message is displayed and the system returns to the Normal Operating mode. If the GPS is installed but it does not have a valid position Fix, you will be notified with a “No Fix” message.

Press the CCW button to view the GPS data. You are given a choice to view the Latitude or Longitude. Pressing the ‘Mode’ Button will exit back to the operating condition (Remote Mode or User mode).

**Voltage Monitor**
Selecting this option will display the current power supply input voltage. Voltage accuracy is 10 mV and the data is constantly updated. The voltage is calibrated at time of system assembly but is user changeable as needed. A full or Partial Reset will not reset this value.

To change the value, using a digital multi-meter, obtain the voltage reading by measuring the voltage at the inside and outside of the DC power barrel connector used to power the system. Power on the system and enter the Voltage Monitor mode by pressing all 3 buttons. Press the CW button for Calibrate and then by pressing the CCW and CW buttons, set the displayed voltage equal to the previously tested voltage. When finished, press the Mode button twice to exit the Voltage Monitor mode and save the calibration value to the flash memory.

**Antenna Auto Calibration**
There are 3 options in the Antenna Calibration sub-menu’
- CM - Calibrate Magnetometer
- RH - Return To Home
- AC - Antenna Auto Calibrate

Three choices are given; CM for Calibrate Magnetometer, RH for return to Home and AC for Antenna Auto-Calibrate
Calibrate Magnetometer
The Sensor Unit must be calibrated prior to its first use. Until it is calibrated, the system will not use it for antenna positioning. The calibration process takes approximately 12 minutes and will move the antenna system taking elevation data samples at 10 degree increments, rotating 30 degrees per elevation cycle. This data is used to remove possible anomalous readings caused from stray magnetic fields from hard iron and magnetic sources nearby (motors). This operation needs only be done 1 time. The data is stored in the internal in the Hand Control unit. A full system reset will clear the data. See Appendix B for additional instructions.

Return Home
The return home function provides an easy way to reposition the antenna to 000/000 degrees. After turning to 0 degrees azimuth and 0 degrees elevation, the system will read the magnetometer system and make any adjustments as needed. After the Return Home process is complete, 2 ‘beeps’ are generated as a user notification.

Antenna Auto Calibrate
The Auto-Calibrate function causes the Motor Controller to perform an Antenna Auto-Calibration operation and realign to True North (based on detected magnetic orientation and your previously entered Declination value, and return the elevation to 000 degrees. The Calibration option will cause the rotor unit to re-zero and turn to 000 degrees Azimuth and Elevation. Internal program variables are reset.
If the Magnetometer System is not installed, the CM and AC functions are disabled. All return to home operations will not check and adjust for movement drift.

Rotational Stoppage – Antenna Jam
In the event that during the rotation of the Antenna, it comes into contact with a structure, tree, or other unmovable object that stalls the turn for more than 1 second, the Controller will detect that the turn has stopped and will turn off the motor, display the message “Turn Fail / FAULT” on the LCD and turn on the RED led with a constant ON condition.
If a Rotational Jam does occur, stop any further attempts at antenna movement and inspect the antenna site. The drive motor is relatively small but has a very high gear reduction, and when operating from a 12 Volt DC source can produce enough torque to damage a light duty antenna. To clear the condition after you have resolved the physical condition causing the Antenna Jam, using the Rotor Controller in Manual mode, rotate the antenna in the opposite direction that caused the JAM or power-cycle the Controller. Never force a movement by hand.

Reset to Default Settings
The controller can be Reset to the default out of box settings, clearing any user entered settings and resetting all internal stored states. To reset the Controller, turn on the unit while holding down all 3 buttons until the sign on messages are displayed. The Firmware Version will be displayed and you will be asked if you want to Reset the Controller. Press the CCW button for Yes or the CW button for No. If yes, the controller then returns to normal operation, with factory defaults, if No, the Reset is aborted.
Pressing the MODE button will cause a PARTIAL RESET. User entered data along with the magnetometer calibration data are saved but Direction and elevation along with internal state data are reset.

If the controller is experiencing erratic operations in heading reporting or other operations, perform the above Partial Reset operation.

**Voltage and Temperature Monitor**

The Az/El Rotor system is designed to operate on ‘12 Volts’ DC. In general the term ‘12 Volts’ can mean some voltage around 12 volts. Lead Acid and Gel Cell Direct Current batteries do not product an exact 12 Volts DC and most power supplies operate above 12 Volts DC. The 12PRSAT will operate properly at voltages between 11.8 and 14 Volts DC.

