

GREEN HERON ENGINEERING LLC

RT-21
DIGITAL ROTOR CONTROLLER
USER GUIDE

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S/N 1199 and below (PCB Rev 1.x)

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RADIO AND TELEVISION INTERFERENCE

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

You may also find helpful the following booklet, prepared by the FCC: "How to Identify and Resolve Radio-TV Interference Problems." This booklet is available from the U.S. Government Printing Office, Washington D.C. 20402.

Changes and Modifications not expressly approved by the manufacturer or registrant of this equipment can void your authority to operate this equipment under Federal Communications Commissions rules.

NOTICE

The RT-21 may not be certified or recommended by some rotor manufacturers for use with their products. Use of this device may void the warranty of these devices and Green Heron Engineering LLC is not responsible for any damage, direct or incidental, that might occur through such use.

Green Heron Engineering reserves the right to make changes for product improvement or manufacturing, without notice or any obligation to update units already sold.

WARRANTY

This product is warranted to be free of defects in materials and workmanship for 1 year. We will repair or replace, at our option, any equipment proven to be defective within the warranty period. All warranty work is F.O.B. Webster, NY, USA. This warranty is exclusive of abuse, misuse, accidental damage, acts of God or consequential damages, etc. Green Heron Engineering LLC liability shall not exceed the original purchase price of the equipment.

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TIC RingRotor[®] is a registered trademark of TIC General, Inc.

Hy-Gain is a trademark of Hy-Gain Corporation

Yaesu is a trademark of Yaesu/Vertex Standard USA

All other products, company names, brand names, and trademarks are the property of their respective owners.



This unit is normally supplied with a 2 Amp 5x20 mm fuse in the rear panel fuse holder.

If it is necessary, replace only with:

115 VAC – 3 amp max (recommend 2A)

230 VAC – 1.5 amp max (recommend 1.5A)

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1.0 QUICK START GUIDE

IMPORTANT - Please Read This!

This Section of the manual will assist you in getting your new controller running as fast as possible. Everything you need to know to get your unit setup and running is contained in this QUICK START GUIDE along with the single page in the APPENDIX A that corresponds to your particular Rotor. The SETUP UTILITY program on the CD can be used to test your rotor, operate it, or optionally provide a quick calibration for many rotor types. See Appendix 'H' and the separate documentation file included on the CD for SETUP UTILITY capabilities and instructions.

If Green Heron Engineering DID NOT configure your controller OR you are changing to a different type of rotor perform the steps in [Section 1.1 Jumpers and Settings](#) (page 2)

If Green Heron Engineering configured your controller for your rotor type, skip the steps in [Section 1.1](#). They have been completed for you.

Next perform the following steps as defined in this guide.

- [Section 1.2 Set the Offset Value](#) (page 4)
Set your OFFSET (only if you do not want a North Center which is the default)
- [Section 1.3 Connect the RT-21 to Your Rotor](#) (page 5)
Hook your rotor to the rear terminal strip per the instructions for your rotor type.
- [Section 1.4 Calibrate Your Rotor](#) (page 5)

As a quick alternative, you may use the Auto-Cal facility of the SETUP UTILITY described in appendix H. The Pot Auto-Cal, although considered an estimate, may be accurate enough for most needs. The Orion Auto-Cal is recommended and accurate for Orion rotors.



If your rotor does not have mechanical limits, **DO NOT** attempt rotation other than with the CW and CCW pushbuttons before calibration has been completed, and the soft limits are proven to be working as desired.

The remainder of the manual (After the Quick Start) will assist you in getting the most out of your controller by optimizing the various options, using the computer interface, or setting up sophisticated Master/Slave, or Master/Counter-rotate systems. Feel free to contact us with any questions or clarifications –OR- for any custom application you may have. If your rotor is not listed, and you wish assistance using the information contained in this manual, please contact us and we will be glad to assist.

TERMINOLOGY

The following terms may be unfamiliar to new users of the RT-21 and are defined here for clarity. It is important to understand their meanings, as they will be used frequently during configuration and setup tasks:

TERM	DEFINITION
Endpoints	The counter-clockwise (CCW) and clockwise (CW) endpoints refer to the ends of rotation that would normally occur with a system that rotates exactly 360 degrees. Note that CCW and CW endpoint headings are the same, but at opposite ends of a 360-degree arc (with the center-of-rotation being 180 degrees from either endpoint).
Over-Travel	Rotation beyond the normal endpoints of 360 degrees.
Point-and-shoot	This action refers to setting a direction with the front panel Heading Knob and allowing the RT-21 to execute this move automatically, stopping at the selected heading.
Soft Limits	These are travel limits that can be programmed into the RT-21. The effect is similar to the mechanical limits built into many Rotors, but it is achieved inside the controller and is fully programmable to allow over-travel (if supported by the rotor) or to reduce travel for installations requiring limiting the rotation to less than 360 degrees (a sidearm antenna mount, for example). If a Rotor does not have mechanical endpoints, this feature helps avoid turning the rotor past a desired range.
Ramp-up/Ramp-down	This RT-21 feature provides gradual startup and shutdown of rotor power to reduce stress on towers, antennas and rotors. This is achieved by pulse-width-modulating the operating voltage for the rotor. Ramp-up is utilized for all starts, and ramp-down is used on all stops. (The ramp down is abbreviated for manual button releases, CANCEL or computer 'stop' commands)

NOTE: The compass headings of 360 and 0 degrees refer to the same direction. There are cases where the SETUP display may read 360 degrees instead of 0, but it refers to the same compass direction of North. During normal operation, the heading display will always display within the range of 0 to 359.9 degrees.

1.1 JUMPERS and SETTINGS

(YOU MAY SKIP to paragraph 1.2 ONLY if we've pre-configured your unit)

1.1.1 RT-21 Hardware Configuration (Internal Jumpers and Wiring Options)

1. Ensure that the power cable is disconnected from the rear panel of the RT-21.
2. Remove the eight Phillips head screws securing the top cover and remove the cover.
3. Using the appendix A for your rotor, familiarize yourself with main PC board as shown in Figure 1. Note the locations of the various wire connections and jumpers.

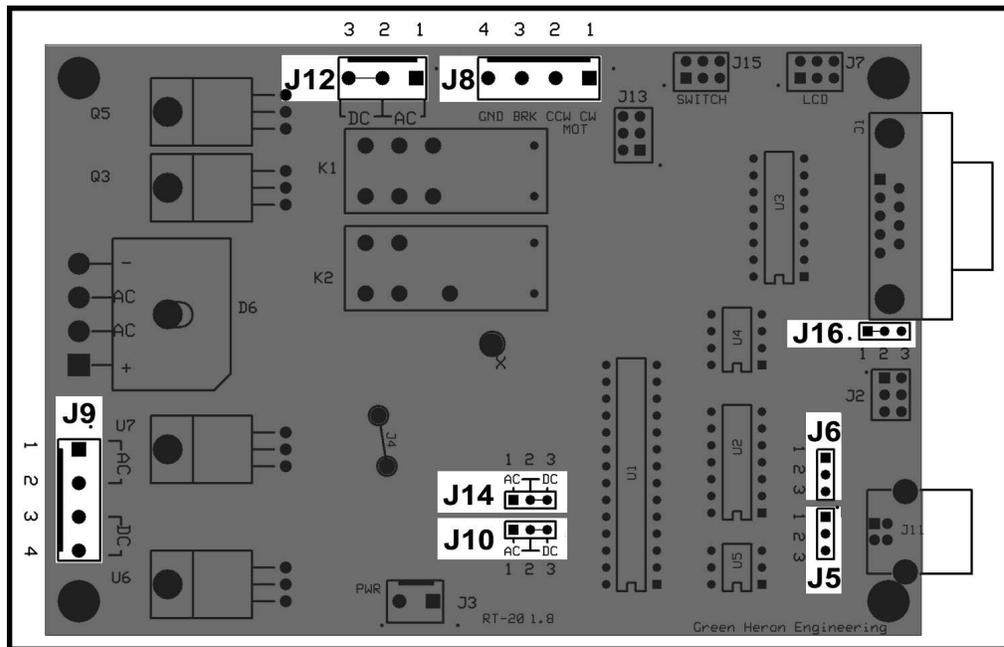


Figure 1 - RT-21 PC Board Layout—Locations of Configuration Jumpers

4. Select your Motor Type (AC or DC) with J10, J12, and J14 as follows:
 - Confirm or move the jumper plugs in J10 and J14 with a needle nose pliers.
 - Confirm or move a bus wire on the 3 term screw connector at J12
5. Select your Transformer Tap connections as follows:
 - Connect the two transformer wires to J9 as indicated. (ONLY CONNECT TWO)
You may need to strip a wire if it was previously not connected.
 - Ensure the wire nuts on the unused wires are secure.
6. Select Your Position Feedback Type:
 - Confirm or move the jumper plugs in J5, J6 and J16 with a needle nose pliers.
7. Reinstall the top cover of the RT-21, securing it with the screws removed earlier.
 - The cover should be oriented so that the overhang is at the front, and the ventilation slots are toward the rear.

8. Verify that the 115/230 VAC switch on the rear panel is set properly.
 - This switch **MUST** be set to the choice that is correct for the primary (mains) voltage that will power your RT-21. A small screwdriver may be used to move the switch, if necessary.
 - If the position of the 115/230 VAC switch is moved, check the rear panel fuse for proper value. The fuse is an International Standard GMA 5mm x 20mm type, and should be a 2A fuse for 115 VAC line, or a 1A fuse for 230 VAC line. Replacement fuses are available at most electronics parts distributors.
9. Connect the power cord to the rear panel receptacle and set the front panel power switch to ON. You should see the software version number displayed briefly, followed by the operating display.

1.1.2 RT-21 Software Configuration (Software SETTINGS)

This Procedure assumes that the SETUP parameters are all at factory default. If you wish to assure this condition, press and hold CANCEL + CCW + CW as described in 2.1.5 until the display indicates RESET EE.

	<p>The correct OPTION for your Rotor must be selected and saved prior to changing any other items in SETUP.</p> <p>Before making this selection, ensure that all hardware jumpers have been made as described above</p>
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1. Go into **SETUP** Mode as follows:
 - Press and hold the SETUP/ITEM button until SETUP appears on the display.
 - Choose the **OPTION** parameter by repeatedly pressing and releasing the SETUP/ITEM button until the display shows **OPTION**.
2. Choose the correct **OPTION** by rotating the heading knob until the “New Value = “ the correct option for your rotor, as defined in the Appendix A., is displayed.
 - **POT** – 2 or 3-wire potentiometer or variable resistor - generic
 - **COUNTER** – Pulse Counter - generic
 - **HAMx** – HAM-X Hy-Gain[®] Rotor with separate wedge brake control
 - **T²X** – T²X Hy-Gain[®] Rotor with separate wedge brake control*
 - **TIC-PST** – TIC RingRotors or Prosistel
 - **ORION** – M2 Orion rotor, DC motor type with 3960 Pulse/360 degrees
 - **SPID** – Alfa Spid types with 1 pulse/degree
3. When the correct option for your Rotor is displayed, save it as follows:
 - Press the **CHANGE** button to change it.
 - Press the **SAVE** button to store the change and exit.

1.2 SET THE OFFSET VALUE

The offset value is the number of degrees that your counter-clockwise (CCW) endpoint is from true North. It is normally equal to the compass heading of your CCW endpoint. This might be a different value than your CCW mechanical stop if your rotor has wider rotation than 360 degrees.

Offset can also be viewed as the desired center-of-rotation (180°) clockwise from North.

For example: If your center-of-rotation were South (with the CCW endpoint at North) then your offset would be 0. If your center-of-rotation were North (with your CCW endpoint at South) then your offset would be 180 degrees (Default).

