GREEN HERON ENGINEERING LLC

RT-20
DIGITAL ROTOR CONTROLLER
USER GUIDE

Document Revision 3.3

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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-20 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 90 days. 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.

TRADEMARKS

M2 Orion is a trademark of M2 Antenna Systems, Inc.

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 3 amp 5x20 mm fuse in the rear panel fuse holder.

If it is necessary, replace only with:

115 VAC – 3 amp max

230 VAC – 1.5 amp max

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Section 1

1.0 Introducing the RT-20

The RT-20 Digital Rotor Controller represents a new concept in antenna aiming technology. Unlike conventional controllers, the RT-20 may be configured for use with virtually any communications-grade rotator, and it adds an array of features not found on any other controller today. At the heart of the RT-20 is an embedded microprocessor that allows for precise, repeatable commands that can be issued by turning a "point and shoot" heading knob, pressing the CW or CCW buttons, or by entering commands on a connected PC. With its flexibility and wide array of features, the RT-20 brings any rotator—old or new—into the digital age.

Of particular interest to "multi-op" contesters and others with multiple arrays, two or more RT-20 Controllers may be linked together for complete control of all station antennas, even those on rotating towers. Side-mounted antennas may all be moved to the same heading simultaneously, or each antenna can maintain its own heading relative to the movement of the tower or other antennas. In the case of a rotating tower, antennas mounted on a RingRotor® or a rotor atop the tower will compensate for tower movement by counter-rotating to accurately hold their position as the tower turns.

Please Read This!

Some users of electronic gear only read manuals when trouble occurs, or when seeking information about an unfamiliar feature or command. While the RT-20 is designed for very easy use and flexibility, the manual is an *essential* part of configuring the unit for use with your rotator. Take the time to read and follow the steps presented here, and you will soon be up and running with your RT-20. After installation, the manual should be retained for future reference.

During the configuration steps, frequent reference is made to the Appendix sections at the back of this manual. These sections contain rotator-specific information needed to make the RT-20 work properly with your rotor. It will also be helpful to have the instruction manual for your rotator handy when determining voltage levels, AC or DC operation, cabling pinouts, etc.

RT-20 manual updates, information on new firmware releases, application notes, and other product information may be found on our website at: www.GreenHeronEngineering.com. The website is especially useful when connecting the RT-20 to rotators that are not listed in this manual. Technical assistance can also be obtained using the contact information that appears on the inside front cover.

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.

1.1 Special Terms Used

The following terms may be unfamiliar to new users of the RT-20 and are defined here for clarity. It is important to understand their meanings, as they will be used frequently during configuration and setup tasks:

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-20 to execute this move automatically, stopping at the selected heading.

Soft Limits—These are travel limits that can be programmed into the RT-20. The effect is similar to the mechanical limits built into many rotators, 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 rotator does not have mechanical endpoints, this feature helps avoid turning the rotor past a desired range.

Ramp-up/Ramp-down—This RT-20 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, except for MANUAL button presses.

NOTE For the purpose of this manual, the terms “rotator” and “rotor” are used interchangeably. Also, the compass headings of 360 and 0 degrees are used interchangeably.

Setting up the RT-20

It is **very <u>important</u>** that you become familiar with the various options and settings described in this section of the manual before using your RT-20. Because of the flexibility of the unit, there are options that MUST be configured prior to hooking up and using it with your rotor

IMPROPER CONNECTIONS OR SETTINGS COULD CAUSE PERMANENT DAMAGE TO YOUR CONTROLLER, ROTOR, OR BOTH.

Green Heron Engineering will not be responsible for damage caused by improper settings or connections.

1.2 Prepare for RT-20 Hardware Configuration

Refer to **Appendix A** of this manual and determine if your rotor type is listed there. This appendix describes settings and connections for most common rotor types. It is divided into subsections (A.1, A.2, A.3, etc.), with each section pertaining to a specific model.

1.2.1 If your rotor type is included in Appendix A, proceed directly to Step 1.3. Keep the appendix information at hand while configuring your unit.

1.2.2 If your rotator is ***not*** described in Appendix A refer to the Universal Setup Information contained in Appendix B. There, you will find a worksheet and tables to determine the proper settings for your controller unit. Use the completed worksheet and the other information in Appendix B to complete the tasks in Step 1.3.

<u>NOTE</u> Contact Green Heron Engineering or check out website for the latest information concerning your rotor. We have experience interfacing with virtually every rotor type in use!

1.3 RT-20 Hardware Configuration

Begin with these steps to configure the RT-20 for use with your rotator:

1. Ensure that the power cable is disconnected from the rear panel of the RT-20.
2. Remove the eight Phillips head screws securing the top cover and remove the cover.

3. Familiarize yourself with main PC board as shown in Figure 1. Note the locations of all jumper plugs and wires identified with arrows.

