Rotor-EZ Assembly and Installation

Building a ROTOR-EZ requires basic electronics skills, such as good soldering techniques and being able to identify basic components. Some components in this kit can be damaged by static electricity – use suitable precautions. Before starting, make sure the rotor control unit is unplugged. Caution: 120 Volts AC will be present at several locations on the circuit card. Note: Due to copyright considerations a schematic for the rotor and rotor controls cannot be reprinted here. However, the circuit is in the rotor manual. Having the circuit available will help understand some aspects of the installation.

Unplug the power cord. Remove the wires going to the rotor; be sure to mark down the colors and rear terminal numbers. Remove the control box covers. Before going further, remove any circuits added to the rotor control box after its manufacture, especially brake delay circuits, and insure that the rotor control box is restored to factory design and specifications.

The Rotor-EZ circuit board fits on the studs of the meter movement of Ham-M and Tailtwister rotor controls. Before board assembly, trial fit the Rotor-EZ PCB (printed circuit board) to the meter. Remove the wires going to the meter, and if there is a PC board attached, temporarily remove that also. (Later you will remove it permanently - the functions performed by that board are taken over by the Rotor-EZ board.)

Remove the metal bar holding the meter lamp. Save the hardware – it will be used later. Now try fitting the PCB over the meter terminals. The rectangular notch in the PCB goes to the top, and the white component layout markings face the rear. Early rotor control units had ¼" meter mounting studs. If yours is one, carefully, using a round file, enlarge the meter holes in the PCB enough to fit the PCB over the meter studs. Do not enlarge the holes unless necessary. (Please note – it was impossible to make the PCB meter stud holes universal – if the hole was made bigger to start, the holes become too large to mount the board on later series meters. Five different meters were used over the years, each with different studs and spacing.)

Board Assembly

( ) Locate diode D8. It is marked "11DQ06" on the body. Install diode D8 11DQ06 with the band oriented away from the circuit card notch. Be sure to orient all diodes correctly, verifying that the banded end is on the side shown on the layout diagram and/or board silkscreen.

( ) Locate the 1N4007 diodes. They are marked with this part number. Install D1, D3, D5, D7, D9 and D10 with the band facing away from the circuit card notch. Install D2, D4, D6, D11 and D12 with the band facing the circuit card notch. Solder all diodes. Trim the leads. As you progress further with assembly, trim the component leads after each step.

( ) Locate the 4 - 4.7K ohm resistors marked with yellow, violet, green, brown and brown bands. Insert R3, R6, R8 and R14. Solder the resistors and trim the leads. **Note:** resistors R7 and R18 are not used, even though they are marked on the circuit board.

( ) Locate the 9 – 221 ohm resistors marked with red, red, brown, and gold bands. Insert, solder and trim R1, R2, R4, R5, R9, R10, R11, R12, and R13.

( ) Insert and solder resonator Y1. This device is symmetric and can be inserted either way.

( ) Insert and solder the 28 pin socket X1, plus devices U2, a 74HC4053N, and U3, a TD62001. Insert U1 into socket X1. IMPORTANT: Make sure the notches in the devices are at the end marked in the layout drawing! Also, confirm before soldering that each chip is in the right location!

( ) Install the .1 uf capacitors, C17 and C18. These are small dipped capacitors marked "104".

( ) Install the .01uf capacitors, C2 and C5, ceramic disc capacitors marked "103".

( ) Install the .001uf capacitors, C3 and C6, ceramic disc capacitors marked "102".

( ) Locate and install fuse F1, which is a small brown or black cylinder, marked "T500maA250V".

Next you will install the electrolytic capacitors. Their value is marked on the side of the part, such as "100uf." When installing them, always be sure to orient the electrolytic capacitors correctly. The negative terminal is typically indicated on the capacitor body with a minus sign in a circle. The board layout and silkscreen will indicate the positive terminal with a plus sign.

( ) Install the 100uf capacitor C10. Insert the device with the negative terminal located towards the PCB notch. Solder and trim the leads.

( ) Install the capacitor 1000 uf C11.

( ) Locate the 4.7 uf capacitors, marked "4.7uf" on the body. Insert C1, C4, C8 with the negative terminal located away from the PCB notch. Insert C9 with the negative terminal located towards U1.

( ) If your kit includes the RS232 option, install .1uf capacitors electrolytic capacitors at C12, C13, C14, C15, and C16 with the terminal marked with "-" located towards U1.

( ) If your kit includes the RS232 option, install and solder in U5, a MAX202 chip. Make sure the notch is correctly oriented! (Note: This chip may be marked MAX232 on the circuit diagram)

( ) Locate and insert 500 ohm trim pots R15, R16, and R17. Solder in the devices.

( ) Locate the voltage regulator U4. The device has 5 pins and a heat sink tab, and is either an LM2575 or a MIC4576-5.0 As per the layout drawing, bend the leads to fit the hole pattern, then insert U4 with the heat sink tab nearest the PCB notch, and solder and trim the leads.

( ) Locate inductor L1. The device is large and rectangular with two leads. Solder in the device.

( ) Solder in relays K1, K2, and K3. The relays are large 4 or 5 leaded black rectangular devices.

There are several software options that can be disabled by using jumpers on the PC Board. They are more completely described in the operating manual. They are:

Preset Electronic End Points – recommended for all users. Prevents the system from slamming into the end stops by removing power from the motor 5 degrees before the end point is reached. Disable by soldering a jumper wire between pin 22 of U-1 and ground hole S-4 next to the pin.

Overshoot Protection – removes power from the rotator motor 3 degrees before the desired bearing is reached, allowing the antenna system to "coast". Disable by soldering a jumper wire between pin 23 of U-1 and the ground hole S-3 next to the pin.

Unstick Routine – Tailtwister rotors in particular often encounter brake jams, where the brake cannot release because of lateral pressure. Rotor-EZ includes an effective automatic brake unstick routine. Disable this routine by grounding pin 27 of U-1 to the ground hole just to the right of it.

90° Offset Support – This option turns the meter needle 90° right or left of the normal bearing, to support antennas at right angles to the main antenna, as explained in the operating manual. Grounding pin 28 of U-1 puts the control in offset mode. If you use this mode you will need to switch it in and out. For now, solder an 8" piece of #24 wire to the hole next to pin 28 of the CPU. The direction of the offset, plus or minus, is determined by pin 24. If pin 24 is not grounded, the offset is +90°. If pin 24 is grounded, the offset is -90°. There is no grounding pad next to pin 24, but you can use the ground pad for any otherwise unused option or use pin 1 of U-2. If you have no present plan to use this feature, do nothing to pins 24 and 28 of U-1.