1.2.1 Configure the desired Offset value

1. Enter SETUP mode
 - Press and hold down the SETUP/ITEM button for 2 seconds
 - Release the SETUP/ITEM button when SETUP appears on the display.
2. Choose the **OFFSET** parameter
 - Repeatedly press and release the SETUP ITEM button until **Offset** is displayed
 - The currently set offset will be displayed after the equals sign (=).
 - The bottom line on the display will indicate **NEW VALUE = XXX**.
3. Set the **OFFSET** parameter for your rotor
 - Rotate the heading knob until the desired **OFFSET** is displayed after **NEW VALUE =** on the display.

NOTE: For North Center – OFFSET = 180 degrees (Default)
 For South Center – OFFSET = 0 degrees

- Press the CHANGE button to store the New OPTION.
- Press the SAVE button to save the option and exit the **SETUP** menu.

1.3 CONNECT THE RT-21 TO YOUR ROTOR



Remove power from the unit before making rotor connections

1.3.1 Connect your Rotor to the rear panel terminal strip of the RT-21 using the chart labeled “Rotor Connections” in the appendix ‘A’ for your rotor. The first column of terminal numbers refers to the terminal numbers of the rotor’s factory controller or the rotor itself. The terminal numbers under the RT-21 column are the correct RT-21 terminals for the same wire.

1.4 CALIBRATE YOUR ROTOR



DO NOT use the Point-and-Shoot knob before your rotor is fully calibrated.

Rotors without mechanical limits may be damaged or rotor loops may be exceeded if unintended over-travel occurs.

If your rotor does not have mechanical stops at 360 degrees of rotation, insure that you or a helper is positioned to watch antenna travel during calibration

1.4.1 Calibrate according to the specific instructions in the Appendix ‘A’ for your rotor. The heading directions when referred to (North or South) in these procedures assume a North center (the default offset). If you have changed the OFFSET from the default for a South center, then the directions in (parentheses) should be used instead

RT-21 QUICK START GUIDE

2.0 FRONT PANEL CONTROLS & DISPLAY

2.1 FRONT PANEL CONTROLS

The controls on the front of the RT-21 include three push buttons, the heading knob and the power switch as shown in Figure 2. Each of the push buttons has two labels, one above and one below. The active function of the buttons depends on whether the unit is in Setup or Normal Operation.

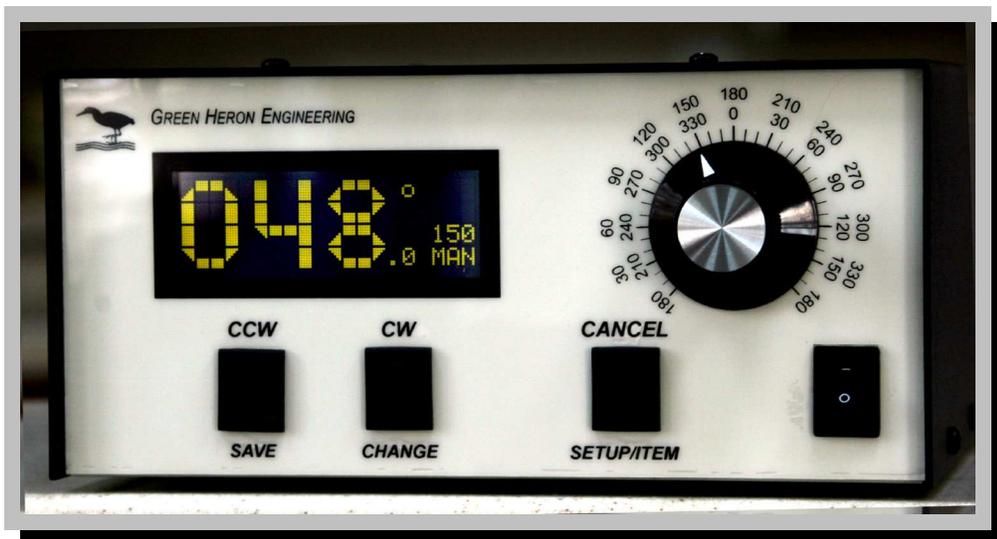


Figure 2. RT-21 Front Panel

2.1.1 Front Panel Buttons—Normal Operation

When the RT-21 is in normal operation, the push buttons function using the labels *above* the buttons. Table 1 summarizes their functions.

Table 1. Button Functions in Normal Operation

Button Label	Button Function
CCW	Turns rotor counter-clockwise (## Ramp-down and creep)
CW	Turns rotor clockwise (## Ramp-down and creep)
CANCEL	In normal operation mode CANCEL can be used in three ways: <ul style="list-style-type: none"> • A click of the CANCEL button cancels the current rotation event from the front panel heading knob or computer command. • Holding the CANCEL button down for 2 seconds places the unit into SETUP. • A click of the CANCEL button toggles in or out of M/C, M/S, or S/C mode to allow a manual operation to be performed.

Clicking the CCW or CW button, while computer or point-and-shoot motion is in progress, will ramp down to Minimum speed but continue to target unless CANCEL is pressed.

2.1.2 Heading Knob—Normal Operation

The heading knob on the RT-21 is used to choose a heading for “Preset/Point-and-Shoot” rotation. The scale is appropriate for either a North or South center-of-rotation. When the knob is moved to the desired heading, the RT-21 begins rotor movement automatically.

NOTE: The scale is a close approximation of the knob position. The exact position is always shown on the front panel digital display.

2.1.3 Front Panel Buttons—Setup Operation

When the RT-21 is in Setup, the three push buttons function using the labels *below* the buttons. Table 2 summarizes their functions.

Table 2. Button Functions in Setup

Button Label	Button Function
SETUP/ITEM	The SETUP/ITEM button has two functions. <ul style="list-style-type: none"> • Initiate Setup Mode: Press and hold down the button for 2 seconds, release when “SETUP” appears in the display window. • Select the next item in the SETUP menu: Repeatedly press the button until the desired setup item appears on the display.
CHANGE	Modify the currently selected item to the value shown in the display window as set by the heading knob.
SAVE	Save changes and exit setup mode

FRONT PANEL CONTROLS AND DISPLAY

2.1.4 Heading Knob—Setup Operation

When in SETUP, the Heading Knob is used to select desired values on the display.

2.1.5 Combined Button Functions

Additional functions are available when certain combinations of buttons are pushed together. Refer to Table 3 for an explanation of these additional functions. When invoking these functions, lead with the CANCEL slightly ahead of the CW, CCW or both.

Table 3. Combined Button Functions

Button Combination	Function
CANCEL+CCW	Calibrate CCW at CCW endpoint. (See 4.1)
CANCEL+CW	Calibrate CW at CW endpoint. (See 4.1)
CANCEL+CCW+CW	Restores all default values to factory settings.

2.2 FRONT PANEL DISPLAY

The front panel display (Figure 3) is a multi-function, backlit LCD. It shows the current heading, position of preset knob, state of operation (MAN for Manual, REM for Remote, and PRE for Preset-in-progress). An explanation of these functions appears in Table 4.

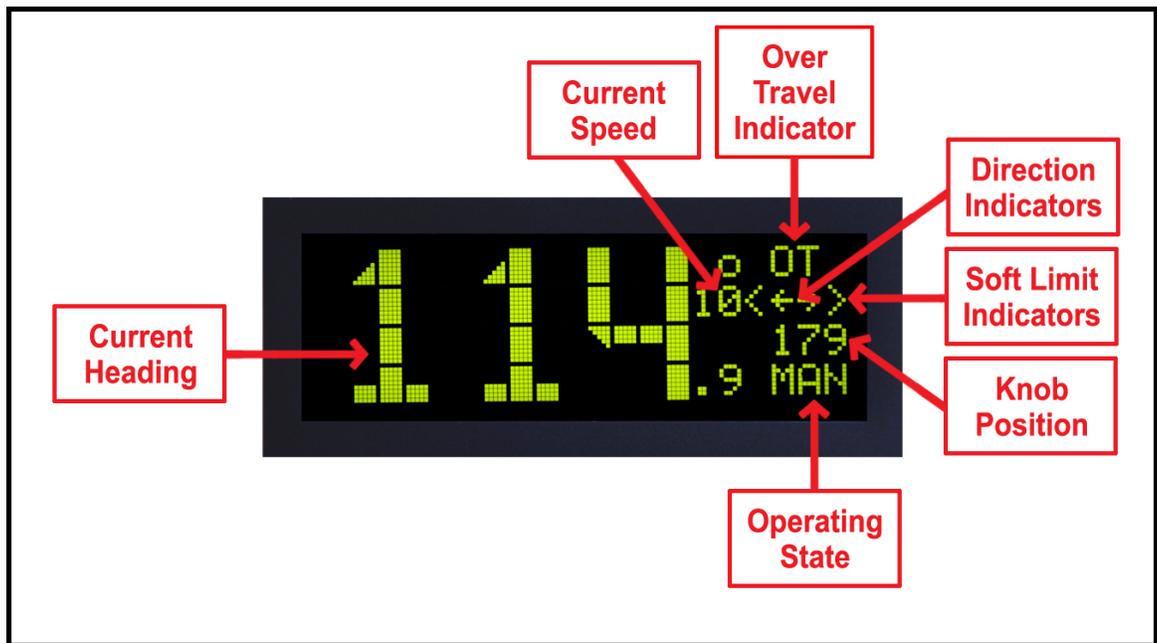


Figure 3. RT-21 Front Panel Display

FRONT PANEL CONTROLS AND DISPLAY

Table 4. Display Fields and Functions

Field Name	Valid Values	Definition
Current Heading	000.0 – 360.0	Compass heading of antenna in a properly calibrated system. Tenths not displayed for OPTION HAM or T2X
Current Speed	1 – 10	While motor is running, this displays the actual PWM speed to the motor. (1 = 10% .. 10 = 100%)
Over-Travel Indicator	OT	Over-Travel outside of the normal endpoints of 360-degree rotation. (Rotors that allow rotation beyond 360 degrees with wider stops, or no stops at all use this.)
Soft Limit	< >	Rotor has reached the soft limit set in the rotor SETUP. The RT-21 will not allow rotation beyond these points.
Direction Indicators	→	Direction of current Rotation/Movement. Right indicates clockwise; left indicates counter-clockwise.
	←	
Knob Position	0 – 359	Shows exact position of the heading knob. It is used for choosing a precise setting when doing setup commands or in “point-and-shoot” operation.
Operating State	MAN	Manual—Local operation with front panel controls.
	PRE	Preset—Displayed when RT-21 has sensed movement of the heading knob and a point-and-shoot operation is in progress.
	REM	Remote—Unit being controlled via the RS-232 line from another device.
	M/S	Master/Slave Mode—Unit connected to other RT-21 for coordinated operation.
	M/C	Master Counter-Rotate—Connected mode S/C unit can compensate for movement from this unit.
	S/C	Slave Counter-Rotate—Slave unit is compensating for movement from mode M/C unit, such as on a rotating tower, where a specific antenna must maintain its heading.
	DBG	Debug—Used for system troubleshooting. Provides continuous display update, and disables error detection and shutdown.

3.0 SETUP MODE

The RT-21 rotor controller allows you to program virtually every aspect of your rotor's operation. The controller's **SETUP** menu is used to set all operating parameters.

The first setup task is to select the **OPTION** parameter. This prepares the controller for the requirements of your rotor system.



The correct **OPTION** for your Rotor must be selected and saved prior to changing any other items in **SETUP**

3.1 OPTION PARAMETER

The **OPTION** parameter setting provides the correct startup conditions for your system and makes items that pertain to your rotor accessible in the **SETUP** menu.

The RT-21 supports the following **OPTION** values:

POT – 2 or 3-wire potentiometer or variable resistor.

The **POT** option uses the potentiometer method of determining the position of the rotor. The RT-21 reads the voltage on the wiper of the potentiometer using a precision A/D converter and displays the result in degrees.

