

# **RT-21 Az-EI Controller**

## **Manual addendum to RT-21 – November, 2022**

### **Overview:**

The RT-21 Az-EI controller consists of two RT-21 units with a shared power supply and shared chassis. The unit features a pair of new OLED displays for sharp, crisp viewing, two main RT-21 PCB each with their own RS232 port, USB port, and 8 position terminal strip on the rear panel. When teamed with appropriate software, this unit provides a fully automatic, hands-free controller for many different combinations of Az-EI rotator schemes.

[www.greenheronengineering.com](http://www.greenheronengineering.com) – Go to the SUPPORT->Rotator Controllers Tab to get the “Setup Utility Software” that supports all RT-21 controllers.

The lower board is configured for azimuth and uses the lower display, serial connectors, and terminal strip. The upper board is configured for elevation and uses the upper display, serial connectors, and terminal strip.

For full details on internal PCB configurations, please refer to the current RT-21 manual for assistance.

### **Rotor Motor Compatibility:**

The RT-21 Az-EI is ideal for our new Sub-Lunar/GH Slew Drive systems, as well as::

Yaesu G5400 Az-EI units

Yaesu G5500 Az-EI units both the original, and the newer G5500DC models

Alfa Spid Az-EI units

M2 Az (OR28900) with MT1000, MT3000 units

Create Design Az and EI rotators – (RC5, ERC)

Pro.Sis.Tel Az and EI rotators

Any combination of Azimuth and Elevation rotators that:

- a. Both use AC or Both use DC motors – AND -
- b. Both use rotators that are within the capabilities of a standard RT-21

Examples of systems that cannot use an RT-21 Az-EI. These types of systems would require separate azimuth and elevation RT-21 controllers:

- Azimuth using a Prop Pitch motor (with PWM speed control) cannot be accommodated with the RT-21 Az-EI because the Prop Pitch requires the 10 amp motor supply. The RT-21pp must be used for the Prop Pitch azimuth rotator. (EXCEPTION – we can configure the azimuth side for relay control without PWM speed control capability, and then utilize an RT-21 Az-EI as long as we match the relay voltage type (ac or dc) with your choice of elevation rotators.)

- Azimuth with A Yaesu G2800, and elevation of G550 (AC version) cannot be accommodated because the G2800 uses DC motor, while the G550 uses an AC Motor. It is possible to use the new elevation DC model of the G-5500 in conjunction with a DC model AZ rotator.

## Features:

RT-21 SETUP UTILITY pc software supports all the RT-21 Az-EI Systems and is updated as new features are added:

[www.greenheronengineering.com](http://www.greenheronengineering.com) – Go to the SUPPORT->Rotator Controllers Tab to get the “Setup Utility Software” for this unit.

The following standard RT-21 features are **not** included in the RT-21 Az-EI Controller:

1. Master/Slave and Counter-rotation features.
2. Alternate Offset features
3. Internal AC motor capacitor that would be required for some AC motor units, Green Heron will supply a suitable capacitor for externally mounting at your rotator, or on the rear of the RT-21 Az-EI.

The following are new or changed features with the RT-21 Az-EI.

- Additional separate Point & Shoot knob for Elevation Control.
- The two individual main boards can each accept the same, or different voltage tap from the main transformer.
- New rear terminal PCB inside RT-21 Az-EI uses plug-in sockets for the protective Transorbs. This allows lightning protector replacement without requiring any soldering.
- Supports any elevation range up to 180 degrees. Soft Limits may be set to limit to any range desired.
- Default settings allow 90 degree elevation, and South Center azimuth.
- Manual (front panel button) control is selectable from Az to EI by pressing the CANCEL button for ~ ½ second. Display showing “MAN” indicates which is active. (Computer control and Point & Shoot control are always active for both Az and EI.)
- Elevation control below the horizon for parking, or maintenance can be supported in the controller.
- Elevation Mode will not change with a System RESET. It is possible to change Elevation Mode with SETUP Utility, but there should be no reason to do this unless a CPU chip, or main PCB is being replaced. The correct setting for Elevation Mode is made at the factory.
- Support for Elevation Inclonometers....GHE has an analog inclinometer (pot replacement) that is great for homemade jackscrew systems.

**“Version 2”**. Beginning in August, 2019 with S/N 2000, the RT-21Az/EI has been updated with a new CPU and includes the following new features:

- Firmware Updates via USB/RS232 using the SETUP Utility Software
- Support for the Sub-Lunar/GHE Slew Drive Systems (very high pulse count resolutions)
- On-the-Fly target heading updates that improve high speed tracking performance. Motors can update the target headings and continue tracking toward a moving target without having to stop.
- Support for high accuracy US Digital T7 RS232 inclinometers. (Not suitable for long cable runs)

**“Version 2.11”**. Beginning in May 2021. 2.11 was released that adds more new features. This release is available for any Version 2 controller.