If the voltage varies outside of the operating voltage margins, a message will be displayed warning the operator the voltage is low or high.

If the voltage goes beyond the maximum or below the minimum safe operating voltage, the system will fault and stop motor movement, halting operations with the error message; “Halting / Hi Volts” or “Halting / LowVolts”. To clear the condition, adjust the DC power to within the above specification and power cycle the system.

The Rotor Unit will monitor its operating temperature, reporting the data to the Hand Controller. If the operating temperature reaches 65 degrees C (149 degrees F) a warning message is displayed. If the temperature reaches 70 degrees C (158 degrees F) and above the system will stop operating, requiring a power cycle to restart normal operations. This is designed to protect the electronics when operating in extremely hot environments.

**Remote Control**

The Az/El Rotor Controller primary use mode is to be attached to a computer system using the USB Type-B jack found on the front of the Controller. The controller supports the Yaesu\textsuperscript{1} GS232A Rotator Control Protocol. Default serial parameters supported are: 9600 baud, 1 Start, 1 Stop, No Parity, No Handshake.

To enter the Remote Control mode of operation, with the controller on, press and hold both the CW and CCW buttons. The display will show the following message:

- **RMT Mode Enabled**
  
  No Heading data is displayed in this mode of operation.  The Ant Jam / Error LED with flash every time it responds to a Report Current Heading Command.

The ‘Antenna Jam’ Red LED will flash each time the controller receives and responds to a command from the host computer.

While in the Remote Control Mode, manual control of Az/El movement along with all other user operations are disabled. You must exit the Remote Control Mode to make any manual azimuth or elevation changes; do not force by hand any antenna position changes.

To exit the Remote Control mode, Press both CW and CCW buttons at the same time. This button combination toggles between Manual operations and Remote Control Mode.

*Note 1 - Yaesu is the registered trademark of Yaesu Munsen CO, LTD and or Yaesu USA*
3rd Party Rotor Control Software
There are a number of applications on the market that can be used to Remotely Control the 12PRSAT Portable Dual Axis Rotor system to track satellites. One such program is called ‘PstRotator’ and is sold by YO3DMU. It is a full featured Windows compatible application that will run as a stand-alone or as an interface between other applications.

Website: http://www.qsl.net/yo3dmu/index_Page346.htm

PSTRotator fully supports the 12RPRSAT Az/El Rotor System including the optional GPS receiver for Location and Elevation setting. Us the following instructions to configure PSTRotator for the 12PRSAT Rotor System. After installing the software and entering your registration code, you must configure the software by setting the COM Port, Controller Type and other operational settings.

Note: On a Microsoft Windows based platform, you may need to install the FTDI Virtual COM Port driver. This driver is available on the FTDI Web Site at the following URL: http://www.ftdichip.com/Drivers/VCP.htm From this location select the driver based on your Operating System and install as instructed by FTDI.

Under the ‘Communications’ Tab – Select ‘AZ/EL COM Port’ and select the USB Port to which the Controller is attached.

Under the ‘Setup’ Tab:
- Select ‘El / Az+EL Controller’ then select ‘Portable Rotation PR12SAT’
- Select ‘Refresh Rate’ and set to 1 Sec
- Select ‘Start in Manual Mode’
- Select ‘Satellite Tracking’
- Select ‘Satellite Tracking Setup -> set “Pos Change” to 5 Degrees or more
- Select ‘3db Beam Width’ and enter a value for your antennas. Example for antennas this unit is designed to support – set to 30 degrees.
- Select ‘My Location’ and enter your current position manually or if using the Optional GPS Module, click the ‘Use GPS’ box and your position will auto populate. When the fields are populated, click ‘Set Location’ and ‘Save’.

There are many other settings that can be set based on user needs. Those listed are the minimum needed to enable this software for this controller. Other applications like SatPC32 have been extensively tested for proper operations. The USB Port is powered by the Host PC so you can turn off the Controller and the USB port will not be dropped by the attached host computer.

Error Messages / Conditions
In the event of operational errors, the Controller will display Error messages to help in system troubleshooting. In most error cases, the problem will be traced down to a bad connection
between the handheld controller and the motor controller, an antenna movement issue, or Power Supply issue. For all ComErr0x errors, check the interconnecting cable.

**ComErr01 FAULT!**
This is a fatal error at startup time. The Rotor Controller did not respond to a status request. No communications between units detected.