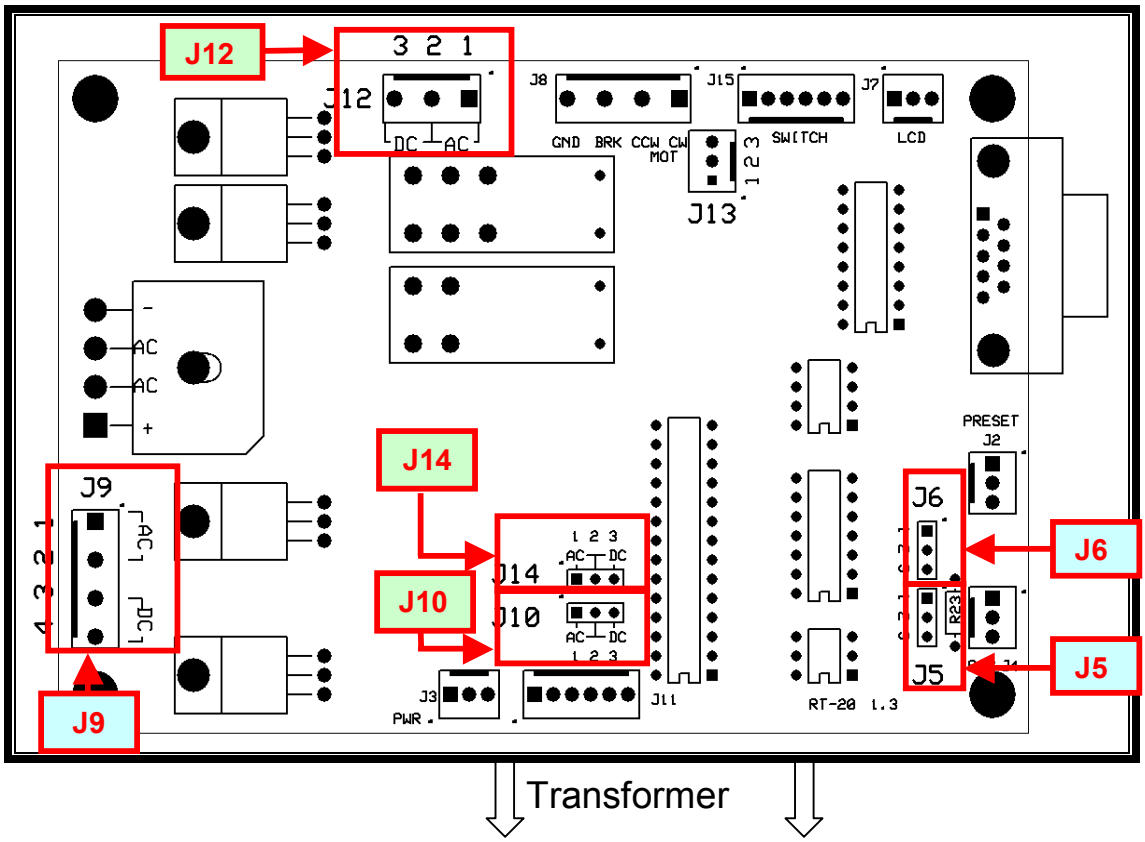


Figure 1. RT-20 PC Board Layout—Locations of Configuration Jumpers

4. Select your motor type (AC or DC) with J10, J12, and J14 as follows:
   - Using the Appendix that applies to your rotor, set the jumpers to the positions listed in the table titled "Settings for J10, J12 and J14." A pair of small needle nose pliers will be helpful when moving jumpers.
5. Select your transformer wire connections as follows:

Only two transformer wires are used, regardless of the installation type.

DO NOT connect unused transformer wires. Protect them from shorts by using the supplied wire nuts

   - In the Appendix for your rotor, refer to the table titled "Transformer Wire Connections to J9" and connect two of the wires as indicated.
   - Place the supplied wire nuts on the unused wires.

5. Select Your Position Indicator Type:

   - In the Appendix for your rotor, refer to the table titled “Settings for J5 and J6” and make the required jumper connections.

6. Reinstall the top cover of the RT-20, securing it with the screws removed earlier.

   - The cover should be oriented so that there is a slight overhang at the top of the RT-20 front panel.

7. 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-20. 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 3A fuse for 115 VAC operation, or a 1.5A fuse for 230 VAC operation. Replacement fuses are available at most electronics parts distributors.

8. 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.

   This completes the hardware configuration of the RT-20.

1.4 Perform Setup

This section explains how to set the correct **OPTION** parameter for your system. This ensures the correct startup conditions for your rotor, and makes items that pertain to your rotor accessible in the **SETUP** menu. For example, the **BRAKE DELAY** item is not available unless **HAM** is the selected **OPTION**.

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

Before making this selection, ensure that all hardware settings have been made as described in Section 1.3 above

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 one of the operating options (**POT**, **CTR** or **HAM**) by rotating the heading knob until the correct operating option for your rotor is displayed:
   - **POT** – 2 or 3-wire potentiometer or variable resistor
   - **CTR** – Pulse Counter
   - **HAM** – HAM-X or T²X Hy-Gain® Rotor with separate wedge brake control*
3. When the correct option for your rotator is displayed, save it as follows:
   - Press the CHANGE button
   - Press the SAVE button

NOTE: Rotors using a separate wedge-style brake 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-20'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.

1.5 Connect the RT-20 to your Rotor

Remove power from the unit before making rotor connections

1.5.1 Connect your rotator to the rear panel terminal strip of the RT-20 using the "Rotor Connections" table in the Appendix for your rotor.

1.5.2 If your rotor is *not* listed in Appendix A, use Appendix B (Universal Rotor Setup Information) along with the documentation for your rotor to determine the correct connections. Please contact Green Heron Engineering if you have any questions about connecting to your particular rotor.

1.6 Configure the OFFSET Value

The offset value is the number of degrees that your counter-clockwise (CCW) endpoint is from true North. 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, then your offset would be 0 (default) or if your center-of-rotation is North, then your offset would be 180 degrees.

1.6.1 Configure the proper Offset value by following the steps below:

1. Press and hold SETUP/ITEM until SETUP appears.
2. Press SETUP/ITEM until OFFSET appears.
3. Rotate the heading knob until the desired offset is displayed.
   - Press the **CHANGE** button
   - Press the **SAVE** button

1.7 Calibrate Your System

1.7.1 Refer to the Appendix for your rotor. If your operating **OPTION** was set to **CTR** (Pulse Counter), set the value as follows:

1. Enter the divide ratio (number of pulses in a 360-degree rotation) for your rotor as follows:
   - Press and hold down the SETUP/ITEM button until SETUP appears in the display window.
   - Repeatedly press SETUP/ITEM until DIVIDE HI appears on the display.
     - Select the two high-order digits by rotating the heading knob. (Example: For 1785 pulses, “17” would be the high-order digits.)
     - Press the CHANGE button.
   - Repeatedly press SETUP/ITEM until **DIVIDE LO** appears on the display.
     - Select the 2 low-order digits by rotating the heading knob. (Example: For 1785 pulses, “85” would be the low-order digits.)
     - Press the SAVE button.
2. Calibrate to the actual (physical) heading of your antenna.
   - Note the current heading of your antenna using a compass.
   - Press and hold down the SETUP/ITEM button until **SETUP** appears in the display window.

- Repeatedly press SETUP/ITEM until **CALIBRATE** appears on the display.
- Rotate the heading knob until the display indicates the current heading of your antenna.
- Press the CHANGE button, followed by the SAVE button.