COUNTER – Pulse Counter

The **CTR** option uses the “pulse counter” method of determining the position of the rotor. A reed or proximity switch generates pulses, which are read and counted by the RT-21. This count is used to calculate the current position of the Rotor in degrees.

HAMx – HAM-X Hy-Gain® Rotor with separate wedge brake control.

The RT-21 uses half the potentiometer in these rotors because the wiper is grounded. The software smoothes out the readings during A/D conversion for HAM-style rotors.

T2X – Tailtwister (T2X) Hy-Gain® Rotor with separate wedge brake control.

This **OPTION** is very similar to the HAMx option EXCEPT that it adds automatic motor reversals to help eliminate the inherent “brake stick” problem in these units. Prior to starting a Point and Shoot or a computer generated motion, the RT-21 will momentarily run the unit in the opposite of the intended direction to relieve any back tension on the BRAKE in order to help it release properly. Also, the RT-21 will try to

SETUP MODE

prevent the T2X rotor from going all the way to the end stop so that the limit switch won't disable this reversal.

TIC-PST TIC RingRotor or Prosistel

This OPTION is the same as the POT option EXCEPT that it adds an additional safety mechanism to prevent these rotors from running beyond their pot limits and causing motor damage. These rotors have no mechanical limiting switches and their POT arrangement is such that they never need to run near either end of the POT. The RT-21 limits the operation of these rotors to the middle 88% of the POT range and will display a POT OUT-OF-RANGE error if it gets near either end. This error can be overridden by using MODE = DEBUG.

ORION – M2 Orion (Pulse System units)

This OPTION is the same as the COUNTER option EXCEPT that it sets the Pulse Divider HI and LO to the correct 3960 value automatically. Also sets the Soft Limits to +/- 14 degrees of over-travel that this unit allows.

SPID – Alfa Spid Rotors

This OPTION is the same as the COUNTER option EXCEPT that it sets the Pulse Divider HI and LO to the correct 360 value automatically.

To setup the **OPTION** parameter, perform the following steps:

1. Enter SETUP mode
 - Press and hold down the SETUP/ITEM button for 2 seconds
 - Release the SETUP/ITEM button when SETUP appears on the display.
2. Choose the **OPTION** parameter
 - Repeatedly press and release the SETUP ITEM button until **SETUP-OPTION =** is displayed
 - The currently set option will be displayed after the equals sign (=).
 - The bottom line on the display will indicate **NEW VALUE = XXX**.
3. Set the **OPTION** parameter for your rotor
 - Rotate the heading knob until the desired **OPTION** is displayed after **NEW VALUE =** on the display.
 - Press the CHANGE button to store the New OPTION.
 - Press the SAVE button to save the option and exit the **SETUP** menu.

3.2 SETTING OTHER PARAMETERS

This same sequence that was used to set up the **OPTION** parameter is used to modify any setup parameter (SELECT, CHANGE, SAVE).



It is important to remember that if you change an **OPTION** parameter, you must SAVE and reenter the **SETUP** menu to make any other changes

TIP: Some menu items can change calculations and affect related options, so it's a good idea to only change one item at a time until you become familiar with the RT-21. For example, changing the **CTR** divide ratios will change the **CALIBRATE**, the **OFFSET** will change the **SOFT LIMITS** to match, etc.

3.2.1 SETUP ITEMS

This section provides a detailed description of the options available in the **SETUP** menu. The parentheses () indicate the option setting(s) under which the item is available.

CALIBRATE (COUNTER, ORION, SPID) – This item calibrates the directional display to the physical direction of your antenna.

OFFSET (ALL) – Sets the CCW endpoint for your system in degrees clockwise from true North. The default setting is “180”. This means that the default stops are at South with a North center-of-travel. To set a South center, you would set the **OFFSET** to “0”. This setting also affects the soft limits within the RT-21 and repositions them automatically if you change the **OFFSET** value.

- You may have both “South center” and “North center” antennas on the same mast and rotor. For example, you may wish to put a VHF antenna on South center and HF antenna on North center. You can select which center-of-rotation is to be used by simply changing the **OFFSET**.
- The **OFFSET** is also useful in a POT system to compensate for mast slippage as a temporary measure until you can re-align correctly.
- Mobile “rover” stations can use the **OFFSET** feature as well. Simply enter the amount of offset depending on how far off your vehicle is parked from a North heading.

DELAYS (ALL) – This sets the delay times enforced by the RT-21 before allowing a reversal in motor direction, or before the Brake engaged. This delay setting is adjustable in 100 ms increments up to a maximum of 5.9 seconds (59 on the display).

MIN SPEED (ALL) – This sets the minimum speed that that is used for starting and stopping the motor as it ramps up and/or down, 1 to 10 where 1 is 10%... 10 is 100%.. The MIN SPEED setting has no effect when ramps are not used (Max Speed = 11). Generally, this is set to the slowest speed that allows your rotor to turn reliably, typically 2 or 3 for DC motors. See the NOTE on AC Motors later in this section.

MAX SPEED (ALL) – This selects the motor speed, 1 to 11 where 1 is 10%...10 is 100%. For speeds within 1 to 10, ramp-up and ramp-down power is applied to the Rotor. This reduces tower stress on large arrays. Speed 11 is full speed with no ramp-up or ramp-down conditioning. An Additional “Speed” of “AC MOTOR” can be selected for rotors that use them. AC MOTOR selection changes the Speed Controls to a lower PWM frequency more appropriate for AC motors and forces the MAX SPEED to 10.

CCW LIMIT (ALL) – Selects the absolute heading for the CCW soft limit. The soft limit may be set +/- 180 degrees from the normal CCW endpoint. (Normal endpoints apply to systems that allow 360 degrees of rotation with mechanical stops.)

CW LIMIT (ALL) – Selects the absolute heading for the CW soft limit. The soft limit may be set +/- 180 degrees from the normal CW endpoint. (Normal

SETUP MODE

endpoints apply to systems that allow 360 degrees of rotation with mechanical stops.)

OPTION (ALL) – Selects the rotor type. Described earlier in this section.

DIVIDE HI (COUNTER, ORION, SPID) – Selects the first two digits (high order) of the pulse divider. The divider number is equal to the number of pulses in a 360-degree rotation. For example, if your rotor provides 1785 pulses in 360 degrees, the **DIVIDED HI** value is set to **17**.

DIVIDE LO (COUNTER, ORION, SPID) – Selects the last two digits (low order) of the pulse divider. The divider number is equal to the number of pulses in a 360-degree rotation. For example, if your rotor provides 1785 pulses in 360 degrees, the **DIVIDE LO** value is set to **85**. (Always set the **DIVIDE HI** first, then the **DIVIDE LO**.)

CAL RANGE (POT, HAM, T2X, TIC-PST) – This is the degree range that the potentiometer calibrate routines will assume for the distance traveled between the CCW and CW calibration points. This value defaults to 360 degrees and should not be changed unless you cannot rotate your antenna full 360 degrees in order to perform the potentiometer calibration. (A sidearm application on a tower may be one example of this.) You can calibrate the rotor prior to physical installation, or use the **CAL RANGE** to set this parameter. Refer to Section 5—Advanced Features—for a detailed sidearm calibration procedure.

MODE (ALL) – Selects the operating mode of the RT-21 controller.

- **NORMAL** Mode – NORMAL mode allows manual control, point-and-shoot and computer control via one of the rear panel communication ports.
- **M/S** – Master/Slave Mode, where multiple RT-21 controllers are linked together.
 - Usage and Examples:

Master/Slave mode allows one RT-21 to control other RT-21 controllers via the EIA-232 port. This allows movement of multiple rotors and antennas to the same heading without having to set each one individually.

The **M/S** MODE is intended for use in controlling stacks of HF monobanders or tribanders that are on different rotors (or even different rotor types). It allows the operator to turn the entire stack together or quickly separate them for individual rotation.

When you set the **MODE** to **M/S**, you may quickly disable or enable the M/S mode by pressing the CANCEL button.
 - Functionality

If you only have a stack of two antennas, each with its own rotor, either controller may be used to turn the pair.

If you have three or more antennas on different rotors, then one of the controllers must be designated as the Master. The controller designated as the Master is the only one that will turn all of the

SETUP MODE

antennas. The other controllers will only turn the antennas they are directly connected to.

Refer to Section 5—Advanced Features—for more detail on M/S operation and EIA-232 connections.

- **M/C** – “Master/Counter-Rotate” Mode
 - Usage and Examples
Master/Counter-Rotate Mode is used for the bottom rotor (or tower) in a system where two rotors are used in series along the same “mast”. Examples of this are a rotor at the top of a rotating tower, or two rotating joints on the same structure (or rotating rings mounted on a rotating tower).
 - Functionality
M/C mode sends the heading data to other RT-21s that control the upper rotor(s) so that it may calculate the heading for the antennas above.
- **S/C** – Slave/Counter-Rotate Mode
 - Usage and Examples
S/C mode is used for the slave rotor(s) as described in M/C. It reads the data from the M/C unit and maintains the heading for the upper antennas while the bottom is moving. The S/C controller in a properly implemented system allows complete independent operation of the slave antennas from the ones fixed to the rotating tower.
- **DEBUG** – Debug Mode (see paragraph 5.6 for details)

RAMP (ALL) – Adjusts the variable ramping, (0-9) of the speed control features of the controller. 0 = shortest, 9 = longest ramp. Generally, the larger your system, the longer ramp up and down you will want to use. Default is 3. If MAX SPEED = 11, ramping is disabled regardless of the ramp setting.

BRIGHT (ALL) – Adjusts the variable brightness of the LCD display 1 to 10. (1 to 4) for the VFD used in the ‘D’ models. The display auto-dims somewhat after a short time of no display updates.

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4.0 CALIBRATION



Use the **CCW** and **CW** buttons to turn your antennas during calibration steps.

DO NOT use the **Point-and-Shoot** knob before your rotor is fully calibrated.

Rotors without mechanical limits may be damaged or rotor loops may be exceeded if unintended over-travel occurs.

NOTE: These are generic procedures for calibration and are indicative of the process required in order to calibrate either a Potentiometer type system, or a Pulse Count system. You either do 4.1 or 4.2 depending on your rotor OPTION type.

Specific instructions, for each documented rotor type, are in the Appendix 'A' for each rotor.

4.1 POTENTIOMETER SYSTEMS

(TIC, Hamx, Yaesu, Prosistel, etc)

It is recommended to begin with the default calibration settings in the controller. You can restore these if necessary with the **RESTORE EE PROM** command, (CANCEL + CCW + CW buttons).

Always use the **RESTORE EE PROM** command when connecting the RT-21 to a new rotor type.

4.1.1 Perform the following steps to properly calibrate the RT-21

1. Use the **CCW** button to turn the rotor in order to define the normal (non-over-travel) CCW limit.
 - If your rotor has 360-degree stops, turn the rotor CCW to the mechanical stop.
 - If your rotor **DOES NOT** have 360-degree stops
 - If the OFFSET is at 0, turn CCW to **visual** due north.
 - If the OFFSET is at 180. turn CCW to **visual** due South.
2. Press **CANCEL** and **CCW** simultaneously and hold until CCW CAL is displayed. This sets the CCW Endpoint
3. Use the **CW** button to turn the rotor in order to define the normal (non-over-travel) CW limit.

CALIBRATION

- If your rotor has 360-degree stops, turn the rotor CW to the mechanical stop.
- If your rotor **DOES NOT** have 360-degree stops
 - Use the **CW** button to turn the rotor exactly 360 degrees until the antennas are positioned back in the same **visual** direction as in Step 1 above. This is the CW endpoint.