**RTR Fail FAULT!**
This is a fatal error at startup time. The Rotor Controller reported bad data at initialization.

**FW Match FAULT!**
Hand Controller and Motor Controller Firmware are not compatible.

**ComErr01 NStatACK**
Rotor unit failed to respond to a Calibrate command.

**ComErr02 No ACK**
Rotor unit failed to respond to an Az/EL Move Command

**ComErr03 No ACK**
Rotor unit failed to respond to a Stop command

**ComErr04 No ACK**
Rotor unit failed to respond to a Set AZ or El position command

**ComErr05 No ACK**
Rotor unit failed to respond to a Get AZ or El position command

**ComErr06 No ACK**
Rotor unit failed to respond to a Get Status command

**HALTING! LowVolts**
Input voltage is below minimum operating range of 11.50 VDC. System has stopped motor operations and is now faulty. Turn off the system and resolve under voltage problem.

**HALTING! Hi Volts**
Input voltage is above maximum operating range of 14.00 VDC. System has stopped motor operations and is now faulty. Turn off the system and resolve over voltage problem.

**Warning! LowVolts**
Input voltage is below recommended operating range of 11.90 VDC. The controller will continue to work, but the Rotor Unit may not be able to accurately move the antennas causing tracking errors.

**Warning! Hi Volts**
Input voltage is above recommended operating range of 13.75 VDC. The controller will continue to work, but the Rotor Unit may not be able to accurately move the antennas causing tracking errors.

**Turn Out Of Range**
New Turn command will cause a turn greater than 540 Degrees.

**FAULT! TurnFail**
Turn failed – Make sure there is nothing blocking the antenna path; check connection between rotor units. Power cycle unit.
**FAULT!**

HighTemp

Rotor Unit reporting high operating temperature of 75°C (167°F) inside the Az enclosure.

In most cases, ComErr01 through ComErr06 will clear with an automatic system restart. These Communication Errors are usually caused by a cabling issue; Recheck cable connections between the Elevation and Azimuth units and the hand controller.

In the event that the Motor Controller detects a motor movement error and cannot automatically recover from the movement error, it will perform an internal reset and wait for the Hand Controller processor to take action. In most cases The Hand Controller will perform an internal reset and reinitialize and then wait for the next command from the host computer or user entered command. The Hand Controller stores the position data as reported by the Motor Controller. The error recovery process takes the stored position data and updates the Motor Controller with the last knows position after every Reset or Power Cycle.

Power supply capacity is important for proper rotor system operation. A single beep tone is generated after a Power Cycle or System Reset.

**Interconnect Information**

**Connector Details**

- 5-Pin Connector For Optional Auto Calibration Hardware
- 2-Pin Connector For User Provided Receiver Preamp or other low current Hardware
- 6-Pin Connector from Elevation Unit
- 4-Pin Connector to The Control Unit

Cable Connection Details. Note the Optional 3-Pin GPS Connector is on the front side of the Az enclosure

**25 Foot Cable Details**

The rotor cable is a 4 conductor, 18 AWG, 7 strand cable using female connectors at each end:
- Pin 1 to Pin 1 – Power out to Rotor (12VDC)
- Pin 2 to Pin 2 – Ground
- Pin 3 to Pin 3 – RS-485 Serial Data (+)
- Pin 4 to Pin 4 – RS-485 Serial Data (-)

Required Cable Connector: 4-Pin Female connector:
- Philco P61605
An extension cable will require one 4-Pin Male and one 4-Pin Female connector. Cable lengths over 100 feet are not supported. An optional 50 Ft extension cable can be purchased from Portable Rotation.

Caution should be used if making your own cables as connecting the power pins to the data communications pins will damage one or both of the controllers and require replacement of the either or both the Controller and the Rotor Unit voiding the warranty.

**Serial Communications Commands**

Below are the supported Yaesu GS232A protocol commands:

- Start Left Turn: ‘L’ Command
- Start Right Turn: ‘R’ Command
- Start Up Movement  ‘U’ Command
- Start Down Movement  ‘D’ command
- Stop Az Turn:  ‘A’ Command
- Stop El Turn:  ‘E’ Command
- Stop All Turn:  ‘S’ Command
- Auto Turn to new Az Heading:  ‘WXXX<CR>’ Command
- Auto Turn to new Az/El Heading: ‘WXXX YYY<CR>’ Command
- Report Current Az Heading:‘C’ Command
  Responds with: ‘AZ=XXX<CR>’
- Report Current Az/El position: ‘C2<CR>’ command
  Responds with: ‘AZ=XXX EL=YYY<CR>’