- Fixes a display brightness not-saving issue and rounding errors on high resolution rotators
- Adds the Rotator OPTION for G-5500DC
- Improves the response time of computer commands to improve fast tracking custom applications
- Improves the reliability of low-resolution pulse type systems to eliminate pulse counting after the motor stops (non-EME) or after the “DELAY” time for EME Advanced Option
- Improvements to external program heading values to show negative elevations in (R21; Command only), and SETUP Utility fixes for limit settings.
- Enhanced DEBUG Mode, display more information:
  - Analog Pot systems display Cal set values along with the current A/D value for easy trouble shooting of pot systems.
  - Pulse Systems display real time pulse sensing and internal counting values.

**“Version 2.12”**.

- Allows UPPER limit to be set above 180 (as high as 225)
- Allows “on-the-fly” to up if the direction is closing in (for changing satellite priority real-time).
- Lowered the default brightness to 2

**“Version 2.13”**.

- Adds support to for the “rev 2” display modules. The original OLED displays are no longer available. The new ones have Screen Saver instead of brightness control which may be set from 1 to 60 minutes. 50 minutes is default.
- Improves the “Button Swap” function to be much more consistent and reliable.
- Bug Fixes the ability to change limits from SETUP Utility on the Elevation side.

- Bug fix which sometimes gave “Counter Range Errors” when using SETUP Utility to change parameters.

### **Tracking Software Compatibility:**

These packages support the RT-21Az/EI directly and are recommended

- Ham Radio Deluxe
- PSTRotator AZ/EI
  - \*\* PSTRotator may also be used as an interface between many other software packages and the RT-21Az/EI. See PSTRotator documentation for details.
- MacDoppler (the latest MacDoppler now supports both Az and EI Com ports for the RT-21Az/EI.)
- SatPC32

The following software are supported with the addition of GH Tracker (free on the website). This “middleware” will take data from the following trackers and provide RT-21 COM port connections and commands via either UDP (network), Disk File, DDE (same computer) interfaces.

- WSJT
- MoonSked
- F1EHN
- Nova for Windows
- MacDoppler via network UDP

\*\*\* Note: GH Tracker has not planned updates beyond its current implementation. PSTRotatorAz/EI can accomplish all of the interfaces (and more) that are done in GH Tracker.

**The following section includes connection and setup information for some of the most common Az/EI and Elevation only rotators that are supported. Use the RT-21 manual for separate Az and EI combinations that are not described here.**

# YAESU G-5400/G5500 Az El (Also G550 Elevation)

## CONNECTIONS AND SETUPS

Azimuth - Use SETUP->OPTION = G5400 or G5500

Elevation – Use SETUP ->OPTION = Yaesu

### AC Motor

Jumper	Position
J10	1-2
J14	Open
J12	1-2

### Transformer Taps

Transformer	J9 Connection
Brown	J9-1
Orange	J9-2

### Position Feedback

Jumper	Position
J5	1-2
J6	1-2
J16	1-2

### Rotor Connections

Function	Yaesu #	RT-21
REF	1	5
POS	2	4
GND	3	3
MOT CCW	4	2
MOT CW	5	1
MOT COM	6	3

NOTE: Term 3 gets 2 wires

### NOTES:

1. There should be no calibration required because the default settings provide normal accuracy for these rotators. If you wish to refine the calibration for more accuracy, you will need to calibrate the endpoints (180 to 180 for azimuth, and 0 to 90 for Elevation) using either RT-21 SETUP Utility, or the front panel calibration procedure. This procedure can be found in the RT-21 manual for various rotator types, contact the factory if you need assistance.
2. Default elevation is 90 degrees. These rotators allow for 180 degrees of "elevation" control. To change the RT-21 to allow different elevation angles, set the "CW" Limit to the value you want to allow. To allow full 180 degrees, set the CW Limit to 180. To allow only 70 degrees of elevation, set the CW Limit to 70.
3. If you are using the G550, setup the elevation according to this page. For your specific Azimuth rotator (must be an AC motor type) you would use the appendix page for your desired azimuth rotator.
4. If your azimuth rotator is a G5400, HAMx or T2X rotator, you will need to add a motor start capacitor across terminals 1 and 2 of the RT-21 azimuth barrier strip. Green Heron will provide you with an appropriate capacitor on request.