4. Press **CANCEL** and **CW** simultaneously and hold until CW CAL is displayed.

The numbers displayed are the results of the analog-to-digital (A/D) conversion of the voltage read on the potentiometer. They will vary depending on the amount of travel the indicator potentiometer actually moves, but the CCW value should be fairly low and the CW value should be significantly higher. The larger the difference between the two numbers, the higher the resolution of the heading display will be.

A system that only uses 2 turns of a 10- turn pot will not have nearly the resolution of one that uses 8 or 9 turns of the same pot. The accuracy and resolution of the RT-21 controller depends entirely on the amount of change of this A/D reading and the linearity of the potentiometer used. The maximum resolution is about 1/3 degree with this option.

4.2 PULSE COUNTER SYSTEMS

(Orion, SPID)

Ensure that the correct divider value is set with **DIV HI** and **DIV LOW** based on the number of pulses in a 360-degree rotation.

Simply turn your antenna to a known direction visually, and then set the **OFFSET** value to yield the desired end or center-of-rotation headings. Finally, set the **CALIBRATE** value to the same heading as the antennas are physically pointed.

NOTE: The RT-21 cannot adjust the actual position of your antenna in relation to the physical endstops OR in relation to your coax rotor loops as installed.

5.0 OPERATING HINTS & ADVANCED FEATURES

5.1 OPERATING HINTS

A review of the Operating Hints below will help you get the most out of your RT-21 and resolve minor difficulties that may be encountered. In addition, Green Heron Engineering is available to assist with any questions you may have about your controller. Use the contact information at the front of this manual to reach us.

1. The voltage taps listed in the configuration charts (Appendix A) are normal settings for short-to-moderate cable runs. If you find that your rotor turns more slowly than usual, or the ramp-down function does not operate correctly, try using the next higher voltage tap on the transformer (i.e., use red wire instead of orange). Any two wires may be used to connect to J9. e.g. If you connect the Yellow to term 3 and the Orange to term 4, you will get approximately 14 VDC for the motor. The transformer voltage taps are approximately 0, 18, 28, and 38 VAC.
2. Some rotors work better under pulse width-modulated (PWM) speed control than others. In general, DC motors appear to operate better than AC motors in this regard. Also, lightly loaded rotors and heavily loaded rotors behave differently as they are ramped down. Experimentation may be needed with the speed controls, ramp setting and voltage setting to optimize your system. We run the PWM frequency at 1.2 KHz for DC motors, and much lower when the Max Speed is set to "AC MOTOR".
3. When evaluated with the RT-21, HAMx and T²X rotors exhibited the least effective speed control. For these rotors, we recommend setting the RT-21 to **SPEED= 11** to eliminate the PWM control.
4. We recommend that the RT-21 soft limits be set to values that will prevent your rotor from turning into (or possibly through) its mechanical limits. Setting the soft limits to 5 degrees "early" is a good practice and will help avoid this problem. The OPTION = T2X setting does this for you to ensure there is room to reverse the motor prior to running in the correct direction.
5. Rotors without mechanical limits must depend entirely on the controller to prevent rotation beyond the desired range and to prevent damage to your coax and/or potentiometer. We strongly recommend you use the FAIL-SAFE option in

Appendix D for TIC RingRotor, Alfa-Spid or Prosistel as these rotors do not have limit switches.

6. Your RT-21 comes set for your rotor type from the factory. (if we know it) If not, the factory defaults are for a 36 VDC motor (mid-voltage) and a potentiometer-positioning indicator system. The offset value is 180, which needs a CCW & CW endpoint of South, and a North center-of-rotation. You can return to these default settings at any time by pressing the CANCEL, CW, and CCW buttons at the same time and holding until the unit resets.
7. The RT-21 is protected by a fuse on the rear panel. If the controller shows no sign of power, the fuse may be blown. The fuse is an International Standard GMA 5mm x 20mm type, and should be replaced with a 2A fuse for 115 VAC operation, or a 1A fuse for 230 VAC operation. Replacement fuses are available at most electronics parts distributors, including Radio Shack.

5.2 COMPUTER CONTROL OF RT-21

The RT-21 is equipped with a fully operational RS-232 port and a USB 'B' connection. Virtually all programs that support rotor control via a COM port can be used with the RT-21 on either port. The RT-21 USB port implements the standard COM port emulation that works with standard Windows drivers. See 5.2.2 for installation instructions.

The protocol implemented in the RT-21 is based on the Hy-Gain® DCU-1 protocol and runs at **4800 8N1** using a **straight through serial cable** with at least pins 2-2, 3-3 and 5-5 wired. It reports headings and turns to headings with the same commands implemented in DCU-1. Set your software to use DCU-1 protocol at 4800 8N1 if your program does not have a Green Heron setting. Many additional commands are provided for the advanced features that only your RT-21 can perform. These include the ability to computer track to 1/10th degree, or operate your controller as part of an IP network using software from Green Heron.

- 5.2.1 USB Functionality is limited to computer control. You cannot use the USB to interconnect RT-21s for the purpose of Master/Slave, or Counter-rotate functions.

NOTE: The EIA-232 Port (dB-9) MUST be used for interconnection to other RT-20, or RT-21 controllers AND for loading new software updates from Green Heron.

5.2.2 USB INSTALLATION

The RT-21 requires a driver settings file (INF) file to be installed on your system. When your system first sees an RT-21 connected to a USB port on your computer, the New Hardware Wizard will appear. Although the exact procedure will vary depending on your operating system, Windows will ask you for the location of the Driver for an RT-21 controller. You browse to the CD provide to the drivers folder and select the driver file ghntrt21.inf, and then install the driver. You may ignore the "digital signature" error if you get one.

5.3 CALIBRATION OF SIDEARM INSTALLATION

If your rotor uses a **COUNTER** position type indicator, sidearm calibration is easy. Simply calibrate as specified earlier, and set the soft limits to ensure that your antenna does not turn far enough to hit the tower.

If your rotor uses a **POT** or is a **HAM/T2X** type indicator, the calibration is slightly more involved, as the antenna cannot be turned through a complete 360 degrees in order to set the A/D values. Although it can be done while maintaining **OFFSET** at a nominal 0 or 180 degrees, we suggest you start with the method below:

1. Using **SETUP** menu, change the value of **CAL RANGE** to **180**. (Allowable options are 90, 180, 270, and 360.)
2. Turn the rotor CCW to the most CCW heading you want to allow, keeping in mind that the antenna must not be allowed to strike the tower.
3. Perform the CCW Calibration by pressing the CANCEL + CCW buttons.
4. Turn the antenna CW until it is visually 180 degrees from the position noted in Step 2 (or to **CAL RANGE** setting). Perform the CW Calibration by pressing the CANCEL + CW buttons.
5. Turn the antenna to a known heading visually and subtract this “real” heading from the indicated heading on the display. Set the **OFFSET** value to this difference.
6. Set the soft limits to values that prevent the antenna from striking the tower.

NOTE: For new installations you could calibrate before you mount the antenna, or calibrate the rotor on the ground, then mechanically set the antenna to match a 0 or 180 degree **OFFSET**. In any event, you must make sure the mechanical stops of the rotor are outside the intended range of rotation.

5.4 MASTER/SLAVE (M/S) MODE

M/S mode allows multiple antennas to be rotated as if they were on the same mast, even if in fact they are on separate towers, masts or rotor types. Primarily intended for stacked arrays of similar antennas, this mode could be useful in other ways. One might be the VHF operator with antennas for different bands on different rotors or towers. You could turn the SHF array to a desired heading as you work a distant station on the lower bands on a different tower.

A controller in the M/S mode sends commands to other controllers using the EIA-232 port. Controllers in **NRM** mode or **M/S** mode will “read” these commands and turn their motors to match. If you wish to momentarily disable the commands from being sent from the Master unit, simply press the CANCEL button and the **MODE** will change to **MAN** on the display. Pressing CANCEL again will return to **M/S** mode.

An M/S unit will send commands for point-and-shoot and computer-generated events, but not for manual button presses. If you have only two controllers, both units may be set to **M/S** and then either one will turn the stack, unless momentarily disabled with

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CANCEL. With three or more rotors in the stack, only one unit may be designated as **M/S**. In addition, computer control may still be used on the stack. The computer must be connected to the unit that will be the **M/S** mode unit, if a computer is used with a two-unit setup, then only one RT-21 (the one connected to the computer) can be the Master unit. A computer port may be directly connected to any or all unit in a stack if the USB port is used. In this case, only the Master unit's connected port will send the stack to a heading, while Slave unit's connected port will only act on that Slave.

5.4.1 INTERCONNECTIONS:

1. For two controllers without a computer interface
 - Connect the two units together with a DB-9 null modem cable.
 - The only pins needed are 2-3, 3-2, and 5-5.
2. For connection with a computer and two or more RT-21 units, proceed as follows: (IF USB port is used with the Master, than the Computer part of the cable on the right side of the drawing isn't used).
 - Cable the units as shown in Figure 4.
 - Note that only two wires are needed on units set to **MODE NORMAL**.
 - Pre-made cables are available from Green Heron Engineering. Check our website for details.

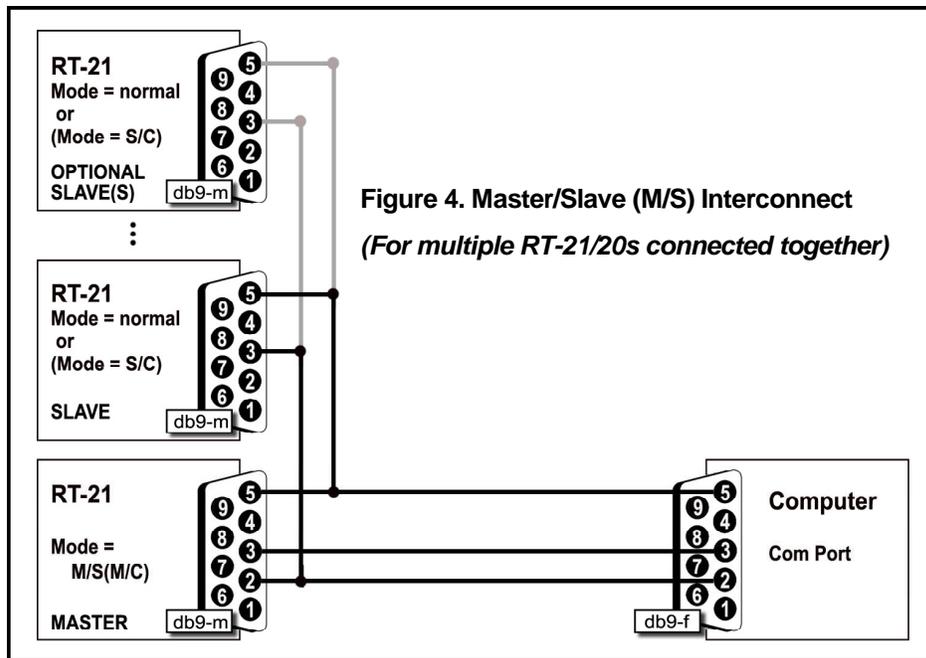


Figure 4. Master/Slave (M/S) Interconnect
(For multiple RT-21/20s connected together)

5.5 M/C and S/C MODES

These modes are used to configure a counter-rotating scheme where one rotor is mounted above another as you might wish to do with a rotating tower. In this case, the tower turns the antennas that are fixed to it, and a separate rotor turns a mast above the tower. This could allow separate or slaved operation of stacked antennas, or separate control of two independent antenna systems.

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In this configuration, the lower rotor controller is set to **MODE M/C** while the upper controller is set to **S/C** (Master and Slave Counter-Rotation). The cabling is the same as you would use for the M/S two-Rotor scheme, with or without a computer. The computer can only control the lower Rotor in this configuration. The **S/C** unit always seeks the heading set with the point-and-shoot knob on the front panel.