1.7.2 If your operating **OPTION** was set to **POT** or **HAM**, proceed as follows:

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. Using the **CCW** button on the front panel, turn your rotor until the CCW endpoint is reached.
   - If your rotor has mechanical stops at 360 degrees, simply turn it until it stops. Otherwise, turn the rotor only as far as 180 degrees CCW from the desired center-of-rotation.)
2. Press **CANCEL** and **CCW** simultaneously until **CAL CCW** appears on the display.
3. Using the **CW** button on the front panel, turn your rotor 360 degrees clockwise from the previous setting until your antenna is back to exactly the same heading as before. (Or against the CW stop if your stops are 360 degrees apart.)
4. Press **CANCEL** and **CW** simultaneously until **CAL CW** is displayed. This completes the calibration.

Section 2

2.0 FRONT PANEL CONTROLS & DISPLAY

2.1 FRONT PANEL CONTROLS

The controls on the front of the RT-20 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.

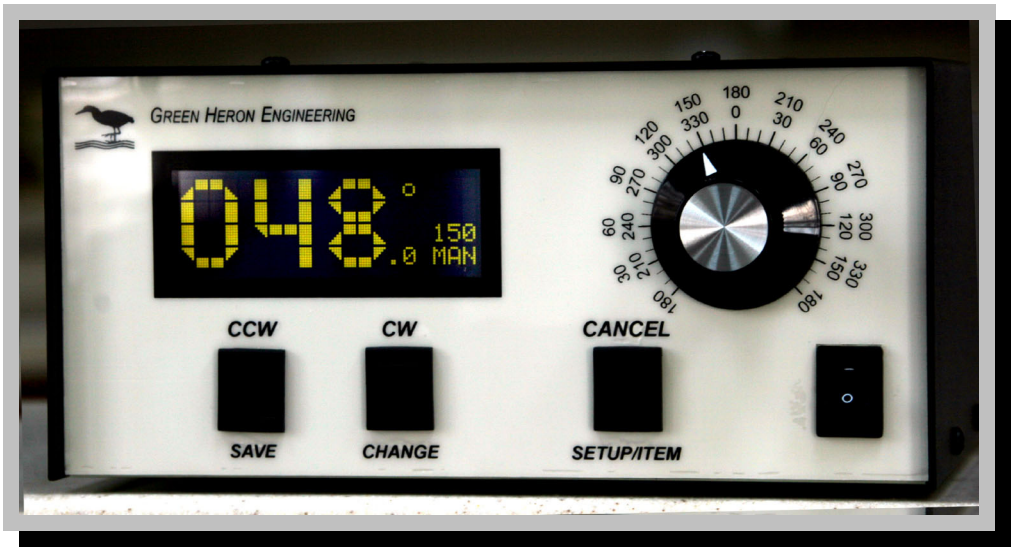


Figure 2. RT-20 Front Panel

2.1.1 Front Panel Buttons—Normal Operation

When the RT-20 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
CW	Turns rotor clockwise
CANCEL	In normal operation mode CANCEL can be used in three ways: • A click of the CANCEL button cancels the current rotation event from the front panel heading knob or external RS-232 line. • 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.

2.1.2 Heading Knob—Normal Operation

The heading knob on the RT-20 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-20 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-20 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. • 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

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.
CANCEL+CW	Calibrate CW at CW endpoint.
CANCEL+CCW+CW	Restores all default values to factory settings except for the OPTION parameter.

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.

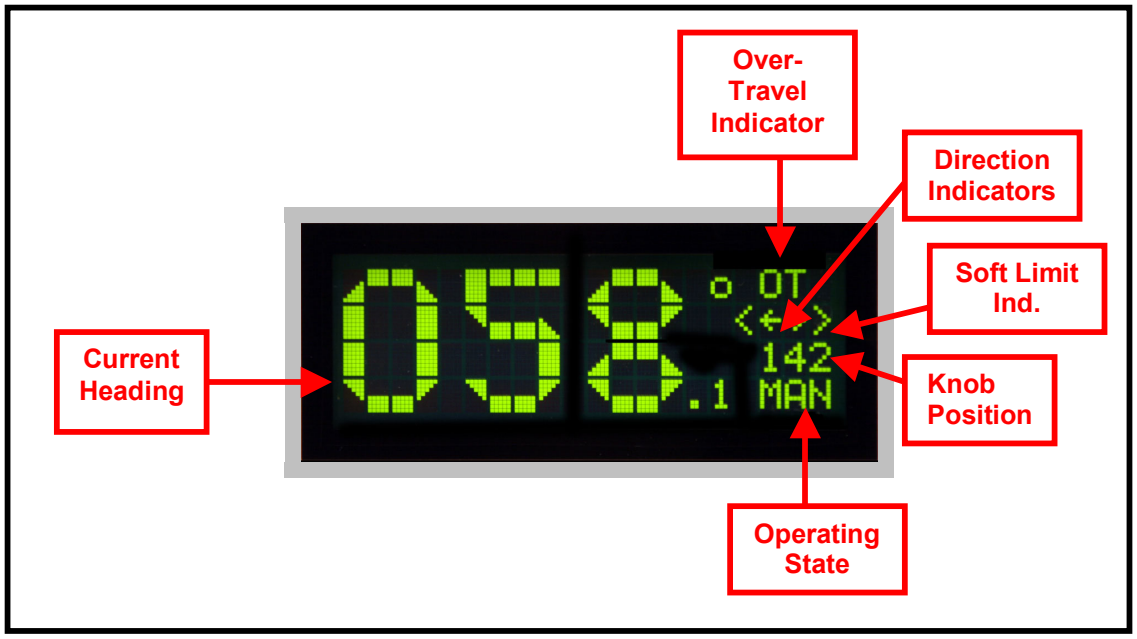


Figure 3. RT-20 Front Panel Display

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.)
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.)
	BRK	Brake Activated (HAM X style electrical brake)
Soft Limit	**<** **>**	Rotor has reached the soft limit set in the rotor SETUP. The RT-20 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-20 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-20 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 motor shutdown. No position feedback is present.

