

# Antenna BOSS II™

## Motorized Antenna AutoResonator™

**READ THIS ENTIRE MANUAL BEFORE YOU  
INSTALL or APPLY POWER to *The Antenna BOSS II*  
••• This Means to Read All of the Footnotes Too! •••**

The Antenna BOSS II solves the tedious and annoying tuning process for motorized antennas when used with the ICOM IC-706 series of radios. The BOSS II can also be used with many other AH-4 compatible radios. When used with the appropriate LDG Electronics One-Touch Tune module<sup>1</sup>, many Yaesu and Kenwood radios can also be interfaced with the BOSS II. Present and recent production motorized antennas from High Sierra Antennas, Hi-Q Antennas, and Tarheel Antennas, with or without a shunt coil, can be interfaced with the BOSS II. If the run current of your antenna<sup>2</sup> exceeds about 750 mA, you should contact your antenna provider and inquire about a motor upgrade or use the Super Antenna BOSS™ (available late-spring 2005).

When you want to tune your radio, press the radio's TUNE button<sup>3</sup> and the BOSS II takes control of adjusting your motorized antenna system for resonance, i.e., the BOSS II is an AutoResonator™. The BOSS II can perform the AutoResonating function on any band that your antenna system can be tuned throughout the 6-160 m bands. **ATTENTION:** *You must have your radio and antenna installed properly so that it can be tuned to your bands of interest. The importance of having a good RF ground and suppression of common-mode currents on your coax shield exterior can not be overstressed. If you don't, it is very likely that you will not be able to find a tuning of your antenna that will have a low SWR (< 1.5:1) or you may have multiple SWR dips that can result in false tuning.<sup>4</sup> You are encouraged to sweep your antenna system with an antenna analyzer to determine if your system is okay or not. The BOSS II is an AutoResonator, not an autotuner.*

As mentioned above, the Antenna BOSS II can be used with certain Yaesu and Kenwood radios. Specific information regarding how to accomplish this interface may be found on the W4RT Electronics web site, www.w4rt.com. **It is suggested that you check the W4RT Electronics web site from time to time for additional information about installation and operation of your radio system with the BOSS II.**

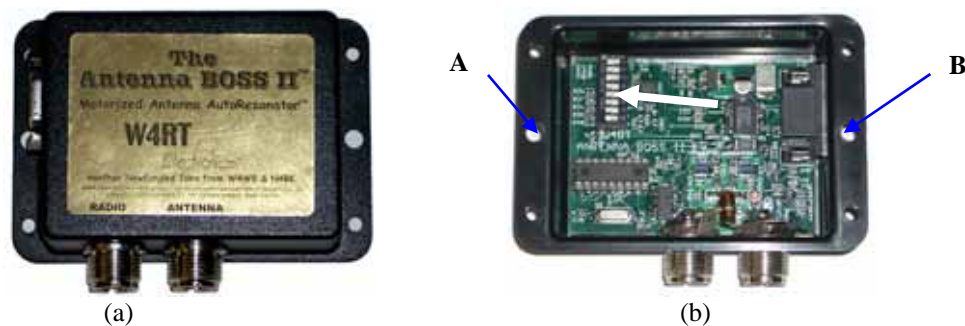


Figure 1. The Antenna BOSS, (a) external view; (b) internal view.

The Antenna BOSS II, shown in Fig. 1, is about 4" by 3" by 1-1/4". The bottom is readily removed for easy access to the dipswitch, denoted by the large arrow in Fig. 1 (b), which allows you to select control features and the motor (pre)stall trip current.<sup>5</sup> If you mount BOSS II using the mounting holes A and B, you may screw or bolt the BOSS II into place. If you use another means to mount the BOSS II, then be sure that the bottom is affixed to the unit.

<sup>1</sup> The LDG Y-OTT must be one modified to be Antenna BOSS II compatible. Contact W4RT for more information, not LDG Electronics.

<sup>2</sup> Older versions of these antennas and many of the other motorized antenna manufacturers have motors that draw several amperes while running. The Super Antenna BOSS provides the means to properly control and manage the higher current levels (availability is late-spring 2005).

<sup>3</sup> ICOM and Kenwood have front panel tune buttons. A separate or external pushbutton tune switch is needed for the Yaesu radios.