( ) Add jumper wires to disable unwanted options, and to determine the offset direction, using a discarded resistor or capacitor lead wire. This completes PC board assembly.

Before proceeding further, check all solder connections, preferably with a magnifying glass. Especially check the pins of the CPU socket. Confirm that all chips are in the right locations, with the notched end of the chip properly oriented. Do the same for the diodes, and the electrolytic capacitors. Confirm that there are no resistors at unused locations R7 and R18. A few minutes checking now can save hours of grief later.

Rotor-EZ uses four different LED's to report the operating status of the unit. Early control boxes have no existing holes. Some later control boxes have three LED's already mounted. Other control boxes may have three holes already drilled in the secondary front panel, even though the primary panel does not have them. In any case, you will need four holes. Put the control back in its case. This makes hole drilling easier. Drill through the front panel to open existing holes if there. Follow these instructions carefully.

( ) Mark, center punch and drill a 3/32 pilot hole, then a ¼" hole centered within the front panel "Clockwise" graphic, and repeat for the "Counter Clockwise" graphic.

( ) Mark, center punch and drill two 3/32 pilot holes centered ¼" and ¾" above the "BRAKE RELEASE" graphic, then drill them to ¼". Remove the case, and inspect for metal burrs, removing any found.

( ) If your kit has the RS232 option, you will need a 5/16" hole on the rear panel. You may find a suitable hole already punched, perhaps with a plastic plug. If not, drill a hole approximately 2 1/2" in from the right side of the chassis, and 1" from the bottom of the chassis, and well clear of the power cord. Be sure to center punch and use a pilot hole. After drilling, clean the hole and insert the rubber grommet supplied.

( ) Remove all wires and circuitry going to the meter. If there is an existing circuit card on the back of the meter, remove it. You may want to make a sketch of where the wires go to aid restoration later should it prove desirable for this and the following step.

( ) Disconnect and remove all wires and circuitry to the front mounted calibration pot. If a switch is mounted behind the pot remove those wires as well.

( ) Remove all wires going to terminals 3 and 7 on the rear terminal strip.

Notes on wire: two gauges of hook-up wire supplied, #18 and #24, for board installation. Use #24 gauge except where the instruction specifically calls for #18 gauge. Multiple colors are provided to make identification easier. Select different colors as makes sense. Note the color of each wire used in this instruction manual to make later identification easier.

LED Installation: Wire the LED's to the PC board first, but do not mount the LEDs to the panel yet.

(✓) First attach the bicolor LED, which has three terminals. The lead nearest the notch on the side lip of the LED is connected to hole "X" on the PC board. The center lead connects to hole "W" and the remaining lead, which is the shortest of the three leads, is connected to hole "V". Use three wires 8" long.

(✓) Install a 6" wire from hole "P" to the lamp body terminal (Note that the wires from the smaller transformer are to remain attached to the lamp socket)
(✓) Install a 6" wire from hole "Q" to the lamp center terminal. **Important:** Note that hole "R" is not used.
(✓) Terminal #1 on the rear has a wire going to a chassis ground solder terminal. Install an 11" wire from hole "S" to that grounded solder terminal. Do not remove the original wire from the terminal.
(✓) Install a 5" wire "from the hole marked "+5" to the most clockwise terminal of the three terminals of the calibration pot as viewed from the front of the unit. Be sure you get this wire and the next two wires below on the correct terminals of the pot and the correct holes on the board or you may blow the fuse when you power the unit. If there is a switch mounted on the rear of the pot, do not use the switch terminals at this time.
(✓) Install a 5" wire from hole "Z" to center terminal of the calibration pot.
(✓) Install a 5" wire from hole "Y" to the most counter-clockwise terminal of the calibration pot.

Pretest

( ) Mount the PCB on the meter terminals using the meter hardware, notch facing up and components facing away from the meter. Adjust the position of the PCB so that its edges fit inside the chassis extremes, then tighten the nuts. Make sure no wires are loose or inadvertently grounded. Plug the control box in. When power is first applied the meter should go to full scale for 1-2 seconds. It would then display the antenna position; however, since the antenna is not hooked up it will sense an open. The unit annunciates this by wiggling the meter. Rotate the Set Pot on the front panel (formerly the calibration pot) clockwise and verify that the meter moves from left to right. If the meter moves the wrong direction then the "+5" and "Y" wires going to the pot must be reversed. If nothing happens, do not proceed until the problem is resolved. When finished, unplug the control before working on it again. All further assembly will be done with the card remaining mounted to the meter.

When soldering the two-leaded red LEDs, note that the flat side of the LED flange denotes the cathode, which also has the shorter lead, while the anode has the longer lead:
(✓) Install a 7" wire "L" to the anode of the CCW (counterclockwise) LED
(✓) Install a 7" wire "M" to the cathode of the CCW LED
(✓) Install a 10" wire "J" to the anode of the CW (clockwise) LED
(✓) Install a 10" wire "K" to the cathode of the CW LED
(✓) Install a 5" wire "D" to the anode of the BRAKE LED
(✓) Install a 5" wire "E" to the cathode of the BRAKE LED

Inspect work for solder bridges and wiring errors. IMPORTANT NOTE: many wires added will be attached to points in the rotor control that already have a wire soldered to them. Unless otherwise instructed, do not remove the existing wire – rather, solder the new wire over the existing wire(s).

(✓) Install an 8" wire from hole "A" on the circuit board to the rear terminal strip contact "7"
(✓) Install an 8" wire from hole "C" to terminal strip contact "3"
(✓) Install an 11" #18 wire from hole "O" to terminal strip contact "2"
(✓) Install an 11" #18 wire from hole "I" to terminal strip contact "5"
(✓) Install an 11" #18 wire from hole "N" to terminal strip contact "6"

(✓) The main power switch has a wire connected to the BRAKE switch. Remove the end of that wire from the power switch, and solder it to the most clockwise terminal of the calibration pot, over the wire going to "+5".

(✓) Remove the "power transformer input wire" connected to the other side of the BRAKE switch and reconnect that wire to hole "G" on the PCB.

(✓) Using a 7" #18 wire, connect hole "F" on the PCB to the switched side of the main power switch. For identification purposes, note that this switch terminal will also have a wire running to the smaller transformer.