All **S/C** units attempt to hold headings as set with the **Heading Knob**. Although units will respond to the **CW** and **CCW** buttons, the next rotation of the master unit will cause a return to the knob position.

The lower unit will turn as commanded, either manually, point-and-shoot, or by software command, and the upper unit will compensate and hold the desired, indicated heading by turning in the opposite direction. When beyond an endpoint (soft limits), the upper unit “flops over” and turns 360 degrees in the other direction.

It is important to calibrate the slave units *after* the master one. Set the master one to the center-of-rotation (normally North or South) and then calibrate the slaves to the same heading.

Use **M/C** for your main rotating tower base or rotating joint. Use **S/C** for the upper rotor (above the tower) and/or Ring Rotor® or sidearm installations *above* the rotating joint. The master unit may be turned by any allowable method (manual, preset, computer). The slave units will track their current heading as set with the heading knob. **S/C** headings may be changed using the heading knob only. A slave unit counter-rotates beyond the soft limit, the unit “flops over” and turns 360 degrees in the other direction.

5.6 DEBUG Mode

5.6.1 This mode enables troubleshooting of the system by allowing continuous rotation regardless of detected errors:

1. It enables continuous updating of position data on the display.
2. It disables the **NO MOTION** and **POT ERRORS** from resetting the controller so that you may determine the cause of these errors. **Naturally, with MODE = DEBUG, caution to prevent over-rotation should be exercised if your system has no mechanical limit switches.**

5.7 FIRMWARE UPDATES

Firmware updates, should one ever be desired or needed, are easy and fast to field install. The process requires only a straight through serial cable (the same one you may be using for computer control), the loader program that was provided with your RT-21 on the CD (tinybldWin.exe), and the program file (RT-21 n_nn.hex) that you wish to load. The firmware that came installed in your unit is also on the CD in case you need it for any reason. Updates cannot be done using the USB port on the RT-21.

To use the loader:

1. Place the tinybldWIN.exe and the firmware file (.hex) in a folder and go to that folder.

2. Double click the program and “Browse” and select the hex file you want to load. Set the Comm window to 57600 and the COM port you are going to use.
3. With the RT-21 switched ON, connect the serial cable. Click on Write Flash and then quickly turn the controller OFF and then back ON before the loader times out.

The loading process should take just a few seconds. Stored SETUP values are not changed so your calibration should remain intact. If the new load adds new SETUP values or features, you may need to go and set these new values before using your RT-21 with the new software. Green Heron will provide these instructions if needed.

5.8 CHANGING THE VANITY DISPLAY, MOTION TIMEOUT, SECURITY LOCK



THIS PROCEDURE ALLOWS DIRECT ACCESS TO CALIBRATION AND OTHER SETUP PARAMETERS THAT WILL CHANGE THE CHARACTERISTICS OF YOUR CONTROLLER.

Be careful not to send commands, other than the ones that are specifically described here, unless you fully understand the Communications and SETUP features of the RT-21. (Appendix G)

There are a few SETUP items that are not accessible from the front panel SETUP menus. These items are designed to add security or items that should not normally need to be accessed by the “user”. To access or change these items, use SETUP UTILITY (Appendix H) or a terminal program such as HyperTerminal set for 4800 baud, 8 data bits, no parity, 1 stop. (8N1) as described next.

Turn on your controller, and connect to the computer. Connect your terminal program using either the EIA-232 port or the USB port. With the controller in its normal operating display (not SETUP), establish your connection using CAPS LOCK and by typing “A11;” (letter ‘A’, letter ‘I’, number 1, semi-colon) The RT-21 will respond with the current heading in degrees.

5.8.1 Add Vanity Boot Message – Command = “W01<Callsign>;”

You can add your callsign, or any message that can be displayed on one line of the RT-21 display, at boot-up. The Command will center the <Callsign> on the third line. Type “W01W2ABC;” (not the quotes)

5.8.2 NO MOTION Timeout Value – Command = “WP1<seconds>;”

This command will change the timeout value of the NO MOTION error timeout in seconds. To change this value to 4 seconds, type “WP14;”

5.8.3 Security Lockout – Command = “WQ00;”

This command will prevent users from accidentally changing SETUP values or calibration settings by locking the RT-21 into “USER” mode. This locks out all front panel SETUP, Calibration, or RESET EE functions of the controller.

“WQ01;” will return to the “ADMIN” or unlocked mode.

APPENDIX A.1 - TIC RINGROTOR

SETUP/OPTION = TIC-PST

DC Motor

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

Transformer Taps

Transformer	J9 Connection	NOTE
Brown	J9-2	
Orange	J9-4	
J8-3	J9-3	Fail Safe

Position Feedback

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

Rotor Connections

Function	TIC	RT-21
MOT CW	2	1
MOT-CCW	3	2
CW/REF	4	5
Wiper	5	4
CCW/GND	6	3

CALIBRATION PROCEDURE

BEFORE AND DURING CALIBRATION, THE ROTOR CAN GO BEYOND A NOMINAL 360 DEGREES so please ensure that:

A spotter is used, or a view of the antennas is possible.

All motions should be initiated via the CW and CCW buttons, NOT the control knob.

The display will NOT read correctly until after calibration, use visual locations.

1. Ensure your RingRotor is in its factory setting of center. You can confirm by measuring that the wiper of the pot is 250 ohms (or equal) from each end. This ensures that the motor and pot are in their exact center. This is much easier to adjust on the ground if you need to before installation. You can use the controller or any 13.8 VDC power supply to turn the motor. If you use the controller, you must use MODE = DEBUG mode in order to allow the motor to turn without a pot connected. Make sure you are using an Ohmmeter and do not allow the motor to get to the end of the pot. Return the RT-21 to MODE = NORMAL before continuing.
2. Engage the Ring motor so that the cradle is in line with the desired center of rotation. This is most always North and South. If the antenna is installed, ensure that it is pointed in the correct center of rotation direction, North (South)
3. Use the CCW button to rotate the antenna position counter-clockwise until the antenna is pointed exactly 180 degrees CCW from the center or South (North).
4. Press the CANCEL and CCW together and hold 2 seconds until the display reads "CAL CCW = xxx" where xxx should be a number < 200. (It may be helpful to press the CANCEL "slightly" ahead of the CCW button.)
5. Use the CW button to turn the antenna position exactly 360 degrees until it is back pointed in the same direction, South (North). Then Press CANCEL and CW this time until the "CAL CW = xxx" appears. This time the number should be > 700.

APPENDIX A.2 – ORION 2300 (ORIGINAL)

SETUP/OPTION = POT

SETUP/MAX SPEED = AC Motor

AC Motor

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

Position Feedback

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

Transformer Taps

Transformer	J9 Connection	NOTE
Brown	J9-1	
Violet	J9-2	

Rotor Connections

Function	OR-2300	RT-21
MOT GND	1	3
MOT-CCW	2	2
MOT CW	3	1
POT REF	4	5
POS	5	4
GND	6	3

NOTE: Term 3 gets 2 wires

CALIBRATION PROCEDURE

1. Use the CCW button to rotate the antenna position counter-clockwise until the antenna is pointed exactly 180 degrees CCW from the center of rotation, South (North) This should be at the CCW mechanical limit in the rotor
2. Press the CANCEL and CCW together and hold 2 seconds until the display reads "CAL CCW = xxx" where xxx should be a number < 200. (It may be helpful to press the CANCEL "slightly" ahead of the CCW button.)
3. Use the CW button to turn the antenna position exactly 360 degrees until it is back pointed in the same direction, South (North).
4. Then Press CANCEL and CW this time until the "CAL CW = xxx" appears. This time the number should be > 700

APPENDIX A.3 – ORION 2800 (AC)

SETUP/OPTION = ORION (forces Pulse Divider to 3960)

AC Motor

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

Transformer Taps

Transformer	J9 Connection	NOTE
Brown	J9-1	
Violet	J9-2	

Position Feedback

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

Rotor Connections

Function	OR-2800AC	RT-21
MOT GND	1	3
MOT CCW	2	2
MOT CW	3	1
POS	5	4
GND	6	3

NOTE: Term 3 gets 2 wires

CALIBRATION PROCEDURE

1. Find the center of rotation of the rotor.
 - a. If you are replacing an existing system, simply point the antenna at the center, North (South)
 - b. To find the center, first 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, then turn the rotor some more in the CCW direction until you get the "NO MOTION" error. This is the CCW mechanical limit and record the HEADING

Now, using the CW button, turn the antenna until the display reads the recorded value above + 194 degrees. (This is 180 + the 14 degree over-travel that this rotor supports)

2. Now that you're at center, go to SETUP/CALIBRATE and set the value to the desired center of rotation, 0 degrees. (180 degrees)

If an existing antenna is NOT centered correctly on the mast, and is not pointing correctly, simply use SETUP/CALIBRATE to match the display with the actual antenna. Your limits will not be centered, but the display will be accurate. In this case, you may want to match the soft limit values with the actual mechanical stops.

NOTE: Some early OR-2800 had different divide ratios than the standard 3960. Some experimentation with the divider may be required.

NOTE: The "Auto Cal Orion" facility within the SETUP UTILITY program will automate this process for you. See Page 49 for details.

APPENDIX A.4 – ORION 2800 DC

SETUP/OPTION = ORION (Forces Pulse Divider to 3960)

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	OR2800DC	RT-21
MOT CW	1	1
MOT CCW	2	2
POS	5	4
GND	6	3

CALIBRATION PROCEDURE

1. Find the center of rotation of the rotor.
 - a. If you are replacing an existing system, simply point the antenna at the center, North (South)
 - b. To find the center, first 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, then turn the rotor some more in the CCW direction until you get the “NO MOTION” error. This is the CCW mechanical limit and record the heading

Now, using the CW button, turn the antenna until the display reads the recorded heading above + 194 degrees. (This is 180 + the 14 degree over-travel that this rotor supports)

2. Now that you’re at center, go to SETUP/CALIBRATE and set the value to the desired center of rotation, 0 degrees. (180 degrees)

If an existing antenna is NOT centered correctly on the mast, and is not pointing correctly, simply use SETUP/CALIBRATE to match the display with the actual antenna. Your limits will not be centered, but the display will be accurate. In this case, you may want to match the soft limit values with the actual mechanical stops.

NOTE: The “Auto Cal Orion” facility within the SETUP UTILITY program will automate this process for you. See Page 49 for details.

APPENDIX A.5 – CREATE RC5 SERIES

SETUP/OPTION = POT

SETUP/MAX SPEED = AC Motor

AC Motor

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

Transformer Taps

Transformer	J9 Connection	NOTE
Brown	J9-1	
Orange	J9-2	

Position Feedback

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

Rotor Connections

Function	RC5	RT-21
MOT GND	1	3
MOT CW	2	1
MOT CCW	3	2
POT REF	4	5
POS	5	4
GND	6	3

NOTE: Term 3 gets 2 wires

CALIBRATION PROCEDURE

1. Since this rotor has slight over-travel, find the center of rotation visually or simply use the existing "center point" of your antenna if installed.
2. Turn the rotor 180 degrees CCW with the CCW button from this center point VISUALLY South. (North)
3. Press the CANCEL and CCW together and hold 2 seconds until the display reads "CAL CCW = xxx" where xxx should be a number < 100. (It may be helpful to press the CANCEL "slightly" ahead of the CCW button.)
4. Turn the rotor exactly 360 degrees CW (using the CW button) until the antenna is again in the same direction as in #2. South (North)
5. Press the CANCEL and CW 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 CW button.)