<sup>4</sup> False tunings, sometimes called birdies, means that when you examine the SWR vs. frequency for a fixed position of the antenna coil, you should only observe a single dip in the SWR that is less than 3:1 ("resonance"). If there are any other SWR dips that are less than about 4:1, you have a false tuning problem. Observing birdies is a strong indication your installation needs to be improved.

<sup>5</sup> The BOSS II monitors the motor current and stops and reverses the motor when it begins to stall. Setting the trip current too high (above stall current) can defeat this feature and result in improper operation of the BOSS II. Set trip current for minimum value that yields good performance.

**IT IS YOUR RESPONSIBILITY** to select, using the dipswitch, the proper motor trip current for your motorized antenna (*set the trip current for the minimum value that works reliably*). The Antenna BOSS II is for use with nominal 12 VDC motors.<sup>6</sup> Both the BOSS II and the antenna motor are powered by the radio with the power controlled by the radio's power switch.

### ••• INSTALLATION •••



Figure 2. The Antenna BOSS II Package.

- The Antenna BOSS II package contains three items, viz., (1) the Antenna BOSS II unit, (2) Master Cable, and (3) an ICOM Interface Cable. These items are shown in Fig. 2 in their connected configuration.

**WARNING: DO NOT, repeat DO NOT, attach the red & black leads to any power source. If you do, you can DESTROY your Antenna BOSS II and your warranty becomes void.**



Figure 3. Dipswitch (random switch positions shown).

Function	Switch Number							
	1	2	3	4	5	6	7	8
<b>Radio Type</b>								
ICOM	<b>ON</b>							
Yaesu & Kenwood	OFF							
<b>Tuning Time Out<sup>7</sup></b>								
90 seconds		<b>ON</b>						
160 seconds		OFF						
<b>Threshold<sup>8</sup></b>								
Standard			<b>ON</b>					
Alternative			OFF					
<b>Trip Current<sup>9</sup> (mA)</b>								
100				ON	OFF	OFF	OFF	OFF
500				OFF	ON	OFF	OFF	OFF
700				<b>OFF</b>	<b>OFF</b>	<b>ON</b>	<b>OFF</b>	<b>OFF</b>
900				OFF	OFF	OFF	ON	OFF
1200				OFF	OFF	OFF	OFF	ON

Table 1. Dipswitch settings (Factory Default settings are shown in **BOLD** type with lightly shaded background).

- Remove the cover of BOSS II and observe the dipswitch shown in Fig. 3.
  - Table 1 presents the various dipswitch settings. Set dipswitch settings to values appropriate for your radio and antenna. The Factory Default settings shown in Table 1 are appropriate for the IC-706 radios and antennas such as the larger Tarheel, Hi-Q, and High Sierra antennas.
  - The Little Tarheel uses a low-current motor that typically needs switch 4 ON and switches 5-8 OFF. In the event this trip current setting *does not* appear to work,<sup>10</sup> try setting both switches 4 and 5 ON. This reduces the trip current from 100 mA to about 80 mA. If a lower trip current is still needed, then set ON switches 4-6 for about 75 mA, switches 4-7 ON for about 70 mA, and switches 4-8 for about 65 mA.
  - Replace the cover.
- Mount the Antenna BOSS II wherever you desire. This can be done using (not supplied) two screws/bolts or Velcro.

<sup>6</sup> The voltage output from the BOSS II to the motor is the same as supplied by the radio, e.g., 13.8 VDC.

<sup>7</sup> This value should be more than twice the time it takes for the antenna to go from one end to the other of its travel. This is a safety feature since the BOSS II will stop the motor after it has reversed twice while tuning.

<sup>8</sup> For some non-IC-706 radios, selection of the alternative threshold values will provide improved performance.

<sup>9</sup> The BOSS II monitors the current drawn by the motor. When the antenna reaches its end of travel, the motor current begins to increase as the motor starts to stall. When the *motor trip current* is exceeded, the BOSS II will automatically reverse the motor and, if a second end-of-travel reverse during a tuning attempt occurs, the motor will be stopped. See BOSS II operation section for more information.

<sup>10</sup> Some of these antennas have been observed to have a stall current somewhat less than 100 mA.