(✓) Connect a 10" wire from hole "B" on the PCB to the BRAKE switch terminal from which you removed the power transformer wire earlier. (Note: the switch may have a terminal that was not used before. If so, it is not used now either!)

(✓) Following the above modifications to the Brake Switch, confirm that the brake switch is wired correctly as follows, or damage to the unit may result: One side of the Brake switch is wired to hole "B" on the PCB. The other side of the switch is connected to 5 volts, coming from the front mounted calibration pot. All other existing wires on the brake switch have been removed. (Relay K3, when activated, now connects "switched main power" wire "F" to the input of the power transformer wire "G".)

( ) If you have the RS232 option, mount the supplied solder terminal under the transformer nut nearest the PCB on the bottom of the unit. Dress the supplied 18" piece of shielded two conductor cable so that the shield of the cable goes to the solder terminal, and will absorb any inadvertent tugs. The two wires go to holes "U" and "T" on the PCB. Solder the wires, noting which color goes to which hole.

( ) Assemble the connector and hood to the cable. The shield/ground goes to Pin 5 of the socket assembly. Hole "U" of the PC board goes to Pin 3, and Hole "T" goes to pin 2 of the Socket Assembly.

( ) Inspect work for solder bridges and wiring errors. Confirm that no wire goes to hole "R". If you removed the bar holding the meter lamp, now replace it and tighten the nut, and position the lamp and lamp socket.

( ) Mount the LED's in the appropriate panel holes. The bicolor LED goes in the top center hole. Plug the unit in and turn on to confirm that the meter lamp lights. Unplug the control box and re-attach the rotor control wires. Plug the unit in and turn on. The unit should function in the normal manual mode as before, except that the brake will not engage for five seconds after any other operation is completed. The rotational LED's do not light in manual operation. The operating manual describes the use and features available.

( ) If you added a wire to the PCB for the 90° offset feature, bring that wire to the switch mounted on the rear of the original calibrate pot if there is one. Use an ohm meter to determine which terminal is switched, and solder the wire there. Solder another wire from the common terminal of the switch to ground. Thus, when the switch is actuated, the wire is grounded, enabling the option. Test the circuit with an ohm meter to see that the activating wire from the PCB grounds when switched, and ungrounded when switched back! You can also add an RCA connector or the like to the back of the control box, and run a wire paralleling the switched wire so that the wire may be grounded externally. The connector should be bypassed to ground with a .1 uF capacitor. Before beginning calibration, make sure the 90° offset wire is ungrounded!

CALIBRATION

Arrange the unit so that the meter movement is sitting in its normal orientation.

( ) Using the brake switch and clockwise switch rotate the antenna clockwise and verify that the meter moves left to right. If the meter moves the wrong direction then wires "A" and "C" need to be reversed. Again, be sure to unplug the unit before working on it. When finished power the unit again.

( ) Rotate the set pot fully counter clockwise. Using a jeweler's screwdriver, adjust the "zero" meter setting using the mechanical adjustment behind the hole beneath the center of the meter to set the needle for 180 degrees. Note: after 5 seconds the meter pointer will return to its prior reading. Should you need more time, turn the set pot back a few degrees, then back to the fully counter clockwise position and try again.

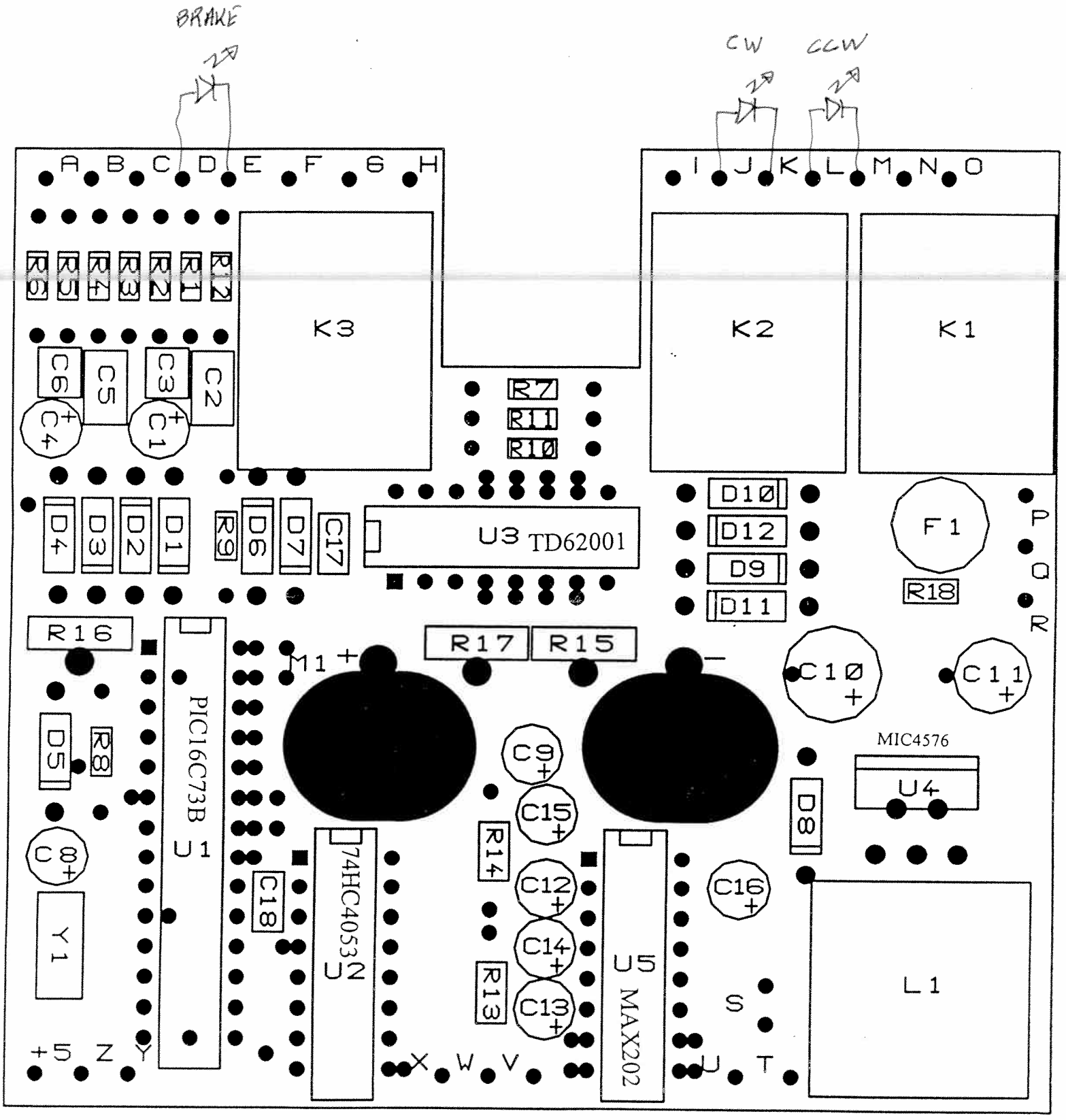
( ) When performing the following steps, be careful the screwdriver shaft does not short out anything. If necessary, put tape over the screwdriver shaft to temporarily insulate it. Preset pots R16 and R17 by turning them full counterclockwise when viewing the black side of the pots, or fully clockwise if viewing the orange side of the pots. If the rotor pot strip and the rotor-control electronics are closely matched, the calibration pots on the Rotor-EZ board may need very little further adjustment in the following steps.