Section 3

3.0 SETUP MODE

The RT-20 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 rotator **must** be selected and saved prior to changing any other items in **SETUP**

3.1 SETTING THE 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. For example, the **BRAKE DELAY** item is not available unless **HAM** is the selected OPTION.

The RT-20 supports three different **OPTION** values: **POT**, **CTR** and **HAM**.

3.1.1 **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-20 reads the voltage on the wiper of the potentiometer using a precision A/D converter and displays the result in degrees.

3.1.2 **CTR** 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-20. This count is used to calculate the current position of the rotator in degrees.

3.1.3 **HAM** – HAM-X or T^2X Hy-Gain® Rotor with separate wedge brake control.

The **HAM** option uses the potentiometer method of determining the position of the rotor. In addition it controls a separate wedge brake included in these rotors.

When the **HAM** option is selected, the RT-20 waits 300 milliseconds (ms) after disengaging the brake before starting the motor. It also delays setting the brake after rotation is complete. The user may adjust the brake delay from 0 to 5.9 seconds.

The RT-20 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.

3.1.4 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 = XXX**.
3. Set the **OPTION** parameter for your rotor
   - Rotate the heading knob until the desired **OPTION** (**POT**, **CTR** or **HAM**) is displayed after **NEW =** on the display.
   - Press the CHANGE button when the correct **OPTION** for your rotator is displayed.
   - Press the SAVE button to save the option and exit the **SETUP** menu.

3.1.5 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-20. For example, changing the **CTR** divide ratios will change the **CALIBRATE**, the **OFFSET** will change the **SOFT LIMITS** to match, etc.

3.1.6 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 (**CTR**) – This item calibrates the directional display to the physical direction of your antenna.

OFFSET (**CTR**, **POT**, **HAM**) – Sets the CCW endpoint for your system in degrees clockwise from true North. The default setting is "0". This means that the default stops are at North with a South center-of-travel. To set a North center, you would set the **OFFSET** to 180. This setting also affects the soft limits within the RT-20 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.

REV DELAY (**CTR**, **POT**, **HAM**) – This sets the delay enforced by the RT-20 before allowing a reversal in motor direction. This is done to reduce tower stresses, and the delay is adjustable in 100 ms increments up to a maximum of 5.9 seconds (59 on the display).

BRK DELAY (**HAM**) – This sets the delay for brake application, after rotation, of a HAM-style rotor that employs a separate wedge brake. The delay is adjustable and displayed in 100 ms increments up to a maximum of 5.9 seconds (59 on the display).

SPEED (**CTR**, **POT**, **HAM**) – 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 rotator, whether using point-and-shoot or external control. This reduces tower stress on large arrays. Speed 11 is full speed with no ramp-up or ramp-down conditioning.

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

OPTION (**CTR**, **POT**, **HAM**) – Selects the rotor type. Described earlier in this section.

DIV HIGH (**CTR**) – 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. Thus if your rotor provides 1785 pulses in 360 degrees, the **DIV HIGH** value is set to **17**.

DIV LOW (**CTR**) – 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. Thus if your rotor provides 1785 pulses in 360 degrees, the **DIV LOW** value is set to **85**. (Always set the **DIV HIGH** first, then the **DIV LOW**.)

CAL RANGE (**POT**, **HAM**) – 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 (**CTR**, **POT**, **HAM**) – Selects the operating mode of the RT-20 controller.

- **NRM** Mode – NORMAL mode allows manual control, point-and-shoot and computer control via the rear panel EIA-232 port.
- **M/S** Mode–Master/Slave Mode, where multiple RT-20 controllers are linked together.
  - Usage and Examples:

    Master/Slave mode allows one RT-20 to control other RT-20 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 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-20s that control the upper rotor 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.

Section 4

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.

You either do 4.1 OR 4.2 depending on your rotor OPTION type.

4.1 POT or HAM OPTIONS ONLY

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-20 to a new rotor type.

4.1.1 Perform the following steps to properly calibrate the RT-20

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.
   - 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-20 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 CTR OPTION ONLY

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-20 cannot adjust the actual position of your antenna in relation to the physical endstops OR in relation to your coax rotor loops as installed.

Section 5

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-20 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).

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 control and voltage setting to optimize your system.

3. When evaluated with the RT-20, HAMx and T^2X rotors exhibited the least effective speed control. For these rotors, we recommend setting the RT-20 to **SPEED= 11** to eliminate the PWM control.

4. We recommend that the RT-20 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.

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 RingRotors and Alfa-Spids as there rotors do not have limit switches.

6. Your RT-20 comes from the factory set up for a 36 VDC motor (mid-voltage) and a potentiometer-positioning indicator system. The offset value is zero, which needs a CCW & CW endpoint of North, and a South 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-20 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 3A fuse for 115 VAC operation, or a 1.5A fuse for 230 VAC operation. Replacement fuses are available at most electronics parts distributors.

5.2 COMPUTER CONTROL OF RT-20 (EIA-232 Port)

The RT-20 is equipped with a fully operational RS-232 port. This port can be used for simple computer "read and control" or in combination with other RT-20 controllers in order to implement Master/Slave or Master/Counter-Rotation control of antenna arrays.

The protocol implemented in the RT-20 is based on the Hy-Gain® DCU-1 protocol. It reports headings and turns to headings with the same commands implemented in DCU-1. Set your software to use DCU-1 protocol and the RT-20 should work fine with it. Additional commands are provided for the advanced features that only your RT-20 can perform.

5.3 CALIBRATION OF SIDEARM INSTALLATION

If your rotor uses a **CTR** 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** 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 M/S 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 CANCEL. With three or more rotors in the stack, only one unit may be designated as **M/S** because of the interconnection scheme. 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-20 (the one connected to the computer) can be the Master unit.

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-20 units, proceed as follows:
   - Cable the units as shown in Figure 4.
   - All connectors are assumed to be DB-9 type.
   - Note that only two wires are needed on units set to **MODE NRM**.
   - Pre-made cables are available from Green Heron Engineering. Check our website for details.