Additional Command to read GPS data from the Controller

- Report GPS Latitude, Longitude and Elevation  ‘G’ Command
  Responds: G=ddd.nnnnnnX ddd.nnnnnnY hhhh<CR>
  If valid GPS data is available
  Where:
  First Data Set is Latitude, Second Data Set is Longitude and hhhh = height in meters
  Response: G=---.------- ---.------- ----<CR>
  If no GPS module was detected
  Response: G=000.0000000 000.0000000 0000<CR>
  If no valid GPS data is available, No Fix
Minimum / Maximum Turn Explanation

The PR12SAT Rotor System allows for a Maximum Turn of 540 Degrees (1 ½ 360 degree turns in both directions) from the center heading of 000 Degrees True North. The system is designed to not allow more than the max amount of turn so that cable-wrap is minimized. Turning past the 1 ½ turn limit would cause damage to the interconnecting cables.

The system will turn to a new heading using the shortest turn direction to accomplish the turn the fastest. As an example, if you continually do clockwise turns starting from 000 degrees, you will reach 000 degrees again (1 full turn), but the cables will have 1 full turn on them. Continuing to turn clockwise an additional 180 degrees the controller will display ‘A180Exxx’ on the display and report to the host computer 180 degrees but internally the controller knows that the turn count is 540 degrees. The next clockwise turn would cause a turn past the 540 degrees limit. At that point the turn is stopped at the 180 degree point. The controller will respond to the host computer that it has reached the commanded turn position even though the turn was stopped at the max turn position of 180 degrees plus 360.

The next commanded azimuth turn will cause a turn to the new location in the direction needed to unwind the cables and to return the physical system to +/- 180 degrees from the original heading of 000 degrees. At Min/Max turn location (540 degrees of turn clockwise or counter clockwise) a commanded turn to 000 degrees will also cause a cable unwrap operation to be performed.

When the Sensor Unit option is installed, a turn from any position to 000 degrees will cause the controller to adjust if necessary the azimuth and elevation to the Sensor Detected 000/000 degrees.

A fail safe is built into the software that will cause the Rotor Controller to reset, subsequently causing the Hand Controller to reset if the Min or Max turn count goes 5 degrees beyond 540 degrees from home position. User intervention is then needed to unwrap the cables by using manual turn commands.
APPENDIX A – Position Sensor

Introduction
The Automatic Antenna Position feature provides the user with a fast and simple way to deploy the 12 Volt Dual Axis Portable Rotor System by providing automatic True North and 0 Degree Elevation antenna system positioning. The system consists of a Tilt Compensated 3-Axis Magnetometer and 3-axis Accelerometer that attaches to the Left (when viewed from the back) Antenna Arm. When deploying the system, the user only needs to set the Antenna in a Northerly position and approximately level and instruct the Hand Controller to do an Antenna Calibration. When finished the system will move the antenna back to 0 degrees True North and to 0 Degrees Elevation. While in Remote Control mode, a move command to 0 Degrees Azimuth and 0 degrees Elevation will cause a short re-calibration to happen. This will correct any drift inaccuracies in the system and bring the antenna back to 0 degrees Azimuth and 0 degrees Elevation.

Specifications:
• Azimuth Accuracy: +/- 4 Degrees
• Elevation Accuracy +/- 1 Degree

Installation:
• Power off The Az/El Rotor System and remove the Left Antenna Arm and slide the aluminum fixture over the end of the antenna arm. Position such that it does not interfere with the Arm Set Screws or rub on the Elevation unit Enclosure.
• Make sure the sensor is facing Up and towards the front of the Elevation Unit when installed. Up is in reference to the sensor’s flat surface with the direction Arrow and “TRUE NORTH” etched into the cover.
• Re-Attach the Antenna Arm, tightening the set screws
• Adjust the sensor Arm such that it is in alignment with the attached antenna and lightly tighten the set screw
• Plug in the 5 pin connector to the matching socket at the bottom of the Azimuth Unit. Tightening locking collar finger tight
• Use Velcro straps in a few locations to mate the cable to the main Elevation cable, leaving some slack in the cable at the top.

Initialization:
There are two required steps to initialize the Position Sensor for use: Setting your locations Declination and Calibrating the Sensor. The Calibration function has been done prior to shipping and only needs to be done again if a full Reset is performed.
• To set the Declination, Power on the System while holding the “CW” button. Press the “Mode” Button to select Magnetic Declination. Prior to this step it is recommended to look up your locations Declination, a number of web sites can be found with your locations information.

```plaintext
Config AC MD BR
Ent MD MagD : +12
```

[NOTE: When doing a Power-On full Reset operation, all data including the Declination and Calibration data are cleared if the ‘All’ option is used. A partial ‘Part’ will not clear saved magnetometer calibration and declination data but will clear direction data.]