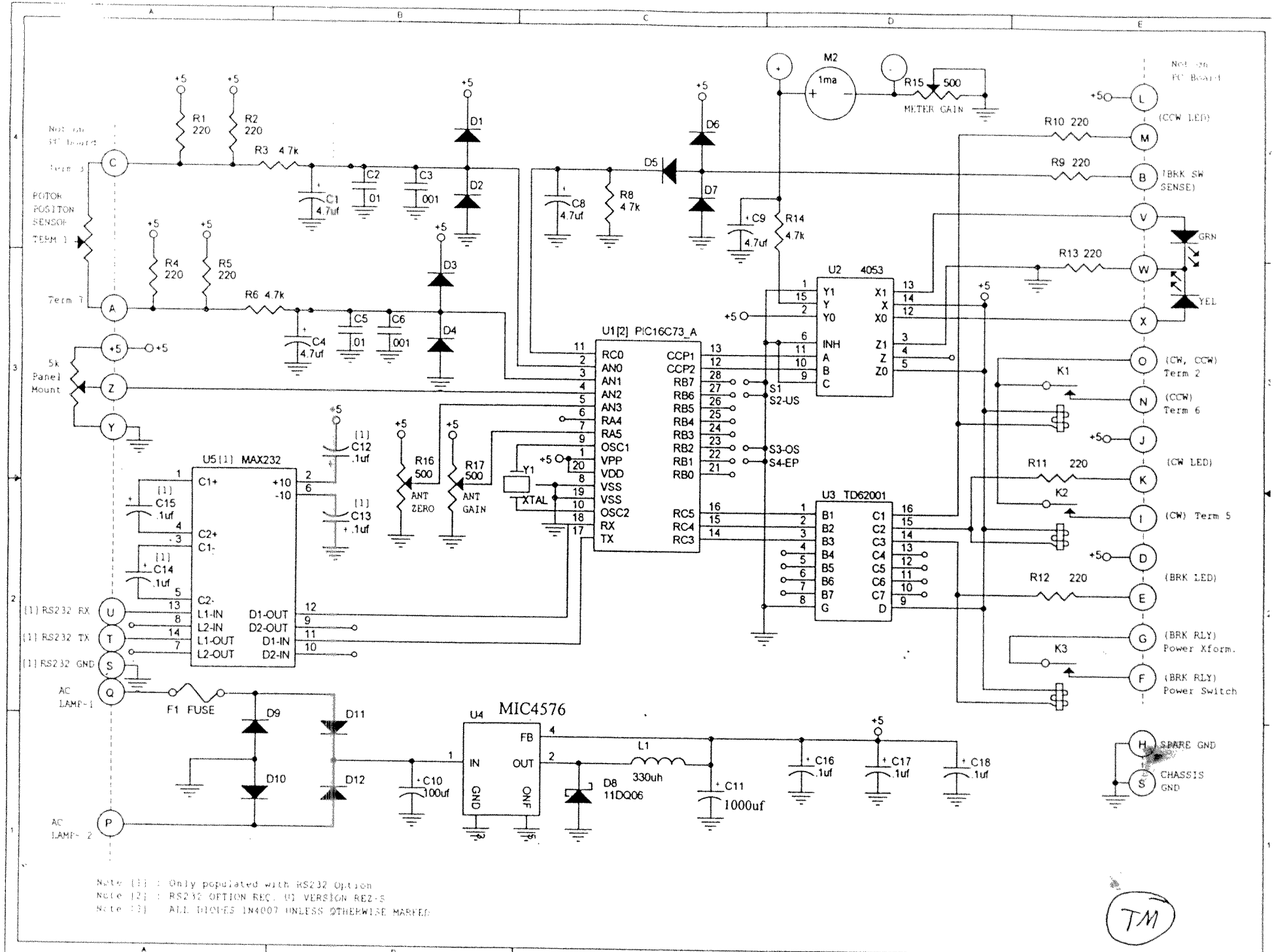
( ) Rotate the set pot fully clockwise. Adjust R-15 so that the meter needle lines up on the clockwise 180 degree line. Reset the needle if the five second timeout occurs.