- 4. Attach the supplied Master Cable to the DB-9 connector on BOSS II, and then plug the ICOM Interface Cable into the Master Cable and into the radio's tuner connector.
- 5. Connect a coax cable (not supplied) from the radio's HF antenna connector to the SO-239 coax connector on BOSS II marked **RADIO** and then connect the antenna's coax cable to the SO-239 coax connector on BOSS II marked **ANTENNA**.
- 6. Connect the antenna motor leads to the BLACK and RED cable from the master cable. **Note:** These leads may need to be reversed should the motor move the wrong way. This connection is antenna manufacturer dependent. **You must make the determination of which is the correct connection.** A simple way to determine if the connection is correct is to allow the BOSS II to perform the initialization tuning (see next page). Then QSY up or down a band or two. If the antenna coil moves the correct direction, then leave the connection alone. Otherwise, reverse the leads. Cut the leads to the length needed ... avoid coiling up the leads.

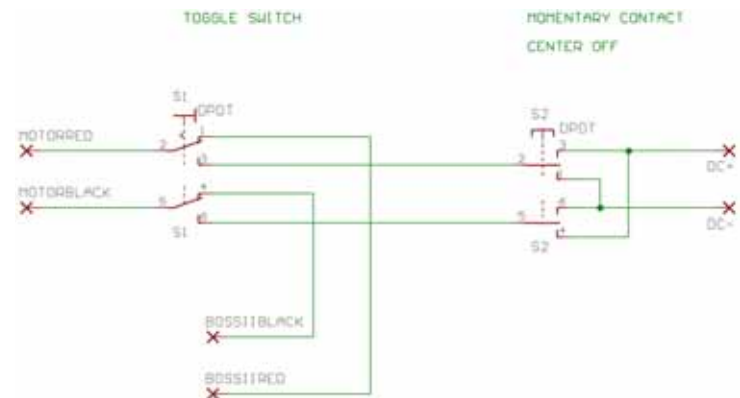
### ••• AUTOMATIC TUNING OPERATION for IC-706 Series of Radios •••

1. Turn the radio ON. The BOSS II will also power up and then go to standby (processor sleep mode).
2. **READ THIS CAREFULLY:**
  - Press and hold for one second the TUNE button to tune (AutoResonate) the antenna. • While autoresonating, you will notice that the LED in the TUNE button blinks ON and OFF. • When the AutoResonating has completed successfully, the LED stays ON constantly. • Should the AutoResonating not be successful, then the LED will be turned OFF. • To abort while in the AutoResonating process, simply press the TUNE button (do not hold). • If, for some reason, after successful AutoResonating you want to turn the LED OFF, then press the TUNE button quickly once.
3. When initialized, the BOSS II has no knowledge of the antenna's coil location or where the antenna may have last been tuned. Consequently, the BOSS II will adjust the coil in one direction until it either finds a tuned condition or it reaches the end of travel. At the first end-of-travel, it will reverse the motor and continue to search for the tuned condition. If the other end-of-travel is reached, the motor is stopped and you need to determine if your antenna can actually be tuned at the selected frequency.<sup>11</sup> If the tuned condition is found, the motor will be stopped at this location of the antenna coil. If you abort tuning (see 2. above), the BOSS II will likely need to perform another initialization.
4. After the initialization tuning (see Step 2), you only need to press the TUNE button a single time to start a new tuning process. The BOSS II remembers the last tuned frequency and knows which way to adjust the coil. The BOSS II examines the SWR of the antenna as the motor adjusts the coil. When the BOSS II determines that the resonance or tuned region has been found, it will then control the motor to achieve the desired tuning. If you observe the IC-706 SWR meter, you will notice that the SWR will pass through a minimum, then increase, stop, and finally return to the minimum. If you watch the antenna, you will see it move at normal speed, then suddenly stop, and finally reverse motor direction moving at about 1/2 normal speed until it again stops. This procedure, combined with dynamic braking of the motor, effectively mitigates motor overshoot that could foul the tuning.
5. Even if you do not QSY before you next press the TUNE button, the BOSS II doesn't mind. It will understand and retune. Since the coil movement required is small, the tuning will typically occur very quickly. This feature is important to address the situations where you may have tuned up next to a metal building and then gone onto the highway. Often the tuning will have changed, particularly for an antenna system with high-Q.
6. **NOTE:** Depending upon your antenna's capabilities, whip length, etc., it is possible that the BOSS II can locate multiple tunings. For example, if the antenna system can be tuned to both the 1/4 and 5/8 lambda conditions for a certain band (e.g., 6 m), then you need to be careful when you QSY to select the correct one. Consider that you are operating on 80 m and desire to QSY to 6 m. It is likely that the 5/8 lambda tuning will be found and then the BOSS II will be confused if you then QSY to say 10 m. Why? It "thinks" you are at the 1/4 lambda tuning and, consequently will direct the motor to move the wrong way. Not to worry, the BOSS II will sort it out for you and find the 10 m tuning ... just takes a little longer. The way around this is to first QSY to 10 m and then to 6 m.