# YAESU G5500DC Az El

## CONNECTIONS AND SETUPS

Aimuth and Elevation both use SETUP->Option = G-5500DC

(Prior to Version 2.11 use:) Use:

Azimuth - Use SETUP->OPTION = G800/G1000

Elevation – Use SETUP ->OPTION = Yaesu (set MIN SPEED to 3 to enable speed control)

### DC Motor

Jumper	Position
J10	2-3
J14	2-3
J12	2-3

### Transformer Taps

Transformer	J9 Connection
Brown	J9-3
Yellow	J9-4

### Position Feedback

Jumper	Position
J5	1-2
J6	1-2
J16	1-2

### Rotor Connections

Function	Yaesu #	RT-21
REF	1	5
POS	2	4
GND	3	3
MOT CCW	4	2
MOT CW	5	1

### NOTES:

1. There should be no calibration required because the default settings provide normal accuracy for these rotators. If you wish to refine the calibration for more accuracy, you will need to calibrate the endpoints (0 to 0 degrees for azimuth, and 0 to 90 for Elevation) using either RT-21 SETUP Utility, or the front panel calibration procedure. This procedure can be found in the RT-21 manual for various rotator types, contact the factory if you need assistance.
2. Default elevation is 90 degrees. These rotators allow for 180 degrees of “elevation” control. To change the RT-21 to allow different elevation angles, set the “CW” Limit to the value you want to allow. To allow full 180 degrees, set the CW Limit to 180. To allow only 70 degrees of elevation, set the CW Limit to 70.

# M2 ORION 2800 DC/MT-1000 AZ EL

Azimuth - Use SETUP->OPTION = Orion  
 Elevation – Use SETUP ->OPTION = MT1000

## DC Motor

Jumper	Position
J10	2-3
J14	2-3
J12	2-3

## Transformer Taps

Transformer	J9 Connection	NOTE
Brown	J9-3	
Orange	J9-4	

## Position Feedback

Jumper	Position
J5	2-3
J6	2-3
J16	1-2

## Rotor Connections

Function	M2	RT-21
MOT CW/UP	1 (Black)	1
MOT CCW/DN	2 (White)	2
POS	5 (Orange)	4
GND	6 (Blue)	3

(Opt: cable shield to 6-32 ground stud (if shield used)  
 (Shielded rotor cable is not required with an RT-21)

## CALIBRATION PROCEDURE

### Existing System from front panel (antenna already installed and working)

1. Look at the current direction of the antenna and note the true heading/elevation. Then press SETUP until the displays says "Setup", then let go and you will be in the "Calibrate" item. Turn the knob until NEW VALUE is equal to the current true heading or elevation. Press CHANGE, then press SAVE. Do this for both azimuth and elevation.

### New system

1. (Always test and calibrate on the bench before installing if at all possible). M2 and Green Heron always ship these rotators and controllers preset to the center of their rotation range. In most cases, simply connect as in the Rotor Connections above, and verify that it works. No other calibration is required. Then turn to a convenient heading, and once the rotator is installed, bolt the mast in with the antennas matching the displayed heading. Center is best as that makes it easier to get the rotor loop correct.

### If you need to re-find the center for any reason: (in order of ease)

1. Using SETUP Utility (recommended)
  - a. Click on Auto-Cal Orion. Unit will run CCW until it is sure it found the CCW limit switch, then will turn rotator to its center of rotation and calibrate it there.
2. Use Front panel SETUP
  - a. Press SETUP and hold, display will say "Setup" then ~ 6 seconds later, will change to say "Auto Cal, Orion". Follow the displayed prompt. This will leave the rotator at its extreme CCW limit, and calibrate it there.
3. Manually find the center (hardest)
  - a. Find the CCW limit switch by turning the rotor with the CCW button as far as it will go CCW. If you reach the soft limit shown by the "<" on the LCD, then go into SETUP->CALIBRATE and change the heading to full CW position of the knob, press CHANGE, then SAVE. Now continue to turn the rotator CCW until you get the "ERROR, NO MOTION". This is the CCW mechanical limit.
  - b. Using the CW button, turn the antenna 14 degrees CW from this point until the display reads the recorded heading above + 14 degrees. This moves the rotator out of the 14 degree Over-travel zone.
  - c. Go back into SETUP->CALIBRATE. Turn the knob fully CCW (New Value = 0 if you have the normal South Center), then press CHANGE, and then SAVE.