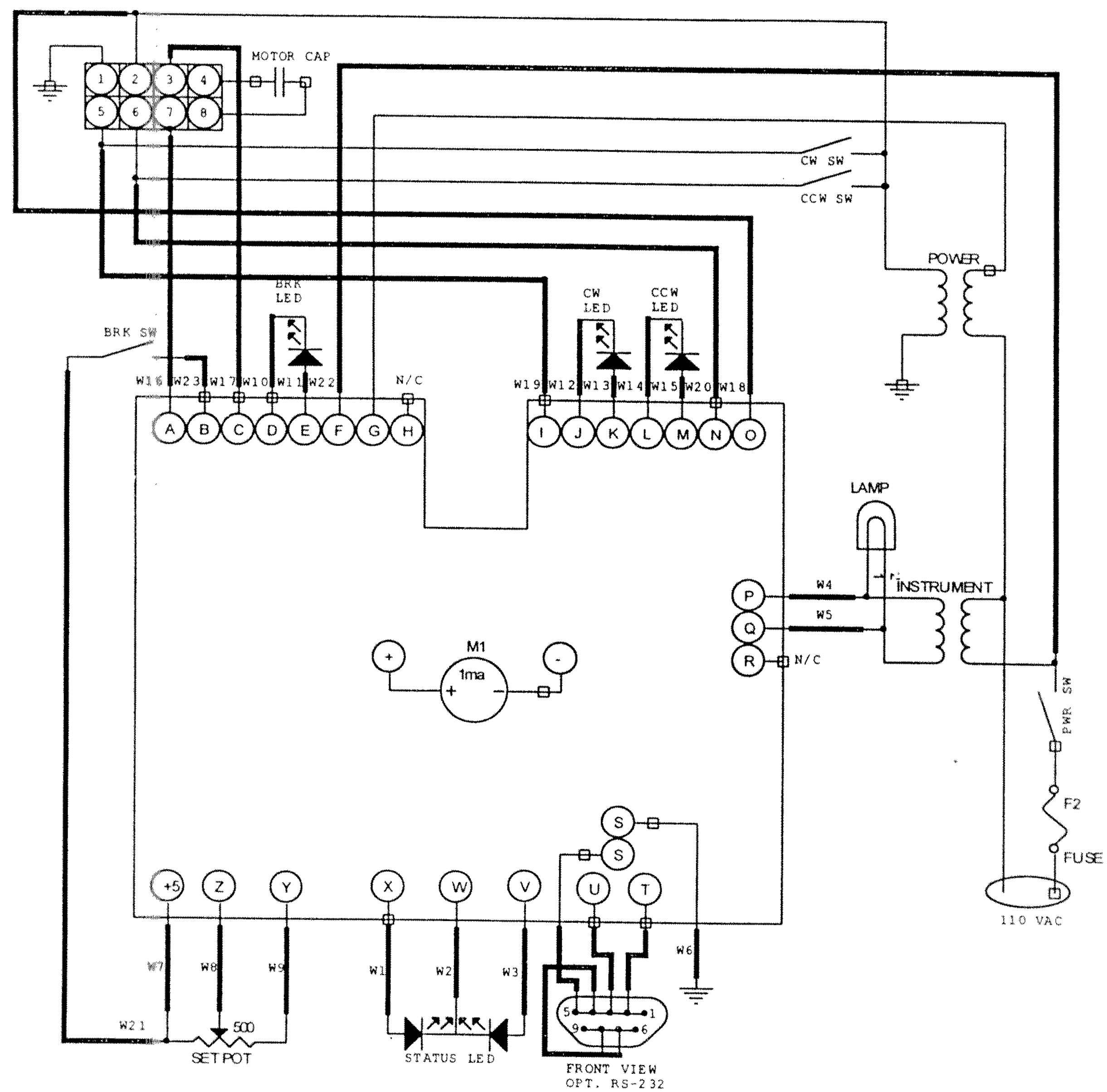
( ) Using the manual paddles, rotate the antenna full counterclockwise. Do not rely on the meter for this as it is not yet calibrated. Adjust pot R16 until the meter needle has gone as far left as it will go. Do NOT turn the pot further - once the meter needle reaches its peg, further pot rotation will cause miss-calibration even though the meter appears correct.

( ) Using the manual paddles, rotate the antenna fully clockwise. Adjust R17 until reaching maximum meter deflection at the clockwise 180 degree mark. Further clockwise pot rotation will result in a miss-calibration even though the meter appears correct, due to physical limits of the meter movement.

This completes assembly and calibration of your unit. Use the supplied cable ties to dress up the wires in the rotor control assembly before replacing the covers. Then, read the operating manual so you will fully understand Rotor-EZ's capabilities.


BRAKE
CW
CCW
A B C D E F G H
I J K L M N O
K3
K2
K1
R6 R5 R4 R3 R2 R1 R12
C6 C5 C3 C2
C4 C1
R7
R11
R10
D4 D3 D2 D1 R9 D6 D7 C17
U3 TD62001
D10
D12
D9
D11
F1
R18
P
O
R
R16
R17 R15
M1 +
M1 −
C10
C11
MIC4576
U4
D5 R8
C8
PIC16C73B U1
C9
C15
R14
C12
C14
R13
C13
74HC4053 U2
C18
Y1
D8
C16
U5 MAX202
L1
+5 Z Y X W V S U T


R1 220
R2 220
R3 4.7k
C1 4.7uf
C2 .01
C3 .001
D1
D2
D3
D4
R4 220
R5 220
R6 4.7k
C4 4.7uf
C5 .01
C6 .001
POTOR POSITON SENSOR
Term 1
Term 7
5k Panel Mount
D5
D6
D7
C8 4.7uf
R8 4.7k
C9 4.7uf
R14 4.7k
M2
1ma
R15 500
METER GAIN
U1[2] PIC16C73_A
RC0
AN0
AN1
AN2
AN3
RA4
RA5
OSC1
VPP
VDD
VSS
VSS
OSC2
RX
TX
CCP1
CCP2
RB7
RB6
RB5
RB4
RB3
RB2
RB1
RB0
RC5
RC4
RC3
S1
S2-US
S3-OS
S4-EP
U2 4053
U3 TD62001
Y1
XTAL
R16 500
ANT ZERO
R17 500
ANT GAIN
U5[1] MAX232
C1+
C2+
C1-
C2-
+10
-10
L1-IN
L2-IN
L1-OUT
L2-OUT
D1-OUT
D2-OUT
D1-IN
D2-IN
C12 .1uf
C13 .1uf
C14 .1uf
C15 .1uf
[1] RS232 RX
[1] RS232 TX
[1] RS232 GND
AC LAMP-1
AC LAMP- 2
F1 FUSE
D9
D10
D11
D12
U4 MIC4576
FB
IN
OUT
GND
ON/OFF
L1
330uh
D8 11DQ06
C10 100uf
C11 1000uf
C16 .1uf
C17 .1uf
C18 .1uf
R10 220
R9 220
R13 220
R11 220
R12 220
(CCW LED)
(BRK SW SENSE)
GRN
YEL
(CW, CCW) Term 2
(CCW) Term 6
(CW LED)
(CW) Term 5
(BRK LED)
(BRK RLY) Power Xform.
(BRK RLY) Power Switch
K1
K2
K3
SPARE GND
CHASSIS GND
Note [1] : Only populated with RS232 Option
Note [2] : RS232 OPTION REQ. U1 VERSION RE2-5
Note [3] : ALL DIODES 1N4007 UNLESS OTHERWISE MARKED