• Before starting a Calibration sequence, perform a Full System Reset and make sure the Azimuth and Elevation are close to North and level. To perform a Magnetometer Calibration, with the Rotor System On, press all three buttons. After the firmware version is displayed the Function Menu is displayed.
• Press the “CW” button to select the Calibrate function. The Calibrate System sub-menu is displayed. Press the “CCW” button to select the Calibrate Magnetometer option. The message “Stand By / Mag Cal” is displayed and both the Green and Red LEDs will alternately flash at a ½ second duty cycle.
• The calibration cycle takes approximately 12 minutes to complete. The system moves the sensor through 180 degrees of elevation movement, then moves the azimuth by 30 degrees and
then rotates the elevation unit back 180 degrees. This cycle repeats 6 times taking samples as the sensor moves. At the end of the calibration cycle, the data is saved and used to calculate the correction factor for hard metal and other magnetic interference sources.

- You only need to perform the Sensor Calibration after doing a Full Reset operation.
- 

### Operation

The Automatic Antenna Calibration feature has two modes of operation; Manual and Automatic.

When in the Manual Mode, from the Calibrate System sub-menu, press the “CW” button for Antenna Calibration. The system will attempt to position the antenna to 0/0 degrees. The antenna direction must be within +/- 30 Degrees of True North and +/- 10 degrees of level with (0 Degrees Elevation). The Manual or Automatic Antenna Calibration function will not be done if the Calibration Process has not been done first.

When in Manual Mode, press the “Mode” button, or RH for Return to Home, causes an automatic turn to 0:0 degrees.

When using the Auto Turn Function, a turn to 0 degrees Azimuth and 0 degrees Elevation will cause an Antenna re-calibration after returning to 0:0 degrees. When in the Remote Mode of operation, any computer commanded turn to 0 degrees Azimuth and 0 degrees Elevation will cause an Antenna re-calibration after returning to 0:0 degrees. This can be automated by configuring the tracking application to park at 0:0 degrees.
APPENDIX B - Firmware Update Instructions

Introduction
Starting with Firmware revision 1.2D the Dual Axis Rotor System firmware includes a small boot-loader that allows for in the field firmware updates through the Serial USB port. Units prior to Jan 1, 2017 can be returned for free upgrading to the 1.2D release, customer pays for shipping charges only. The only difference from release 1.2C and 1.2D is the addition of the boot-loader technology.
There are 2 microcontrollers in the system, one in the hand controller and one inside the Azimuth enclosure, each controller is loaded with the boot-loader feature. With most firmware releases, both controllers will need to be updated as the releases are version matched for operation reasons.

Requirements
The update process requires the use of a Serial Communications program and a host computer. The upgrade process has been tested under Windows XP, Windows 7, and Windows 10. To upgrade the Motor controller, the Hand Controller becomes a pass through communications device, taking the data from the host and passing it onto the Motor Controller. This requires an inter-character delay of 1ms. The communications Program used needs to support this function.

The serial Port Settings
- 38400 baud
- 8 Data bits
- No Parity
- 1 Stop Bit

The recommended Windows based Application that has been tested is called RealTerm which can be downloaded free of charge at:
https://sourceforge.net/projects/realterm/
Or by doing a web search for ‘Realterm’ and finding the application yourself.

Updating the Hand Controller
The below example shows how to upgrade the firmware using RealTerm as the communications program.
To start the update process, attach the Hand controller to the Host Computer and the Azimuth Motor Unit and turn on the controller.
Next, if you do not know already, find the COM port number assigned to the Hand Controller. You do this by using ‘Device Manager’ within the Windows operating system.
Start RealTerm and go to the ‘PORT’ tab. There you will set the baud rate and port number. Once changed to match your environment, click the ‘Change’ box to make the new values active.
Now select the ‘Display’ tab. While holding the ‘c’ (lower case) key down, power on the Hand Controller. When you see the ‘cccc...’ appear, release the key and the Boot-Loader menu will be displayed.

The boot-loader has only one function, and that is to program the flash with a firmware image. Press the ‘p’ (lower case) key when you are ready to update firmware. The boot-loader will first erase the current flash contents from program memory. When finished erasing the memory, you will be prompted to send the new image file to the Hand Controller.