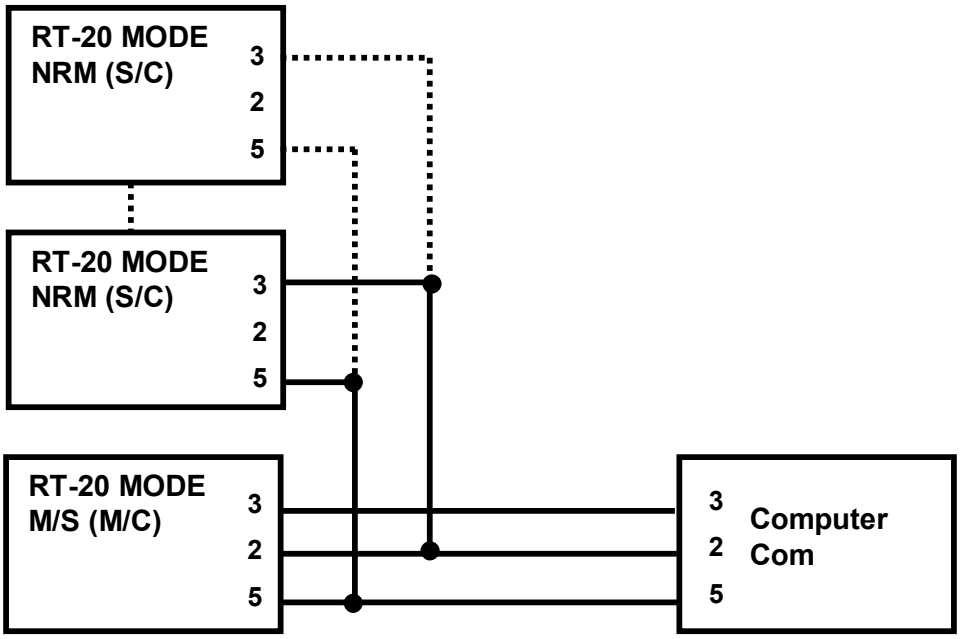


Figure 4. Master/Slave (M/S) Interconnect Example
(For multiple RT-20s connected together)

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.

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-rotator scheme, with or without a computer. The computer can only control the lower rotator 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 DBG (Debug) Mode

5.6.1 This mode enables troubleshooting of the system by allowing access to some normally-suppressed features:

1. It enables continuous updating of position data on the display.
2. It disables the **POSITION FAIL** motor shutdown if position feedback indicates that the rotor is not moving.

NOTE: The RS-232 port will not accept commands in **DBG** mode.

APPENDIX A.1 - TIC RING Setup Information

1.1. Setup Information for TIC RING

1.1.1 OPTION (Software Setup Selection)

Rotor	SETUP OPTION
TIC RING Rotor	POT

1.1.2 SETTINGS for J10, J12 and J14

Jumper	Position	Connection type
J10	2-3	Jumper short
J12	2-3	Jumper short
J14	2-3	Screw connector short

1.1.3 Transformer Wire Connections to J9

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

1.1.4 Settings for J5 and J6 (Standard Potentiometer)

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

1.1.5 Rotor Connections

TIC	RT-20	Description
2	1	MOT CCW
3	2	MOT CW
4	5	CW/REF
5	4	WIP/POS
6	3	CCW/GND

The TIC Ring rotator has no mechanical stops or limit switches.

Please install FAIL-SAFE OPTION in Appendix D on page 43 as the RT-20 soft limits are the only protection against over-rotation.

Please be careful to nsure that your TIC Ring does not over-travel during calibration.

APPENDIX A.2 - ORION 2300 (Original)

1.2. Setup Information for the Orion 2300

1.2.1 OPTION (Software Setup Selection)

Rotor	SETUP OPTION
Orion 2300 (Original) rotor	POT

1.2.2 SETTINGS for J10, J12 and J14 (36 VAC Motor)

Jumper	Position	Connection type
J10	1-2	Jumper short
J12	1-2	Jumper short
J14	1-2	Screw connector short

1.2.3 Transformer Wire Connections to J9

Wire Color	Connect	Jumper
Brown	to	J9-1
Red or Vio	to	J9-2

1.2.4 Settings for J5 and J6 (Standard Potentiometer)

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

1.2.5 Rotor Connections (Note that Terminal 3 gets two wires)

OR-2300	RT-20	Description
1	3	MOT GND
2	2	MOT CCW
3	1	MOT CW
4	5	POT REF
5	4	POSITION
6	3	GROUND

APPENDIX A.3 - ORION 2800 (AC)

1.3. Setup Information for the Orion 2800 AC

1.3.1 OPTION (Software Setup Selection)

Rotor	SETUP OPTION
Orion 2800 AC rotor	CTR DIV HIGH=39 DIV LOW=60

1.3.2 SETTINGS for J10, J12 and J14 (36 VAC Motor)

Jumper	Position	Connection type
J10	1-2	Jumper short
J12	1-2	Jumper short
J14	1-2	Screw connector short

1.3.3 Transformer Wire Connections to J9

Wire Color	Connect	Jumper
Brown	to	J9-1
Red or Vio	to	J9-2

1.3.4 Settings for J5 and J6 (Pulse Counter)

Jumper	Position	Connection type
J5	2-3	Jumper short
J6	2-3	Jumper short

1.3.5 Rotor Connections

OR-2800 AC	RT-20	Description
1	3	MOT GND
2	2	MOT CCW
3	1	MOT CW
5	4	POS
6	3	GND

NOTE: The ORION 2800 AC supports +/- 14 degree over-travel. The RT-20's soft limits may be set to match if desired.

APPENDIX A.4 - ORION 2800 (DC)

1.4. Setup Information for the Orion 2800 DC

1.4.1 OPTION (Software Setup Selection)

Rotor	SETUP OPTION
Orion 2800 DC rotor	CTR DIV HIGH=39 DIV LOW=60

1.4.2 Pulse Counter Hi/LO Settings

Rotor	Xxx	Value
Orion 2800 DC rotor	DIV HIGH	39
Orion 2800 DC rotor	DIV LOW	60 (3960)

1.4.3 SETTINGS for J10, J12 and J14 (42 VDC Motor)

Jumper	Position	Connection type
J10	2-3	Jumper short
J12	2-3	Jumper short
J14	2-3	Screw connector short

1.4.4 Transformer Wire Connections to J9

Wire Color	Connect	Jumper
Brown	to	J9-3
Red/Vio	to	J9-4

1.4.5 Settings for J5 and J6 (Pulse Counter)

Jumper	Position	Connection type
J5	2-3	Jumper short
J6	2-3	Jumper short

1.4.6 Rotor Connections

OR-2800 DC	RT-20	Description
1	1	MOT CW
2	2	MOT CCW
5	4	POS
6	3	GND

NOTE: The ORION 2800 DC supports +/- 14 degree over-travel. The RT-20's soft limits may be set to match if desired.