MOTOR CAP
CW SW
CCW SW
POWER
BRK LED
CW LED
CCW LED
BRK SW
W16 W23 W17 W10 W11 W22
N/C
W19 W12 W13 W14 W15 W20 W18
A B C D E F G H
I J K L M N O
LAMP
INSTRUMENT
P Q R
W4
W5
N/C
M1
1ma
PWR SW
F2
FUSE
110 VAC
S S
+5 Z Y X W V U T
W7 W8 W9 W1 W2 W3 W6
W21
500
SET POT
STATUS LED
FRONT VIEW
OPT. RS-232

Rotor-EZ Theory of operation

The Rotor-EZ circuit is made up of the following modules:

1. Power supply
2. Microprocessor
3. Pulse Width Modulators (PWM's)
4. Analog inputs
5. Digital Inputs
6. Relays
7. RS-232 Interface
8. Software

1. Power supply: Since only voltages unsuitable for a linear regulator are available inside the control box, a switching power supply was designed. A simple circuit suffices, due to the low current requirements. U4, D8, L1, C10 and C11 constitute the entire switching power supply design. D9 through D12 act as a full bridge rectifier converting the AC input from the pilot lamp socket to DC necessary for the switching supply. Capacitors C16 – C18 offer decoupling.

2. Microprocessor: The microprocessor U1 is a Microchip PIC16C73B. A ceramic resonator Y1 offers the precision time reference required for serial communication. The Microprocessor contains ROM instruction memory, which is programmed with the control algorithms, serial communication, analog to digital conversion, state machines and lookup tables needed.

3. Pulse Width Modulators: The microprocessor also contains two Pulse Width Modulators. The PWM's control the meter movement and the bi-color LED. An analog MUX - U2 - is controlled by the PWM's and provides a precision 0.0VDC or 5.0VDC to the bi-color LED or to the meter movement's low pass filter. The meter movement uses a simple low pass filter C9 and R14 to change the duty cycle of the PWM into a current source for the 1ma full scale analog meter. R15 is used to calibrate the full scale deflection of the meter.

4. Analog inputs: Analog inputs determine the resistance of the antenna pot. A bridge network R1 –R5 conditions the antenna potentiometer sense circuit. Clamping diodes D1 – D4 and series resistance R3 and R6 protect the processor from erroneous inputs. The bridge network isolates the antenna pot resistance measurement from changes in line impedance. Filtering C1 – C6 prevent 60hz noise and RF energy from affecting the antenna position sense. The Set Pot sense is connected directly to the processor analog input and is not protected because the signal is internal to the controller.

5. Digital inputs: The Brake Switch sense circuit uses R9, C8 and D5 as a half wave rectifier. R8 is used to bleed off energy stored in C8 after the Brake Switch is released. R9, D6 and D7 are used to clamp the Brake Switch sense to valid levels and provide protection from erroneous inputs.

6. Relays: U3 drives the relays and provides protection from the current surge resulting from the relay inductor field collapse. Relay K1 is used to emulate the closure of the Counter Clock Wise switch. Relay K2 emulates the Clock Wise switch. Relay K3 is used to emulate the closure of the Brake switch. R10 – R13 are used to drive the various annunciator LED's

7. RS-232 Interface: U4 performs the signal conditioning necessary to interface with RS-232. This is done with charge pumps C12 – C15 that create low precision positive and negative voltage references which are RS-232 voltage level compliant.

8. Software: The copyrighted software was developed in assembly language written from the ground up specifically for this application.

Rotor-EZ User Manual

The Rotor-EZ adaptation to the rotor control box offers the following operating modes:

Manual Mode: Here, use of the rotator is essentially the same as before. The paddles manually will move the antenna to whatever heading you desire. Always use one finger to depress the brake during manual operation, and another for the actual turning command. In Manual Mode, the only difference from a factory-original unit is that Rotor-EZ adds an automatic five second brake delay. After rotation ceases and you release the paddles, the brake will not engage for another five seconds. This allows the antenna to stabilize first, and enhances the life of the rotor, the tower and the antenna.

Caution – when in manual mode, **NEVER** instantly reverse rotor direction if the rotor is fully under way – this can badly damage or destroy your rotor. Always allow the antenna to coast to a stop before reversing direction. Because you might need to free a frozen rotor or brake using manual control, Rotor-EZ does not prevent instantaneous reversals.

Auto-Point: What was the calibration knob becomes your pointing control. Turning the knob captures control of the direction meter needle, so you can "drive" the needle precisely to the desired bearing. (Note that when the knob captures the needle, the needle may start by moving to a different bearing than the actual bearing of the antenna. The needle is resynchronizing with the pot. This is normal and nothing to worry about.) After you have moved the needle to the desired bearing, press and release the brake paddle, which starts rotation, and your hands are free! The meter needle returns to the actual antenna position and tracks the antenna as it moves. When the antenna reaches the new bearing, rotation stops, and after a 5 second delay the brake sets. LED's signal the motion, brake status, and how near the antenna is to the end of the rotation.

If you turn the pointer knob but do not execute the new heading by pressing the brake paddle briefly, after five seconds the command is abandoned, and the meter needle returns to the actual bearing.

Note that the top LED, which is the Status LED, changes color during an operation. Its steady state is green. Turning the pointer knob changes the LED color to red. Press the brake button to start rotation and the LED changes color to orange. Then, as the antenna moves to the new bearing, the LED color goes slowly from Orange to Green, giving you an indication of how close the antenna is to the final position. This is especially useful in case you have forgotten the bearing you commanded.

If the rotor will not turn at all as the result of a mechanical lock-up or an unusually recalcitrant brake jam after a new positioning command is given, after a few seconds the top LED will begin blinking to warn you that the command is not being executed. (See jam protection further down)

If the rotor control encounters a blank spot on the rotor pot strip, the needle will wiggle, and the Status LED will blink, but rotation will continue for several seconds, usually enough to reach a good spot on the pot strip, and continue rotating to the desired bearing.

The red brake LED, below the status LED, turns on whenever the brake is released. Whenever the brake is set, this LED is off. The two red LED's in the lower corners indicate the direction the antenna is turning. They do not turn on when the rotator is operating under manual control.

While the antenna is turning to a new bearing, you can change the set point provided it does not require the direction of rotation to reverse. If you try to turn the knob back in the opposite direction and pass the point where the antenna actually is, the rotation command is cancelleed, and rotation stops immediately. In this case, the new bearing is held, and once the brake has released, pressing the brake paddle will start the antenna to the updated bearing. At any time during operation, rotation can be halted by simply pressing the brake paddle momentarily.