APPENDIX A.6 – HY-GAIN HAM_x, T²X

SETUP/OPTION = HAM_x

SETUP/MAX SPEED = AC Motor

AC Motor

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

Position Feedback

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

Transformer Taps

Transformer	J9 Connection	NOTE
Brown	J9-1	
Violet	J9-2	

Rotor Connections

Function	Hy-Gain	RT-21
MOT GND	1	3
BRK	2	6
POS	3	4
CAP	4	7
MOT CW	5	1
MOT CCW	6	2
CAP	8	8

NOTE: RT-21 uses only 7 wires

CALIBRATION PROCEDURE

1. Use the CCW button to rotate the antenna position counter-clockwise until the antenna is pointed exactly 180 degrees CCW from the center of rotation, South (North) This should be at the CCW mechanical limit in the rotor
2. Press the CANCEL and CCW 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. Use the CW button to turn the antenna position exactly 360 degrees until it is back pointed in the same direction. South (North)
4. Then Press CANCEL and CW this time until the "CAL CW = xxx" appears. This time the number should be > 700
5. If your unit is a T²X, now set SETUP/OPTION = T2X. This will enable the brake unstick features and set the soft limits to keep the rotor 5 degrees away from the limit switches.

NOTE: These rotors are limited in accuracy for a number of reasons, including the fact that the brake sets in 6-degree increments. Also, these rotors have feedback potentiometers that can introduce significant "noise" into the system due to their mechanical design. It may take some time to get used to seeing these artifacts on the RT-21's highly accurate digital display, even though additional filtering is done in software for these rotors. We also suppress the display of the tenths as superfluous for these types of rotors.

APPENDIX A.7 – YAESU G800S, DXA, 1000S, DXA, 2700SDX, 2800DXA ETC.

(and other 24 VDC motor Yaesu units)

SETUP/OPTION = POT

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	1-2
J6	1-2
J16	1-2

Rotor Connections

Function	Yaesu	RT-21
POT REF	1	5
POS	2	4
GND	3	3
MOT CCW	4	2
MOT CW	5	1
OT N/C	6	N/C

CALIBRATION PROCEDURE

1. Use the CCW button to rotate the antenna position counter-clockwise until the antenna is at the CCW mechanical limit. South (North)
2. Press the CANCEL and CCW 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. Use the CW button to turn the antenna position exactly 360 degrees until it is back pointed in the same direction. South (North)
4. Then Press CANCEL and CW this time until the "CAL CW = xxx" appears. This time the number should be > 600
5. Go to SETUP/CW LIMIT and set the limit + 90 degrees to allow for the 90 degree over travel. This will enable computer commands to reach the over travel area with the "shortest route" feature. This setting is 270 if the default OFFSET = 180 is being used.

NOTE: This is the standard over travel area (90 degrees CW) of the standard Yaesu controller. The RT-21 allows this rotation over-travel to be anywhere, CCW or split. The Calibration procedure to do this is simply resetting the antenna position on the mast to align with the desired CCW mechanical limit, then turning CW with the CW button until the antenna is 180 degrees CCW from the center. Then follow from step 2 above.

APPENDIX A.8 - SPID

SETUP/OPTION = SPID (Forces Pulse Divider to 360)

DC Motor

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

Position Feedback

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

Transformer Taps

Transformer	J9 Connection	NOTE
Brown	J9-2	
Yellow	J9-4	
J8-3	J9-3	Fail Safe

Rotor Connections

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

CALIBRATION PROCEDURE

1. Verify that your rotor is 1 pulse/degree (Pulse Divider = 360) as some SPIDS use 2 Pulse/degree, which would require you to modify the Divider to 720.
2. These 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 its desired center of rotation
3. Go to SETUP/CALIBRATE and match the displayed heading with the physical heading using the knob.

You may skip step 2 if you already know that the antenna is physically adjusted where you want given your coax loops.

APPENDIX A.9 - HY-GAIN HDR-300

SETUP/OPTION = POT

AC Motor

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

Transformer Taps

Transformer	J9 Connection	NOTE
Brown	J9-1	
Orange	J9-2	

Position Feedback

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

Rotor Connections

Function	HDR-300	RT-21
MOT CW	1	1
MOT CCW	2	2
GND	3	3
BRAKE	4	6
POT REF	8	5
POS	9	4
GND	10	3

CALIBRATION PROCEDURE

1. Since this rotor has over-travel, find the center of rotation visually or simply use the existing "center point" of your antenna if installed.
2. Turn the rotor 180 degrees CCW with the CCW button from this center point VISUALLY South. (North)
3. Press the CANCEL and CCW together and hold 2 seconds until the display reads "CAL CCW = xxx" where xxx should be a number < 200. (It may be helpful to press the CANCEL "slightly" ahead of the CCW button.)
4. Turn the rotor exactly 360 degrees CW (using the CW button) until the antenna is again in the same direction as in #2. South (North)
5. Press the CANCEL and CW together and hold 2 seconds until the display reads "CAL CW = xxx" where xxx should be a number > 600. (It may be helpful to press the CANCEL "slightly" ahead of the CCW button.)

APPENDIX A.10 – ALLIANCE HD-73

SETUP/OPTION = POT
 SETUP/MAX SPEED = AC Motor

AC Motor

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

Transformer Taps

Transformer	J9 Connection	NOTE
Brown	J9-1	
Orange	J9-2	

Position Feedback

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

Rotor Connections

Function	HD-73	RT-21
MOT CW, CAP	1	1 & 7
POS	2	4
GND	3	3
GND	4	3
REF	5	** 5 **
MOT CCW, CAP	6	2 & 8

** NOTE: ** Insert 75-100 Ohm Resistor in series with terminal 5

CALIBRATION PROCEDURE

1. Use the CCW button to rotate the antenna position counter-clockwise until the antenna is pointed exactly 180 degrees CCW from the center of rotation. South (North) This should be at the CCW mechanical limit in the rotor
2. Press the CANCEL and CCW together and hold 2 seconds until the display reads "CAL CCW = xxx" where xxx should be a number < 200. (It may be helpful to press the CANCEL "slightly" ahead of the CCW button.)
3. Use the CW button to turn the antenna position exactly 360 degrees until it is back pointed in the same direction. South (North)
4. Then Press CANCEL and CW this time until the "CAL CW = xxx" appears. This time the number should be > 600

APPENDIX A.11 – ROTOR DOCTOR RD-1800

SETUP/OPTION = POT

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	1-2
J6	1-2
J16	1-2

Rotor Connections

Function	RD-1800	RT-21
MOT CW	1	1
MOT-CCW	2	2
GND	3	3
POS	4	4
REF	7	5

CALIBRATION PROCEDURE

1. Use the CCW button to rotate the antenna position counter-clockwise until the antenna is pointed exactly 180 degrees CCW from the center of rotation, South (North) This should be at the CCW mechanical limit in the rotor
2. Press the CANCEL and CCW 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. Use the CW button to turn the antenna position exactly 360 degrees until it is back pointed in the same direction. South (North).
4. Then Press CANCEL and CW this time until the "CAL CW = xxx" appears. This time the number should be > 700

APPENDIX A.12 – YAESU G-450/650XL

(Also for G-400x, 600x models using the 24 VAC motors)

SETUP/OPTION = POT

AC Motor

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

Transformer Taps

Transformer	J9 Connection	NOTE
Brown	J9-1	
Orange	J9-2	

Position Feedback

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

Rotor Connections

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

NOTE: Term 3 gets 2 wires

CALIBRATION PROCEDURE

1. Use the CCW button to rotate the antenna position counter-clockwise until the antenna is pointed exactly 180 degrees CCW from the center of rotation, South (North) This should be at the CCW mechanical limit in the rotor
2. Press the CANCEL and CCW 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. Use the CW button to turn the antenna position exactly 360 degrees until it is back pointed in the same direction, South (North).
4. Then Press CANCEL and CW this time until the "CAL CW = xxx" appears. This time the number should be > 600

NOTES:

1. If indicator appears noisy, additional filtering may be obtained by using SETUP/OPTION = HAM
2. Modifying the G450XL rotor to bring out the 3rd wire of the pot may improve performance. If this is done, then
 - a. Connect new wire to 3 (GND)
 - b. Connect 2 to RT-21-4 (POS)
 - c. Connect 3 to RT-21-5 (REF)
 - d. Change J6 to 1-2

APPENDIX A.13 – PROSISTEL ‘D’

SETUP/OPTION = TIC-PST

DC Motor

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

Transformer Taps

Transformer	J9 Connection	VDC	MODEL
Brown	J9-2		
Yellow	J9-4 **	18 V	61D/2051
Orange	J9-4 **	28V	Newer 71D
Violet	J9-4 **	42V	Older 71D
J8-3	J9-3		Fail Safe

Position Feedback

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

Rotor Connections

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

** Use only 1 wire on J9-4 for your rotor type

** 61D/2051 - if you desire to run as low as 12 VDC, connect J9-2 to Yellow and J9-4 to Orange instead of what's listed in the Transformer Taps above.

CALIBRATION PROCEDURE

(Be careful not to exceed your coax loop limit while performing the calibration.) **DO NOT USE THE PRESET KNOB OR TRUST LCD DISPLAY UNTIL UNIT IS CALIBRATED**

1. Ensure your rotor is set to center of rotation with the POT wiper at 2.8 K Ohms from the high side of the pot. Use an Ohmmeter to verify. (This is the Prosisstel Factory ship setting as well)
2. Mechanically set your antenna to the desired center of rotation direction, North (South) with enough coax loop to reach at least 180 degrees each direction.
3. Turn the rotor with the CCW button and watch (or have helper) until the antenna is exactly 180 degrees CCW from where it was in step #2. South (North) Perform the CAL CCW by pressing and holding CCW and CANCEL at the same time until the display reads "CAL CCW = xxx". The CAL CCW number should be around 300. (You may find it easier to lead slightly with the CANCEL button)
4. Turn the rotor with the CW button and watch (or have helper) until the antenna turns 360 degrees CW until it's back in the exact same spot it was in step #4, South (North). Perform the CAL CW as above except use the CW button instead of CCW The CAL CW number should be around 700.
5. If you desire to increase the amount of allowable rotation to beyond 360 degrees, then set the CCW LIMIT left of center by the number of additional degrees you wish to allow to go CCW. Set the CW LIMIT right of center by the number of additional degrees you wish to allow to go CW

APPENDIX A

APPENDIX B – UNIVERSAL ROTOR SETUP INFORMATION

(for Rotors not listed in Appendix A)

Use the Worksheet below to record the required information for interfacing your rotor to the RT-21.

Worksheet Information

Rotor Configuration Worksheet	
Rotor Type/Brand	
Motor Power	
Does it run on AC or DC	
What is the Voltage?	
Position Indicator Type	
Is the indicator type a Potentiometer (3 wires)?	
Is the indicator type a Pulse Counter (Y/N)?	
If the indicator is a Pulse Counter, record the number of pulses per 360 degrees of antenna rotation.	
Rotational Range	
If your rotor's rotational range is larger than 360°, you will need to keep this in mind for setting soft limits and for calibration.	
What is the Rotational Range in degrees?	

SETTINGS for J10, J12 and J14

For AC Motors

Jumper	Position	Connection type
J10	1-2	Jumper plug
J14	1-2	Jumper plug
J12	1-2	Wire/screw jumper

For DC Motors

Jumper	Position	Jumper Type
J10	2-3	Jumper plug
J14	2-3	Jumper plug
J12	2-3	Wire/screw jumper

APPENDIX B

Transformer Wire Connections to J9

For 18 VAC Motors

Wire Color	Connect	Jumper
Brown	to	J9-1
Yellow	to	J9-2

For 24 VAC Motors

Wire Color	Connect	Jumper
Brown	to	J9-1
Orange	to	J9-2

For 36 VAC Motors

Wire Color	Connect	Jumper
Brown	to	J9-1
Violet	to	J9-2

For 12-14 VDC Motors

Wire Color	Connect	Jumper
Yellow	to	J9-3
Orange	to	J9-4

For 24 VDC Motors

Wire Color	Connect	Jumper
Brown	to	J9-3
Orange	to	J9-4

For 36 VDC Motors

Wire Color	Connect	Jumper
Brown	to	J9-3
Orange	to	J9-4

For 42 VDC Motors

Wire Color	Connect	Jumper
Brown	to	J9-3
Violet	to	J9-4

NOTE: For longer cable runs, it may be necessary to use a higher voltage transformer tap.