APPENDIX A.5 - CREATE RC5 Series

1.5. Setup Information for the Create RC5 Series Rotators

1.5.1 OPTION (Software Setup Selection)

Rotor	SETUP OPTION
Create RC5 Series	POT

1.5.2 Settings for J10, J12 and J14 (28 VAC Motor)

Jumper	Position	Connection type
J10	1-2	Jumper short
J12	1-2	Jumper short
J14	1-2	Screw connector short

1.5.3 Transformer Wire Connections to J9

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

1.5.4 Settings for J5 and J6 (Standard Potentiometer)

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

1.5.5 Rotor Connections (Terminal 3 gets 2 wires)

RC5	RT-20	Description
1	3	MOT RET/GND
2	1	MOT CW
3	2	MOT CCW
4	5	POT REF
5	4	POS
6	3	GND

NOTE: The Create RC5 Series allows moderate over-travel and supports wider soft limits.

APPENDIX A.6 - HY-GAIN® HAMx, T²X

1.6. Setup Information for the HY-GAIN® HAMx and T²X Rotators

1.6.1 OPTION (Software Setup Selection)

Rotor	SETUP OPTION
HY-GAIN® HAMx and T²X	HAM

1.6.2 Settings for J10, J12 and J14 (34 VAC Motor)

Jumper	Position	Connection type
J10	1-2	Jumper short
J12	1-2	Jumper short
J14	1-2	Screw connector short

1.6.3 Transformer Wire Connections to J9

Wire Color	Connect	Jumper
Brown	to	J9-1
Red or Vio	to	J9-2

1.6.4 Settings for J5 and J6 (This rotor is a Potentiometer type, but the RT-20 uses only two wires from the pot, as a grounded wiper is employed.)

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

1.6.5 Rotor Connections (3rd pot wire N/C)

HAMx	RT-20	Description
1	3	MOT RET/GND
2	6	BRK
3	4	POS
4	7	CAP
5	1	MOT CW
6	2	MOT CCW
8	8	CAP

APPENDIX A.7 – YAESU G-800DXA, 1000DXA, 2800DXA (2700SDX *) Setup Information

1.7. Setup Information

1.7.1 OPTION (Software Setup Selection)

Rotor	SETUP OPTION
Yaesu types referenced above	POT

1.7.2 Settings for J10, J12 and J14 (42 VDC Motor)

Jumper	Position	Connection type
J10	2-3	Jumper short
J12	2-3	Jumper short
J14	2-3	Screw connector short

1.7.3 Transformer Wire Connections to J9

Wire Color	Connect	Jumper
Brown	to	J9-3
Yellow	to	J9-4 (24 VDC) for 2700SDX*
Orange	to	J9-4 (36 VDC) for G-800DXA, 1000DXA and 2800DXA

1.7.4 Settings for J5 and J6

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

1.7.5 Rotor Connections

Yaesu	RT-20	Description
1	5	POT REF.
2	4	POS
3	3	GROUND
4	2	MOT CCW
5	1	MOT CW
6	4	N/C
7	3	N/C

APPENDIX A.8 – SPID (Alfa-Spid) Setup Information

1.8. Setup Information for Alfa-Spid

1.8.1 OPTION (Software Setup Selection)

Rotor	SETUP OPTION
Alfa-Sid	CTR DIV HIGH=3 DIV LOW=60

1.8.2 Settings for J10, J12 and J14 (24 VDC Motor)

Jumper	Position	Connection type
J10	2-3	Jumper short
J12	2-3	Jumper short
J14	2-3	Screw connector short

1.8.3 Transformer Wire Connections to J9

Wire Color	Connect	Jumper
Brown	to	J9-3
Yellow	to	J9-4 Short runs (24 VDC)

1.8.4 Settings for J5 and J6 Pulse Counter

Jumper	Position	Connection type
J5	2-3	Jumper short
J6	2-3	Jumper short

1.8.5 Rotor Connections

SPID	RT-20	Description
1	1	MOT CW
2	2	MOT CCW
3	3	GROUND
4	4	POS

The Alfa-Spid rotator has no mechanical stops or limit switches.

Please install FAIL-SAFE OPTION in Appendix D on page 43 as the RT-20 soft limits are the only protection against over-rotation.

Please be careful to ensure that your Alfa-Spid does not over-travel during calibration.

APPENDIX A.9 - HY-GAIN® HDR-300 Setup Information

1.9. Setup Information for HY-GAIN® HDR-300 Rotators

1.9.1 OPTION (Software Setup Selection)

Rotor	SETUP OPTION
HY-GAIN® HDR-300	HAM

1.9.2 Settings for J10, J12 and J14 (24 VAC Motor)

Jumper	Position	Connection type
J10	1-2	Jumper short
J12	1-2	Jumper short
J14	1-2	Screw connector short

1.9.3 Transformer Wire Connections to J9

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

1.9.4 Settings for J5 and J6

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

1.9.5 Rotor Connections

HAMx	RT-20	Description
1	1	MOT CW
2	2	MOT CCW
3	3	GROUND
4	6	BRAKE
8	5	POT REF
9	4	POS
10	3	GND

APPENDIX A.10 – ALLIANCE HD-73 Setup Information

1.10. Setup Information for Alliance HD-73

1.10.1 OPTION (Software Setup Selection)

Rotor	SETUP OPTION
Alliance HD-73	POT

1.10.2 Settings for J10, J12 and J14 (20 VAC Motor)

Jumper	Position	Connection type
J10	1-2	Jumper short
J12	1-2	Jumper short
J14	1-2	Screw connector short

1.10.3 Transformer Wire Connections to J9

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

1.10.4 Settings for J5 and J6 (Standard Potentiometer)*

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

* Requires 75-to-100 ohm resistor in series with the POT reference voltage (Pin 5 on RT-20).