After a command is executed, but before the brake has set, a new rotation command can be given by pointing the knob, but note that the command cannot be executed until the brake has set. Once the red brake LED goes out, indicating that the brake is set, the brake paddle can be pressed again momentarily, which will start execution of the latest command.

New users of Rotor-EZ sometimes get confused in using the unit, almost invariably because they try to issue a new command before the old command has completed – i.e. before the brake has set. The solution is simple – wait for the brake LED to go out, then start over. If things get hopelessly confused, you can start all over by simply turning the rotor control box off and back on, completely resetting the system. Be sure, however, never to do this while the antenna is actually turning, because the brake slams home and at the least gives a considerable shock to antenna, tower and rotor.

Rotor-EZ includes selectable options. Each option is active unless the builder overrides them while assembling the printed circuit board. They are:

Unstick routine: If the Unstick option is enabled, when command execution begins, the rotor first pulses in the opposite direction for 1 second in case the brake is stuck, pauses 1 second, then turns in the proper direction. Experienced owners of Tailtwister rotors understand this problem. In really cold weather this routine may not be enough to unjam a brake, though it usually will. In such cases, it may be necessary to rock the rotor back and forth multiple times, manually using the rotor control paddles, as you have done in past. Ham-M rotors are not as susceptible to this problem as are Tailtwisters, and Ham-M owners may elect to disable this option as described in the construction manual.

Electronic End Point option: this option limits the rotation range to exclude the last 5 degrees at each end of the meter scale, preventing the rotor from jamming on the end stop. Tailtwisters especially can jam at the end stop in such a position that the limit switch is open, making it is impossible to turn the rotor back. The end point option virtually eliminates this possibility if enabled. Even though you turn the pointer knob to the endpoint of the rotation range and execute, the rotor will not enter the last five degrees of range at either end. If needed you may move the antenna into that range by using the manual controls. But remember that doing so revives the risk of a jam.

Special Note: Users of "Swinging Gate" side mounted antennas can special order a replacement CPU for their Rotor-EZ that sets the endpoints at custom bearings to avoid bumping into the tower. Contact Idiom Press for a quotation.

Overshoot Option: This option turns off the rotor motor 3 degrees before the set point is reached, allowing the antenna to coast into the setting. This option is useful for all but the smallest antennas, and is normally recommended. The Overshoot option will frequently result in small positional errors, depending on the actual coasting, which in turn may be affected by wind. The error will usually be less than 2 degrees and is of little consequence in real terms.

If desired, builders can substitute switches for the option jumpers on the PC board. Users should understand that changes in option status when a option switch setting is changed will not activate until power is toggled off and on.

Jam protection: the Rotor-EZ circuitry and firmware include provision for detecting rotor jams. If for any reason the rotor refuses to turn, after a few seconds the rotation command is cancelled. The top LED will begin flashing continuously to advise the operator of a jam condition. A momentary press of the brake paddle ends the blinking. Once the brake is set the rotor will than accept a new instruction.

If, in the case of apparent jams, the user does not wish Rotor-EZ to cancel an instruction but instead continue to attempt rotation, strapping pin 25 of the CPU to ground will permanently override the cancel command. However, the LED will continue to blink whenever it appears that rotation is not proceeding. For most users, overriding this option is **not** recommended.

Offset Mode: When in offset mode the meter needle moves plus or minus 90° from the normal bearing. This is to accommodate antennas mounted at right angles to the main antenna. A good example might be a 40 meter yagi mounted at right angles to a Triband Yagi such as the Bencher Skyhawk, to eliminate coupling between the antennas. So, when the control is switched to offset mode the meter needle will point to the direction that the offset antenna is aimed at.

As described in the construction manual, the offset mode is triggered by grounding pin 28 of the CPU. If your aiming pot has a switch on its case, the wire from that pin can be grounded that way. It is often desirable to make the switch to offset mode automatic. This can be done by adding a jack to the back of the control box, bringing the grounding wire to the jack, and using external contacts, such as an antenna switching relay, to ground the circuit. If this is added to the control box you should bypass the jack with a .1 uF capacitor.

With the rotor in offset mode, there is a 90° arc that can go past the end of the meter scale on one end or the other. Rotor-EZ is programmed so that when the needle reaches the meter scale end it then flops over to the other end of its scale, and continues tracking the antenna bearing as the antenna rotates. Note that whenever the 90° offset mode is enabled, the top LED blinks in series of pulses to remind you that you are in offset mode.

If your unit has RS232 capability, the offset mode is fully supported.

You should be aware of one special situation inherent in the design that can occur when you are in the 90° offset mode, and pointed at 180 degrees, at either end of the scale. Because Rotor-EZ digitizes the reading from the pot in the rotor, digital "noise" can simulate readings that vary over the 3° tolerance so that the end result is readings on both sides of 180 degrees. This situation will cause the meter needle to flop back and forth between the end points. The way to avoid the situation is simple – point the offset antenna 5° away from the 180° end point of the meter.

RS-232 Mode: This mode is an option for the Rotor-EZ unit. Rotor-EZ's built without RS232 can be easily modified at a later date to add RS232 capability; request quotation from Idiom press for the upgrade kit.

With the RS-232 option, Rotor-EZ accepts rotation commands from any computer or terminal with an RS232 port. This makes your rotor compatible with any of the popular logging and contest

programs that offer compatibility with the HyGain DCU-1 protocol. A sophisticated free Windows 9X program will also be available via the Idiom Press website - www.idiompress.com.

Important note: The program you are using **must** insert leading zeros into bearing commands, such as "009" degrees, instead of "9" degrees. Most programs are already configured this way, but some are not in their default mode, and in such cases you must change the default setting or the RS-232 portion of Rotor-EZ will not work properly.

Rotor-EZ can also be commanded from any terminal having RS232 output, using the following configuration: 4800 baud, 8,N,1 Note that upper case/lower case must be used as listed for the commands below to work:

"AP1xxx<CR>" sets target bearing to "xxx" degrees where xxx are three digits between 000 and 360, and executes. A typical command to rotate to 080 degrees would be AP1080<CR> Note that the <CR> is often labeled <Enter> on many keyboards.

"AP1xxx;"	sets the target bearing but does not execute.
"AM1;"	executes rotation to the bearing set by the "AP1xxx;" command
"AI1;"	inquires current bearing; and responds with (000-359) degrees
";"	terminates rotation
"E"	enable endpoint option – effective immediately
"e"	disable endpoint option - effective immediately
"O"	enable overshoot option - effective immediately
"o"	disable overshoot option - effective immediately
"S"	enable unstick option - effective immediately
"s"	disable unstick option - effective immediately
"V"	reports version number
"J"	enable jam protection - effective immediately
"j"	disable jam protection – effective immediately - NOT recommended!