APPENDIX B

SETTINGS for J5 and J6

Position Indicator Type is COUNTER

Jumper	Position	Connection type
J5	2-3	Jumper plug
J6	N/C*	Jumper plug

Position Indicator Type is POT (3-wire potentiometer)

Jumper	Position	Connection type
J5	1-2	Jumper plug
J6	1-2	Jumper plug

Position Indicator Type is HAM, Hy-Gain[®] HAMx or 2-wire variable resistor.

Jumper	Position	Connection type
J5	1-2	Jumper plug
J6	2-3	Jumper plug

Settings for J16

Pro-Sis-Tel Rotors (Range Expansion)

Jumper	Position	Usage
J16	1-2	Normal
J16	2-3	Pro-Sis-Tel Only

This setting (2-3) expands the voltage range of the POT circuit for use with Pro-Sis-Tel rotors only. See Appendix A.13 for additional information

Rotor Connections

Refer to your Rotor's instruction manual to identify its wire functions, then refer to the RT-21 terminal functions below. If you are unsure of the proper connections, please contact Green Heron for assistance. Contact information is provided at the front of this manual.

RT-21 Terminal Functions

Terminal Number	Terminal Name	Function
1	CW	AC Motor Hot or DC +/- for clockwise movement
2	CCW	AC Motor Hot or DC +/- for counter-clockwise movement
3	GND	Ground/Return for AC Motor and Position (CTR or POT)
4	POS	Position CTR High or POT Wiper (+V for HAMx Pot)
5	REF	Pot high-side reference voltage
6	BRK,	Brake AC HOT for HAMx
7	CAP	Motor Start Capacitor for HAMx
8	CAP	Motor Start Capacitor for HAMx

NOTES: AC Motors are referenced to GND and
DC Motors reverse polarity at Terminals 1 and 2

APPENDIX C – EXTERNAL RELAY CONTROL

The RT-21's flexibility allows it to be used with almost any type of rotor, including those requiring external relay switching. External switching is often used for rotors that operate with high voltage or high current, which would be impractical (or unsafe) to control over long cable runs.

When using external relay control, ensure that the RT-21 is configured to match the DC voltage of the relays, rather than the motor voltage. Also, you must set the **MAX SPEED** to **11** to avoid "chatter" in the relays with pulse-width modulated speed control.

Figure C-1 shows one implementation of external relay switching with a 24 VDC relay. Some minor modifications are required to the RT-21 as described on the drawing. Many variations of this basic scheme are possible. If you intend to operate with external relay control, please contact Green Heron Engineering to discuss your implementation and receive the latest technical information.

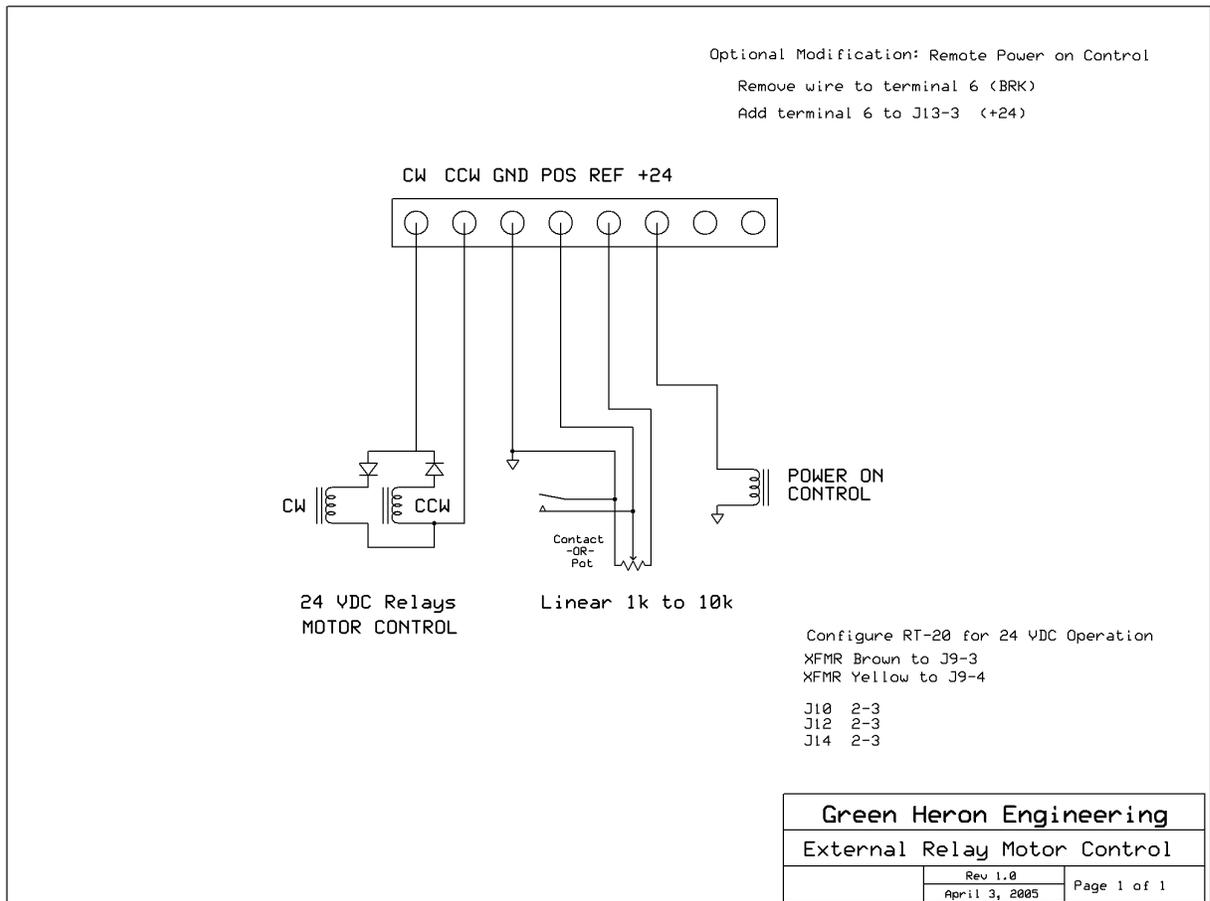


Figure C-1. External Relay Control
(Sample Configuration)

APPENDIX D – FAIL SAFE OPTION

For rotors without limit switches

RECOMMENDED FOR TIC, Prosistel and Alfa-Spid

NOTE: This option is “built” into Appendix ‘A’ setups for these three rotors. No additional changes are required.

This option yields an extra fail safe for DC motor applications where the Rotor unit DOES NOT include mechanical limit switches. There is a simple hardware modification (no soldering) will provide an additional level of security for these rotors. Should the FET driver fail, or a short circuit occur on the return leg of a DC motor, the rotor cannot run away.

This option uses the internal BRAKE relay (normally used with HAM-X or T2X rotors) to switch the power transformer feeding the motor power supply. Then the power supply is not activated until the rotor intends to turn, and remains activated only for the DELAY time set in software. The default delay is 2.5 seconds.

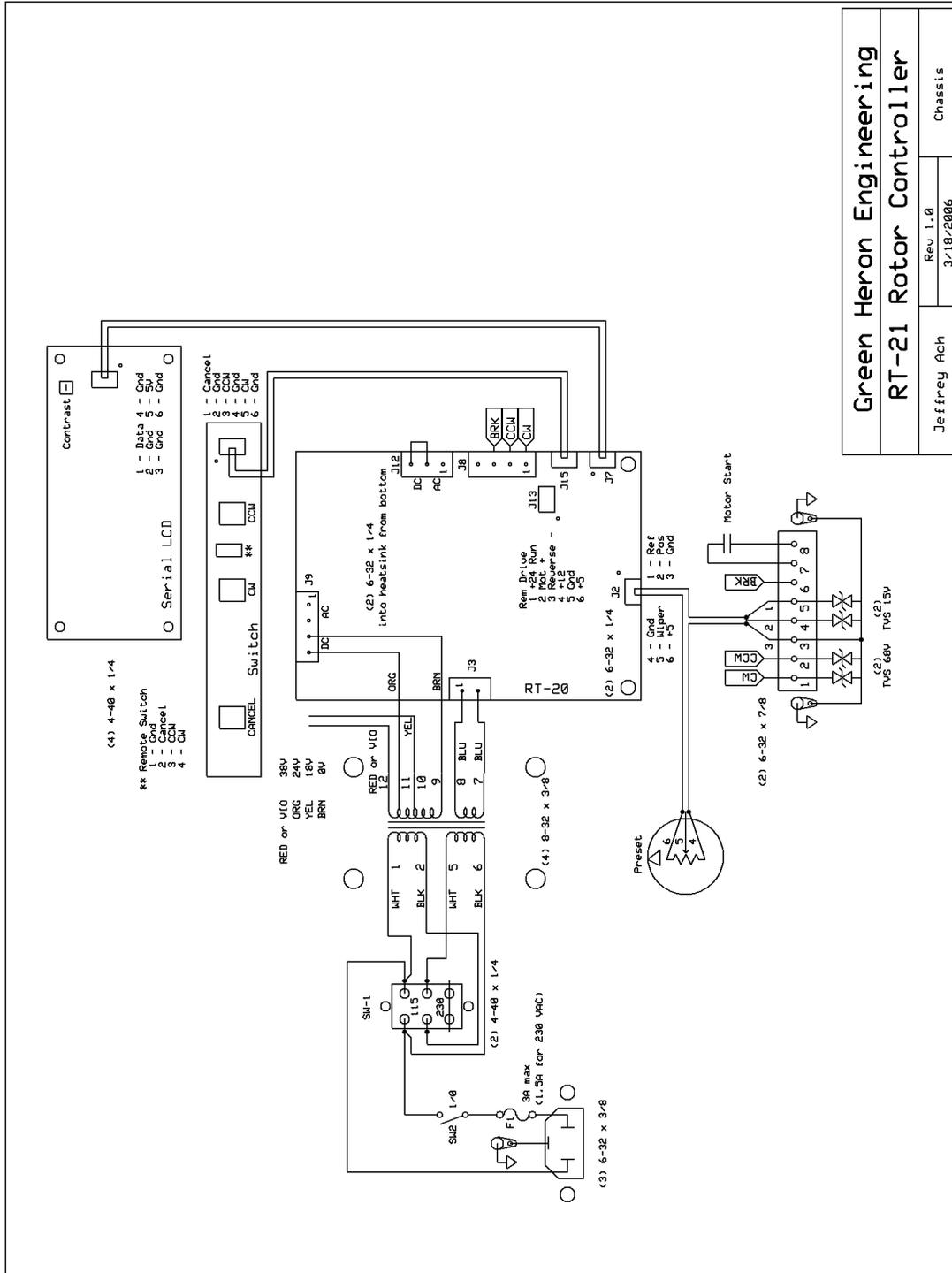
1. Remove the Wire from J8-3 that runs to the BRK terminal on the rear panel. You may park this wire in J8-4 (gnd)
2. Move the transformer wire from J9-3 over to J9-2 (This is the low side of the transformer)
3. Add a #18 or #20 wire from J9-3 (where the wire in #2 was) over to J8-3 (where the wire to the BRK terminal was).

This will work with any DC motor.

Reverse the 3 steps in order to use an AC motor.