1.10.5 Rotor Connections

HD-73	RT-20	Description
1	1 & 7 (Tied together)	MOT CW, CAP
2	4	POS
3	3	GND (Motor Return)
4	3	GND (Pot Return)
5	5	REFERENCE (Add 75-100 ohm resistor in series with this wire)
6	2 & 8 (Tied together)	MOT-CCW, CAP

APPENDIX A.11 – Rotor Doctor RD-1800 Setup Information

1.11. Setup Information for Rotor Doctor RD-1800

1.11.1 OPTION (Software Setup Selection)

Rotor	SETUP OPTION
RD-1800	POT

1.11.2 Settings for J10, J12 and J14 (20 VDC Motor)

Jumper	Position	Connection type
J10	2-3	Jumper short
J12	2-3	Jumper short
J14	2-3	Screw connector short

1.11.3 Transformer Wire Connections to J9

Wire Color	Connect	Jumper
Brown	to	J9-3
Yellow	To	J9-4

1.11.4 Settings for J5 and J6 (Standard Potentiometer)*

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

1.11.5 Rotor Connections

RD-1800	RT-20	Description
1	1	Motor CW
2	2	MOTOR CCW
3	3	GND (Pot Low Side)
4	4	POS (Pot Wiper)
7	5	REF (Pot High Side)

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-20.

1.12. Worksheet Information

Rotor Configuration Worksheet	
Rotor Type/Brand	
Motor Power	
Does it run on AC or DC (Y/N)?	
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?	

1.13. SETTINGS for J10, J12 and J14

1.13.1 For AC Motors

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

1.13.2 For DC Motors

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

1.14. Transformer Wire Connections to J9

1.14.1 For 18 VAC Motors

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

1.14.2 For 24 VAC Motors

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

1.14.3 For 36 VAC Motors

Wire Color	Connect	Jumper
Brown	to	J9-1
Red or Vio	to	J9-2

1.14.4 For 24 VDC Motors

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

1.14.5 For 36 VDC Motors

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

1.14.6 For 42 VDC Motors

Wire Color	Connect	Jumper
Brown	to	J9-3
Red or Vio	to	J9-4

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

1.15. SETTINGS for J5 and J6

1.15.1 Position Indicator Type is CTR

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

1.15.2 Position Indicator Type is POT (3-wire potentiometer)

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

1.15.3 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

1.16. Rotor Connections

Refer to your rotator's instruction manual to identify its wire functions, then refer to the RT-20 terminal functions below. If you are unsure of the proper connections, please contact Green Heron Engineering LLC for assistance. Contact information is provided at the front of this manual.

RT-20 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-20'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-20 is configured to match the DC voltage of the relays, rather than the motor voltage. Also, you must set the **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-20 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.

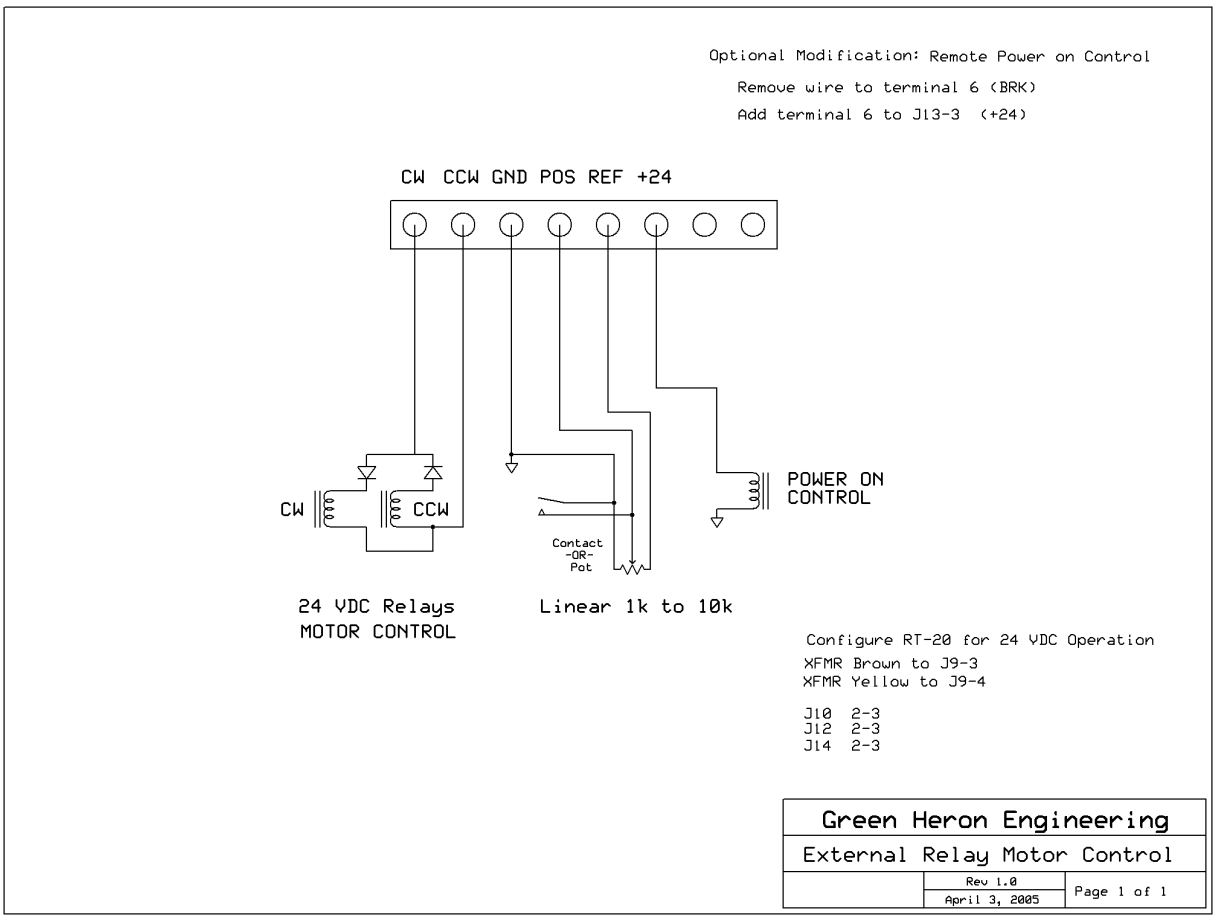


Figure C-1. External Relay Control
(Sample Configuration)

APPENDIX D – Rotors without Limits Switches

Fail-Safe Option

RECOMMENDED FOR TIC RINGS and ALFA SPID

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) that can be installed along with software version 1.58 or later, that 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 BRK DELAY time set in software. The default delay is 2.5 seconds.