### ••• MANUAL TUNING OPERATION •••

Should you desire to have manual tuning, one way achieve this is to implement the power switching circuit shown in Fig. 4. You can tune by peaking for maximum noise or generate a low-power carrier and minimize the SWR. Remember, NEVER connect any voltage source to the red and black leads from the BOSS II (leads to the antenna motor) or else you will surely let the smoke out of the motor controller at least!

Figure 4. Manual Switching Circuit. →



<sup>11</sup> In order to reduce the possibility of the antenna becoming jammed at one end of travel or the other, the motor is stopped shortly after the final motor direction reversal. On most antennas, this amounts to about one turn on the coil.

# SOME QUICK TIPS & HELP FOR MOBILE HF RADIO INSTALLATION AND OPERATION

1. Use heavy gage stranded wire (#10 or #8) to provide power for the radio directly from the vehicle battery.
2. Make sure you use heavy grounding braid (1/2" to 1"). Do not use wire, even heavy gage. A good RF ground is very important.
3. Excessive or over grounding can create ground loops, which can produce numerous problems.
4. Sand to bare metal vehicle frame locations to which braid and/or other items are to be attached. Use an electrical joint compound such as Penetrox-A by Burndy. Protect the connections by coating with an appropriate material such as Grip & Guard by RUST-OLEUM.
5. KEEP WIRING AS SHORT AS POSSIBLE.
6. If the distance from the BOSS II to the antenna motor is significant, then you may need to run heavier gage wires to the motor rather than using the supplied wires from the BOSS II. Excessive resistance in the wires interferes with the expected current behavior of the motor as seen by the BOSS II. Always reduce the wire length to the minimum.
7. Keep radio power wires, motor power wires, and coax separated from one another.
8. Use fully shielded coax. Be careful not to crush or crimp the coax. Avoid using crimp style coax connectors.
9. Be certain that your coax cable and connectors are in good working order. You would be surprised how often problems are traced to a poorly installed or faulty coax connector.
10. Keep the antenna coil above the top of your vehicle if possible.
11. This is a useful article that appeared in QEX (2000). "Automotive RFI Elimination"  
See <http://www.arrl.org/tis/info/pdf/001qex32.pdf>
12. K2BJ provides a lot of useful information on mobile HF-radio noise-suppression techniques on his web site.  
See <http://www.k2bj.com/Pages/Noise/Intro.htm>
13. For a FAQ about low RFI ignition wires, see ... <http://www.magnecor.com/magnecor1/frequent.htm#16>
14. This is an excellent reference book to have in your library. "*The ARRL RFI Book*" which is available from the ARRL.
15. "*Your Mobile Companion*" by Roger Burch, WF4N. He offers answers to such questions as: Which bands should I use?, Which transceivers and antennas are best, and why?, How do I install the antenna without ruining my truck?, and How can I deal with interference? Available from the ARRL.
16. Ferrite beads can dramatically reduce RFI problems. To mitigate any RFI generated by the antenna motor while tuning, loop the motor leads through one bead 3-5 times and locate the bead close to the antenna base. To help stifle common-mode currents on the exterior of the coax shield, loop the coax (3-4" diameter loops) two times through a pair of beads and locate near the base of the antenna. Types 77, 73, or F are recommended, although Type 31 is also often acceptable. Type 43 is NOT as useful for HF, but is fine for UHF. Amidon FB-77-1024 is a good choice and can also be used with RG-213 size coax.  
Sources are Amidon ([http://www.amidoncorp.com/aai\\_cost\\_largerbeads.htm](http://www.amidoncorp.com/aai_cost_largerbeads.htm)) and Fair-Rite (<http://www.fair-rite.com/>).
17. Such devices as the MFJ-805 RFI Detector and the MFJ-854 RF Current Meter can be helpful in isolating problem areas.
18. You can evaluate the ability of your antenna system to be tuned by using an antenna analyzer (such as the MFJ-259, Autek Research VA1, IW3HEV DATOS Antenna Analyzer). Use a power source to directly power the antenna motor. Stay away from the antenna so that your body doesn't affect the tuning. Set the analyzer to 10 m and adjust the antenna for minimum SWR. It should be < 2:1. Now sweep the antenna with your analyzer over the operational range of your antenna and look for any dips in the SWR (birdies) below perhaps 4:1. Repeat this procedure for each band. If birdies are observed, then you should attempt to eliminate them. Many antennas will require the use of a shunt coil or capacitor to achieve a good match on the low bands. One simple solution is to use the MFJ-910 Mobile Antenna Matcher, which allows selection of five capacitors.