Select the ‘Send’ Tab and use the small box with 3 dots “…“ just to the left of the ‘Send File’ box to navigate to the location where the new firmware file is located.
Select the file and click ‘Open’. The field called “Dump File to Port” should now contain the file name and location.

When ready, click the ‘Send File’ box. With no delays set, the programing time is under 1 minute for the Hand Controller firmware. Progress of the transfer is displayed under the file name box. When Finished with the transfer, RealTerm will report ‘Done’ and a ‘Ready>’ message will be displayed in the display area.

At this time you can press ‘r’ to reboot into the new firmware on the Hand Controller or just power cycle the AzEl Rotor system.
If there is a Motor Controller firmware file included in the release, proceed to the next section on how to update the Motor Controller firmware

**Updating the Motor Controller**

As mentioned earlier, programming the flash in the Motor Controller is more complicated from an internal processor point of view though the user process is very similar to the process for updating the Hand Controller. The process of programming the Motor Controller requires the data to be passed through the Hand controller. The data rate between Hand Controller and Motor Controller is 19.2kbaud, while the data rate from the host computer is 38.4kbaud. This process requires a short delay to be inserted between each character to allow the Hand Controller to have time to re-transmit the data byte out to the Motor Controller at a lower rate.

To program the flash of the Motor Controller do the same setup procedure as with the Hand Controller. When ready, press and hold the ‘m’ (lower case) key on the host computers keyboard and turn on the Hand Controller. When you see the ‘mmmm’ start to scroll across the screen, release the key. If the boot-loader is not displayed, make sure the cursor is active in the display window and power off and try again. The boot-loader for the Motor Controller will be displayed. Follow the same steps as used to update the Hand Controller.

Press ‘p’ (lower case), and once the Memory erase process is finished, select the ‘Send’ tab and select the file to be downloaded. For the Motor Controller download process, select a delay value of 8 to 10, and then click the ‘Send File’ box.
If during the transfer you see that the Display area is filling with what looks to be random data, then the transfer has failed. This is caused by the character buffer being overrun with data.

If this happened, just restart the process, increasing the Delay value. You may need to experiment on Delay value based on Operating System and host computer speed and resource loading. This download process can take 5 to 10 minutes based on delay value used. So be patient.
The update is finished when the progress indicator turns Blue and the word ‘Done’ is displayed. After the update finishes, power cycle the Hand Controller. If the AzEl system starts with normal messaging and does not report any Errors, the update was successful.

The update process will not affect the boot-loader; power cycling during an update is not recommended and will cause a firmware load error that may require the unit to be returned for service.

**Appendix C - Quick Set-Up Guide**

**Components:**

Assemble the Rotor System:
Attach the two motor units, tightening the set screws found on the bottom of the Elevation Unit, making sure the screws align with the flat spots on the shaft exiting from the top of the elevation unit.
Az/El System Assembled:

Attach 18 inch Mounting Arms and Position Sensor. Sensor can be mounted on either side of the Elevation Unit.

Finish assembly by attaching all cables and attaching Az/El system to Tripod or mast. Attach antennas with the Director Elements facing forward, in line with the Position Sensor.
APPENDIX D – Quick Reference Card

USB Computer Control Port

On/Off Switch

4 Conductor Rotor Cable Connection

12VDC Power

Fault LED turns on if Rotation is blocked. Will flash when sending data in Remote Mode.

- Use CCW and CW to set values using MODE Button.
- Step through 100s, to 10s, to 1s. After entering 1s value, auto turn starts.

Turn LED turns on during any Turn operation

Backlighted 2x8 LCD with User Programmable Top Line

Multifunction Buttons

Press to Turn Counter Clockwise

Press all 3 buttons with power on to read Power supply Voltage, GPS position, or force an Auto Calibrate operation if options are installed

Press and hold for 1 Second Then select:
- Manual Turn Azimuth
- Manual Turn Elevation
- Enter AutoTurn Mode

Press to Turn Clockwise or Up

While Pressing CCW or CW in Manual turn Mode, press to turn at full turn rate

USB Computer Control Port

Press to Turn Counter Clockwise

Press to Turn Clockwise or Up

While Pressing CCW or CW in Manual turn Mode, press to turn at full turn rate

USB Computer Control Port

Single ‘Beep’ Tone – Power On Reset or Reset or Rest caused by Motor Controller turn Failure.

Dual ‘Beep” Tone – Return to Home operation has completed successfully.