To install this change, first ensure version 1.58 or later is installed

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 Brown transformer wire from J9-3 over to J9-2

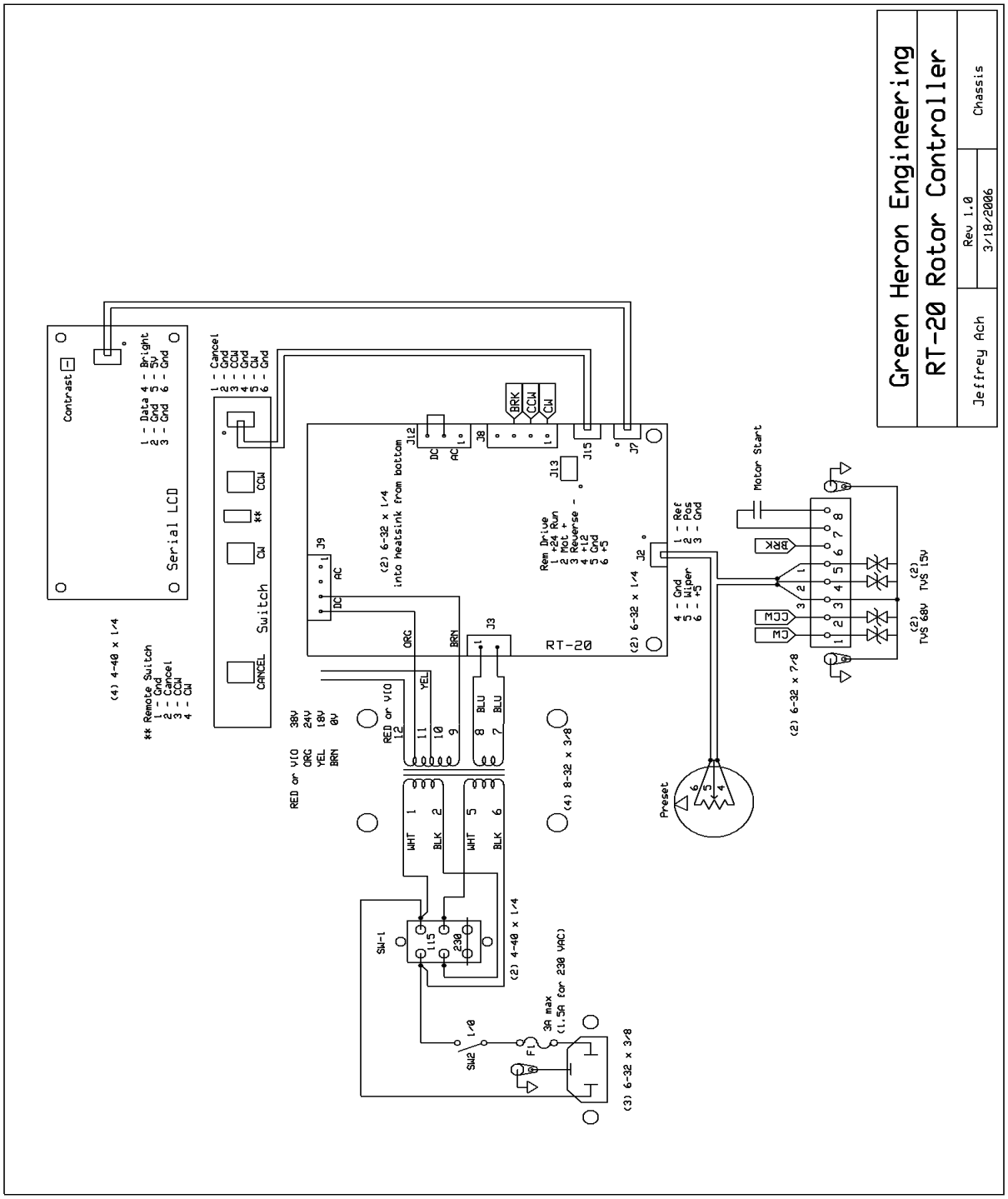
3. Add a #18 or #20 wire from J9-3 (where the Brown wire was) over to J8-3 (where the wire to the BRK terminal was).

This will work with any DC motor. The BRK indicator now indicates that the power supply is enabled.

Reverse the 3 steps in order to use an AC motor, you do not have to re-install older software.

APPENDIX E – RT-20 Schematic

Typical for RT-20 PCB rev 1.6 (LCD connections are slightly different on earlier units)



APPENDIX F – Error Messages

POSITION FAIL

Position Fail occurs if your rotor attempts a rotation but does not see the heading display change by at least 1 degree in the allotted time, typically about 2 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-20 reboots and stops the attempted motion to allow you to diagnose the problem without possibly damaging your coax or antennas.

You will get Position Fail 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-20 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. Consult your rotor documentation if you can't. Be sure you aren't up against a limit switch somehow. Check the RT-20 by connecting a 10k Ohm resistor across 1 and 2, SPEED = 11 and, MODE = DBG. 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 up a 250 Ohm to 10k Ohm linear pot to terminals 3,4 and 5 with the wiper on 4. With the controller in DBG 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.

CTR Systems – With MODE = DBG, 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.

ROTOR POT CAL ERROR

This error indicates that the calibration settings for the POT or HAM options are messed up. Either the values are the same (calibrated on an open circuit or without turning the rotor) or CW and CCW were reversed. Remember, CTR systems DO NOT use the CAL CW and CAL CCW commands. (See Section 4.0) The fix is to RESET EE and start over.

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