Note that during any rotation initiated by an RS232 command, the rotation can be halted and further rotation cancelled by a momentary press of the Brake paddle. Also, an RS232 operation can be overridden by using the pointing control during rotation; when the control is moved rotation will cease and and the control will wait for a new command after the five second brake delay is completed.

Final Notes: Rotor-EZ is a cleverly designed approach to bringing Ham-M and Tailtwister rotors into the digital age. However there are certain inescapable realities. The original designer of the rotor and control box did an elegant job of engineering a simple and inexpensive yet functional product. Analog circuits as originally used in these rotors average out little flaws in the rotor pot strip, are very tolerant of electrical noise and ripple, and are remarkably stable. Unfortunately these factors can cause digital nightmares.

Rotor-EZ uses extensive filtering in its design dealing with these factors. However, at times when the rotor is at rest you may notice the meter needle wiggle slightly, due to digitizing. (A similar situation occurs with digital counters on the rightmost digit.) Sometimes during rotation you will note larger needle excursions, almost invariably due to a scratchy pot in the rotor. Rotor-EZ uses algorithms to manage such problems, but they do have limits. If the variations are extreme enough the system may need to do a partial reset, which it will do automatically. Very rarely, you may need to re-enter a position command. (If you have a lot of this sort of problem, it is clearly time to address the pot strip inside the rotor.)

These issues are not major problems – rather the above notes are simply to explain occasional quirks in the operation which will have little or no effect on actual operational use.

Finally, we ask you make a point of telling your fellow amateurs about Rotor-EZ – word of mouth (or paddle) is our best advertising! Thanks!

Note: Patent Pending

Warranty

All parts in this Rotor-EZ kit are warranted against defects in material and workmanship for 90 days from the date of purchase from Idiom Press or from an authorized Idiom Press dealer.

This warranty does not cover damage or failure caused by or attributable to Acts of God (such as nearby lightning strikes), abuse, misuse, improper or abnormal usage, faulty construction or faulty installation, improper maintenance, application of excessive voltage, or improper repairs.

Idiom Press is not responsible or liable in any way for direct, indirect, special or consequential damages arising out of or in connection with the use or performance of the product or other damages with respect to loss of property, loss of revenues or profit, or costs of removal, installation or reinstallation.

Except as provided herein, Idiom Press makes no express warranties, and any implied warranty of merchantability or fitness for a particular purpose is limited in its duration to the duration of the written limited warranties set forth herein.

For repair, contact Idiom press for instructions. If the unit is returned, shipping prepaid, within 90 days of the purchase of the kit, and if the failure is due to a defective component, the unit will be repaired and returned at no charge. If the unit failure is due to errors in construction, Idiom Press will repair the unit for a fixed price and return the unit. Always contact Idiom Press before returning a unit! Overseas owners apply for quotation.

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Voltage Test Chart

Verify the following Test Point Nominal Steady State voltages

PAD "Y" is used as the Ground Reference

U4-1	25VAC RMS
U4-4	5.0VDC
U1-1,20	5.0VDC
U5-2	9.0 to 10.0 VDC (RS-232 Option only)
U5-6	-9.0 to -10.0 VDC (RS-232 Option only)
U1-4	Follows set pot 0 to 5VDC
U1-2,3	(0 to 4.2VDC),(4.2 to 0 VDC) follows antenna
U1-11	Normally 0 VDC, 4.2 VDC when BRK SW pressed

Pad	Voltage
A	0-5 VDC Follows Ant
B	0 VDC
C	5 – 0 VDC Follows Ant
D	+5 VDC
E	+5 VDC
F	80 VAC
G	35 VAC
H	0 VDC
I	0 VDC
J	+5 VDC
K	+5 VDC
L	+5 VDC
M	+5 VDC
N	0 VDC
O	0 VDC
P	15 VAC
Q	15 VAC
R	0 VDC
S	0 VDC
T	9.2 VDC (RS-232 Option only)
U	0 VDC(RS-232 Option only, not connected to cable)
V	4.4 VDC
W	2.4 VDC
X	1.3 VDC
Y	Reference Ground
Z	0 to 5 VDC Follows Set Pot
+5	5.0 VDC

Parts List - Rotor-EZ kit

	Description	Part	Value
1	Printed Circuit Board	PCB	PCB
1	Capacitor	C-11	330 uf or 1000 uf
1	Capacitor	C-10	100 uf
4	Capacitor	C-1,4,8,9	4.7uf
2	Capacitor	C-17, C-18	.1 uf dipped
2	Capacitor	C-3, C-6	0.001
2	Capacitor	C-2, 5	.01 uf
1	Inductor	L-1	330 uh
9	Resistor	R1, 2, 4, 5, 10, 11, 12, 13	221, 1%, 1/4 w
4	Resistor	R3, 6, 8, 14	4.7K, 1%, 1/4 w
3	Resistor	15, 16, 17	500 ohm pot
1	Resonator	Y-1	Resonator
1	Socket	X-1	Socket, 28 pin DIP
1	Microprocessor	U-1	PIC16C73B
1	IC, 2 channel MUX	U-2	74HC4053N
1	7 channel Darlington	U-3	TD62001
1	Switching Regulator	U-4	LM2575 or MIC4576-5.0
3	Relay	K-1, 2, 3	SPDT Relay
1	Fuse	F-1	T 500 ma A 250 V
11	Diode	D-1 - D-7, D-9 - D-12	1N4007
1	Diode, Schottky	D-8	11DQ06
1	LED	D-13	Bicolor LED
3	LED	D-14, 15, 16	Red LED
4	LED Holder	HW	LED Holder
20	Feet, Wire, #24	#24 Gauge, various colors	
3	Feet, Wire, #18	#18 gauge, various colors	
6	Cable tie	White, 3.9" long	
		Additional Parts for Rotor-EZ	kits with RS-232
5	Capacitor	C-12 - C-16	.1 uf electrolytic
1	RS-232 Port	U-5	MAX202 or DS14C232CN
1.5	feet, wire	3 - #26 conductor + shield	
1	D-sub connector	Plastic Hood	
1	D-sub connector	DB9 Receptacle	DB-9
1	Grommet		
1	Solder Terminal		