# Alfaspid RAS, BIG RAS, REAL

Azimuth - Use SETUP->OPTION = SPID  
 Elevation – Use SETUP ->OPTION = SPID

## DC Motor

Jumper	Position
J10	2-3
J14	2-3
J12	2-3

## Transformer Taps

Transformer	J9 Connection	NOTE
Brown	J9-3	
Yellow	J9-4	

## Position Feedback

Jumper	Position
J5	2-3
J6	2-3
J16	1-2

## Rotor Connections Standard

Function	SPID	RT-21
MOT CW	1	2
MOT CCW	2	1
GND	3	3
POS(Position)	4	4

## Sensor Connections Hi Res only

Function	SPID	RT-21
IN IMP 1 (or IN IMP2)	3 (or 2)	4
12 VDC (for Sensor Power)	6 and 7	5
GND (for Sensor)	8 and 9	3

These sensor connections for Hi Res are used instead of the terms 3 and 4 connections that are utilized with the Standard SPID

## CALIBRATION PROCEDURE

1. Verify that your rotor is 1 pulse/degree (Pulse Divider = 360) which is the standard number for the RAS and REAL. The Big RAS typically is ½ degree resolution for a Pulse divisor requirement of 720. Some units have other divisors, and the **High Resolution versions should be 2880**. The RT-21 supports all versions, contact us if you need assistance determining your correct Divider value.
2. The azimuth rotors have no limit switches, so be certain you do not over-travel beyond the limits of your rotor loops!!!! Adjust the antenna position on the mast or turn with the CW or CCW buttons until the antenna is at some physical known heading or elevation. The elevation rotators do contain limit switches to contain rotation to 180 degrees.
3. Go to SETUP/CALIBRATE and match the displayed heading with the visual, actual heading or elevation into the “NEW VALUE = “ by turning the front panel knob.

**IMPORTANT:** Insure that your coax loop around the rotator will support your rotating range. The Alfa Spid has no internal limit switches on the azimuth rotator.

**NOTE:** If you rotator turns backwards, simply swap the motor wires between terminals 1 & 2.

**NOTE:** If your indicator shows ½ of the actual travel (you turn it 10 degrees on the indicator and the antenna actually turns 20), then change the Pulse Divider to 720.



# Create ERC5x

**Use the RT-21 Manual Appendix A.5 for Connections and Setups for both RC5 and ERC5 rotators.**

## Elevation ERC5 CALIBRATION PROCEDURE

1. Turn the rotor to horizon 0 degrees elevation with the CCW (Down) button watching the antenna, not the display
2. Press the CANCEL and CCW (DOWN) together and hold 2 seconds until the display reads "CAL CCW = xxx" where xxx should be a number < 50. (It may be helpful to press the CANCEL "slightly" ahead of the CCW button.)
3. Turn the rotor using the CW (Up) button until the antenna is physically pointed straight up, watching the antenna, not the display.
4. Press the CANCEL and CW (Up) together and hold 2 seconds until the display reads "CAL CW = xxx" where xxx should be a number > 800. (It may be helpful to press the CANCEL "slightly" ahead of the CCW button.)

NOTE: You may also use the SETUP Utility instead of the front panel. It's much easier to see and set the calibration points with the computer method.

NOTE: The ERC allows about 100 degrees of rotation. You may allow rotation beyond 90 degrees only if you change the CW limit above the default of 90.

# SUB-LUNAR/GHE Slew Drives

## CONNECTIONS AND SETUPS

Version 2 controller (SN >= 2000) only

Azimuth - Use SETUP->OPTION = Sub-Lunar

Elevation – Use SETUP ->OPTION = Sub-Lunar

### DC Motor

Jumper	Position
J10	2-3
J14	2-3
J12	2-3

### Transformer Taps

Transformer	J9 Connection
Brown	J9-3
Violet	J9-4

### Position Feedback

Jumper	Position
J5	2-3
J6	2-3
J16	1-2

### Rotor Connections

Function	Slew TB#	RT-21#
Motor (Black)	1	1
Motor (Red)	2	2
Sensor +v (Red)	3	5
Sensor ret (Black)	4	3
Sensor A (Green)	5	4
Sensor B (Blue)	6	Not Used

#### NOTES:

1. The 2 heavier wires from the Slew Drive are the Motor wires and the Az and El connections are both identical.
2. Optional “high speed” motors are available that have a different “Pulse Divide” ratio setup in the controller. Note that the standard motors use a very low total gear reduction, and high pulse count. For the standard motor, we use a “multiplier” of 2 set with SETUP Utility that allows the actual divide ratio to be ½ of the programmed number.
3. Set “Calibrate” value to the as positioned heading or elevation is the only calibration.
4. The standard configuration has no supplied limit switches. This makes calibration easier because you don’t need to consider the limit switch position when mounting the antennas.