APPENDIX E – RT-21 SCHEMATIC

Typical for RT-21 PCB rev 1.8



Green Heron Engineering	
RT-21 Rotor Controller	
Jeffrey Ach	Rev 1.0
	3/18/2006
Chassis	

APPENDIX F – ERROR MESSAGES

ERROR

NO MOTION

No Motion errors occur if your rotor attempts a rotation but does not detect a heading change of at least 1 degree in the allotted time, typically about 3 seconds. This could indicate either that the rotor is not turning, OR, it is turning but the feedback mechanism is not working. In either event, the RT-21 reboots and stops the attempted motion to allow you to diagnose the problem without possibly damaging your coax or antennas.

You will get No Motion error if you have your soft limits set outside (or beyond) your limit switches as the rotor attempts to keep turning. This, of course, is not a failure and you can prevent it by simply bringing the RT-21 soft limits to, or inside the limit switch positions.

TROUBLESHOOTING

Rotor not turning:

DC Motors – Disconnect wires from terminals 1 and 2, you should be able to read the rotor motor resistance (a few ohms) across the wires removed with an Ohmmeter. Consult your rotor documentation if you can't. Be sure you aren't up against a limit switch somehow. Check the RT-21 by connecting a 10k Ohm resistor across 1 and 2, SPEED = 11 and, MODE = DEBUG. Push the CW or CCW buttons and read the motor voltage across the terminals 1 and 2. Voltage switches polarity with the other button.

AC Motors – Similar except separate wires CW or CCW read voltage to ground (3). Check your rotor and cable following the instructions in your manual.

Rotor turning, no feedback:

POT systems – Connect a 500 Ohm to 10k Ohm linear pot to terminals 3,4 and 5 with the wiper on 4. With the controller in DEBUG mode, you should be able to see the Heading display track the pot setting. You can even check the A/D endpoints by calibrating the controller to this pot at one end, then the other. You can read the position of the rotor's pot back through the wires you removed.

HAM systems – similar except just hook up one end and the wiper of a 500 Ohm (must be this value) pot to terms 3 and 4. Check your Hy-Gain manual for specifics on testing your cable and rotor from the cable end with a meter.

COUNTER Systems – With MODE = DEBUG, use a clip lead to tap across terms 3 and 4. You should be able to see the display move CW or CCW depending on the last direction you attempted to rotate. If this works, you have a problem with you cabling or rotor sending switch.

ERROR

POT OUT-OF-RANGE

XXXX

(OPTION = TIC-PST only)

This error indicates that the value being read by the A/D converter of the controller is below or above the normal operating range of the potentiometer in the rotor. The actual A/D value (xxxx) is displayed to let you know if it's high or low. The controller will NOT function when this condition exists unless the controller is in MODE = DEBUG. A short circuit or open circuit in the pot wiring would cause this error to occur as will an improper calibration of the rotor.

Correct Range: (Terminal 4 (POS) on rear panel)

TIC = 0.5 to 7.2 VDC (PCB Jumper J16 = 1-2)

PST = 4.7 to 6.3 VDC (PCB Jumper J16 = 2-3)

APPENDIX G – COMMUNICATIONS PROTOCOL

The protocol implemented in the RT-21 is a "superset" of DCU-1 and therefore retains its compatibility with most software packages without change. If your software package does not have a Green Heron selection, then use the DCU-1 or Rotor EZ selections.

All RS-232 communications is at 4800 8N1, the DCU-1 standard. The same commands are supported over the USB port.

The following commands are supported, the shaded commands are DCU-1 compatible commands. All commands begin with an upper case letter (except the first one in the list) and all commands end with a semi-colon (;). All letters are upper case. You may type commands at any pace using HyperTerminal, ProComm, or any terminal emulator. There is no inter-character timeout, the buffers may be cleared by simply sending a semi-colon (;).

;	Stops current rotation immediately (short ramp down)
AIn;	Reads Heading 3 digits, leading zeros included in response which is xxx;
AWnxxx(.y);	Writes new Heading xxx.y for Calibrating a Pulse Count System
BIn;	Reads Heading with tenths. Response is xxx.y;
STn;	Stops current rotation immediately (short ramp down)
AVn;	Sends and receives special headings on 232 port only for counter-rotation function.
APnxxx(.y);	Sets rotation degrees to xxx optionally .y (tenths) for the next AMn; command
APnxxx(.y)<cr>;	Sends rotor to heading immediately, no AMn; required
AMn;	Move rotor to last AP send heading
R0n;	Read Rotors pot A/D value, response is <SOH>xxxx; xxxx is 0 to 1023 10 bit A/D value
R1n;	Read RT-21 model and version #. response is <SOH> "RT-21 Version X.Y";
RXn;	Read EE value A through Z (See list below)
W00;	Loads Default EE values and Reset Controller
W0n(callsign);	Write vanity message centered on line three of display for boot message
WXn(value);	Write value to EE location A through Z (See list) (SEE n= below for info on EE Write)
C0n;	Force unit to CAL CCW at current position
C1n;	Force unit to CAL CW ant current position

n = digit 0-9, n = 0 on WX (WriteEE) commands forces reboot, n <> 0 just writes value.
Commands that return values (other than A11;) include SOH ahead of data.

EE Locations value of X =:

A – CCW Cal (0)	J – Option (Pot)
B – CW Cal (950)	K – Pulse Divider (3960)
C – Reserved	L – Cal Range (360)
D – Cal Offset (180)	M - Mode (Normal)
E – Delays (3)	N - Ramp (3)
F – Min Speed (3)	O – Brightness (8)
G – Max Speed (10)	P – Rotor Fail Timeout (2)
H – CCW Limit (180)	Q – Security (Admin)
I - CW Limit (180)	

APPENDIX H – SETUP UTILITY

Introduction

SETUP UTILITY is a Java program and is distributed without the Java Runtime needed for operation. If your computer does not have the correct Java platform installed, you will be directed to the proper web location for download.

SETUP is an easy to use utility that can be used with the Green Heron RT-21 controller to allow computer access to all of the SETUP items that can be done from the front panel SETUP menus. In addition, the SETUP UTILITY additionally provides for:

- Connecting to a controller via RS-232 or USB.
- Rotor control and display of current heading.
- Computer access to the front panel SETUP parameters.
- Access to parameters that are hidden from the front panel.
 - MOTOR TIMEOUT in seconds.
 - Security Setting to allow User lockout of SETUP and Resets.
 - Vanity Display changes for the LCD/VFD at start-up.
 - Direct setting of POT Calibration values
- Additional Calibration features for easy quick setup of new rotors
 - AUTO CAL for Orion
 - AUTO CAL for some POT style rotors
- Ability to Save and Recall calibration parameters for your specific rotor installations

Connecting

Select a COM port. Only ports that are really available are shown in the drop down Port box. Click To Connect – If a controller is on that COM port, Connected will be displayed in the Port section, and all of the various parameters will be read along with the Current Heading.

NOTE: An older RT-20 can display and move to a new heading, but the rest of the window will remain grayed out as no functions, other than Rotor Control, work remotely on the RT-20. An upgrade kit, RT-20 to RT-21, is available that will yield full SETUP UTILITY functionality less the USB connection.

Rotor Control

The lower right corner of the window shows the Current Heading (yellow on black window) with a text box available to select a new heading. You can double click the New Heading box to type in a heading. Then click on Go. Stop will send the stop command to the rotor.

Computer Access to SETUP parameters

Rotor Type is the OPTION setting in front panel SETUP. Mode, Pulse Divisor, Motor Settings, Offset, Cal Range, Soft Limits and the Display Brightness all mimic the Front Panel SETUP parameters. If you have selected a Counter type of rotor, the Pulse Cal will be available too. See the manual for detailed descriptions of these settings. Some settings are with radio buttons. Some with sliders, and others require you to click on a **Change** button and type in a value.

Limits

The red bar in the Limits window gives you nice visual representation of the soft limits as read from the controller, or changed in the SETUP UTILITY. This bar takes into account both the OFFSET value and the Soft Limit values to graphically represent the rotational range. The center of the Limits window IS ALWAYS the center of rotation. This may not always be coincident with the center of the red bar if the limits are not equally set away from their centers.

Do CCW Cal & Do CW Cal

These buttons mimic the front panel CANCEL + CCW and CANCEL + CW buttons that set the actual pot calibration A/D values into the controller. You must first have turned the rotor to the visual CCW and CW 360 degree endpoints by using the front panel buttons. Please refer to the manual for information on calibrating a POT system.

Use the **Read Settings** and **Write Settings** buttons near the bottom of the Utility window, to read and write from and to the controller.

Reset button will mimic the CANCEL+CCW+CW buttons that cause a complete RESET EE function back to factory defaults.

Computer Access to “Hidden” parameters

Security

If set to User, will disable access to SETUP, RESET EE and Pot Calibration from the front panel.

Motor Timeout

Set this value higher than 2 seconds if your rotor is slow or you use very long ramping and may exceed the 2 seconds from time to time.

Set Vanity

Will change the boot-up message on the display. You can enter up to 20 characters and they will be centered on the 3rd line of the display at start up. You must restart the controller after using this button. Close the SETUP UTILITY first if connected via USB.

Pot Cal

You can see the actual A/D value of the pot voltage as read by the CPU. Note that this value doesn't change with the Current Heading. It will only be updated when you Read Settings.

You may also directly set the A/D values in the CW and CCW calibration locations without actually doing the pot calibration. If you know what the values are for your installation, you can put them back using this facility. You can also make small changes to the stored values, or set them full wide (0 and 960) prior to recalibrating. (as a substitute for doing a full Reset EE prior to calibration.)

The A/D values (Analog to Digital Converter) is the voltage returned from the wiper of the indicator pot inside the rotor. It can range in value from 0 to around 960 which correspond to 0 VDC, to around 9.8 VDC.

Auto Calibration

Pot Auto Cal

Click this button to see the rotors that can be Preset Calibrated from standard values that will normally provide pretty close calibration. Different rotors can be added by editing the file RotorPresets.ini (located in the install directory). The values provided in this file are set into the A/D values that would normally be set using the normal calibration procedures. You can edit this file to put in different values for different rotors of the same type. TIC 20, TIC 15 could be examples. You may calibrate each rotor normally, then you can edit the RotorPresets.ini to put the values in so they can be recalled at anytime from the Pot Auto Cal facility.

Auto Cal Orion

Click this button to run the Orion Auto Calibration facility. This is quite different from the Pot Auto Cal that simply stuffs preset values into the controller memory. An Orion uses a pulse count system and has +/- 14 degrees of over-travel (360 + 28 degrees of rotation). It can sometimes be difficult to find the mechanical center of these rotors in order to set the direction of the antenna/mast in the rotor to the desired center.

When you run the Auto Cal Orion, SETUP UTILITY will apply settings to the controller that allow bypassing of soft limits in order to find the mechanical CCW endstop limit switch. Then, it will turn the rotor back to the center by turning 180 plus 14 degrees and then setting the rotor calibrate to the desired center of rotation. SETUP knows that the center is always 180 degrees CW from the OFFSET value.

When Auto Cal Orion is finished, the Orion rotor is run to the mechanical center of rotation and the Calibration value is set there too. You can then either mechanically turn the antenna on the mast to match your desired center, or if it's close, simply reset the Calibrate Heading value to the actual antenna position. If you do change this value, the rotor will no longer be exactly centered. This will limit the amount of overtravel in one or the other direction, but the headings will be accurate.

Save and Recall Settings

You may save and recall complete sets of parameters that are stored in your controllers. This may be useful if you have multiple rotors and controllers and want backup settings in case you need to replace a controller, or accidentally erase settings. You may also use this facility to re-use one controller on different rotors in your stations(s) and quickly setup from one to another without having to reset a bunch of parameters and without having to perform the normal calibrations.

After connecting to a controller that you wish to save, verify the settings and then press **Save to File**. In order to recall, do a **Read from File**. The currently connected controller will be restored automatically.

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