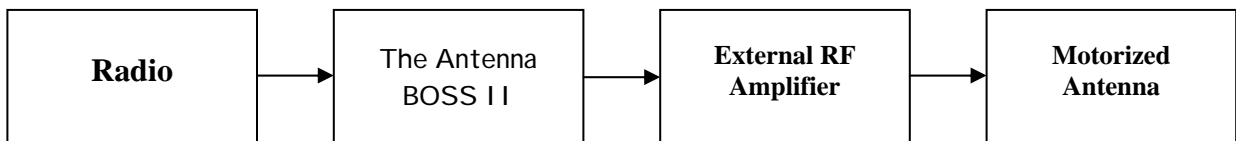


Figure 5. Proper RF order of radio, Antenna BOSS II, external RF amplifier, and motorized antenna.

**NOTICE:** If you use an external RF amplifier with your radio, then it is important that you install BOSS II between the radio and the amplifier as depicted in Fig. 5. NEVER tune your antenna with the amplifier activated!

**ATTENTION:** W4RT Electronics encourages safe-driving practices when operating mobile. This means that when you are tuning/autoresonating your radio-antenna system using the Antenna BOSS II, your vehicle should be safely stopped and off the roadway. To do otherwise could endanger you, your property, and that of others.

**WARRANTY:** The Antenna BOSS II is warranted for a period of one year from the date of purchase to be free of electrical defects in materials and workmanship. If The Antenna BOSS II is determined to be defective, the defective item(s) will be repaired or replaced, at the sole option of W4RT Electronics, provided that the purchaser returns said item(s), postage prepaid, with proof of purchase to W4RT Electronics, ATTN: Technical Support, 3077-K Leeman Ferry Rd, Huntsville, AL 35801. Include a description of the problem, daytime phone number, email address, and return mailing information. Any modification to The Antenna BOSS II by purchaser voids the warranty. The warranty applies only to the original purchaser and is not transferable. 28 February 2005

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## Addendum

Some Antenna BOSS II users have some difficulty in properly setting the dip switches to obtain reliable performance of their system. It is assumed that you have made a proper installation of your system including a good RF ground and have mitigated common-mode current on the exterior of the coax shield between the antenna and BOSS II.



Figure 1. Dipswitch (random switch positions shown).

Figure 1 depicts the dipswitch with switch positions in random order. Be sure that you have moved the switches into the correct positions firmly, but not so hard that you break them. The following discussion will cover the setting of the various switches.

Function	Switch Number							
	1	2	3	4	5	6	7	8
<b>Radio Type</b>								
ICOM	<b>ON</b>							
Yaesu & Kenwood	OFF							
<b>Tuning Time Out<sup>1</sup></b>								
90 seconds		<b>ON</b>						
160 seconds		OFF						
<b>Threshold<sup>2</sup></b>								
Standard			<b>ON</b>					
Alternative			OFF					
<b>Trip Current<sup>3</sup> (mA)</b>								
100				ON	OFF	OFF	OFF	OFF
500				OFF	ON	OFF	OFF	OFF
700				<b>OFF</b>	<b>OFF</b>	<b>ON</b>	<b>OFF</b>	<b>OFF</b>
900				OFF	OFF	OFF	ON	OFF
1200				OFF	OFF	OFF	OFF	ON

Table 1. Dipswitch settings (Factory Default settings are shown in **BOLD** type with lightly shaded background).

Table 1 shows the interpretation of the various switches. Please read the footnotes for the table.

SWITCH 1. **ON:** Use this position **ONLY** if you have an ICOM radio.  
**OFF:** Use for Yaesu and Kenwood radios

<sup>1</sup> This value should be more than twice the time it takes for the antenna to go from one end to the other of its travel. This is a safety feature since the BOSS II will stop the motor after it has reversed twice while tuning.

<sup>2</sup> For some non-IC-706 radios, selection of the alternative threshold values will provide improved performance.

<sup>3</sup> The BOSS II monitors the current drawn by the motor. When the antenna reaches its end of travel, the motor current begins to increase as the motor starts to stall. When the *motor trip current* is exceeded, the BOSS II will automatically reverse the motor and, if a second end-of-travel reverse during a tuning attempt occurs, the motor will be stopped.

SWITCH 2. This switch is used to set the maximum time allowed for the antenna motor to run during a tuning event. The switch selection sets this time limit to 90 or 160 seconds. It should be set to the value that is **GREATER** than the time it takes for your antenna to coil to move from one end to the other and back again. This is one of two safety features. The other is that the BOSS II will halt the tuning if the motor has reversed twice. Why? Because the entire coil has been searched at least once for the desired resonance.

**ON:** 90 seconds.

**OFF:** 160 seconds.

SWITCH 3. This switch provides selection of the tuning threshold. As a general rule, all ICOM radios will use the default value of **ON**. Some non-ICOM radios will interface better if the alternative setting of **OFF** is made.

SWITCHES 4-8 are used to set the Trip Current. Although footnote 3 explains the purpose of the trip current setting, it may be helpful to consider more explicit guidance in determining the switch settings for your antenna. As shown in Table 1, each switch, when it alone is turned ON, sets the Trip Current to a specific value. You should be aware that there are three basic current levels the system experiences. The first is the on-rush current when the motor is started from an off or stopped condition. The second is the run current, which is the current required to sustain the antenna moving in a normal manner. The third is the stall current, which is experienced whenever the coil is driven the the end of travel, and is always greater than the run current. The on-rush current can be many times greater than the run current and stall current. The BOSS II monitors these currents and makes decision accordingly.

The Trip Current is the current level at which the BOSS II considers the motor to be entering a stall condition. When the Trip Current level is exceeded, the BOSS II dynamically brakes the motor before it actually stalls at the end of travel and then reverses the motor travel. If the second reversal occurs during a tuning activity, the BOSS II moves the coil slightly away from the end of travel position as a matter of safety for your antenna, i.e., it attempt to keep the antenna coil from ever becoming jammed at the end of travel. This feature of the BOSS II also reduces the risk of electrical and mechanical damage to the motor and antenna.

### **So how do you decide how to set the switches?**

First, try the default setting shown in Table 1. [If you are using a Little Tarheel, set switch 4 ON rather than switch 6.] If the motor doesn't run or doesn't reverse at the end of travel, then try the following.

If the default settings didn't work for you, then start with only switch 4 set to ON (lowest current) and the rest set to OFF. Turn the radio ON. Press the tune button. If the antenna coil doesn't move, then turn the radio OFF and set switch 5 to ON and the rest to OFF. Repeat the tune test. If the antenna doesn't move, then set switch 6 to ON and the rest to OFF. Repeat the tune test. Repeat the setting of the switches until movement is observed. **NEXT**, allow the antenna to go to its end of travel and observe if the motor reverses itself as expected. If it does, then replace the cover on the BOSS II and enjoy your operations. If it doesn't, then begin turning ON switches having higher numbers than the switch you have set for motor motion. **DO NOT** turn OFF the switch that provided motor motion. This process lowers the Trip Current incrementally. Continue this process until the motor reverses at the end of travel.

An example to consider is the Little Tarheel. It uses a low-current motor that typically needs switch 4 ON and switches 5-8 OFF. In the event this trip current setting *does not* appear to work,<sup>4</sup> try setting both switches 4 and 5 ON. This reduces the trip current from 100 mA to about 80 mA. If a lower trip current is still needed, then set ON switches 4-6 for about 75 mA, switches 4-7 ON for about 70 mA, and switches 4-8 for about 65 mA.

Setting switches 4-8 to OFF defeats the end-of-travel reversal feature, so do not set them all to OFF.

**To summarize, the Trip Current needs to be set to a value that is between the run current and the stall current of the motor.**

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<sup>4</sup> Some of these antennas have been observed to have a stall current somewhat less than 100 mA.