

7000 SCREWDRIVER Control

An Accessory for Icom
IC-7000 Transceivers

by The BetterRF Co.

www.BetterRF.com

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Congratulations on your purchase of the 7000 SCREWDRIVER Control. If you mobile with HF, you will find this unit to be a welcome accessory. Keeping your eyes on the road by letting the Control do the antenna tuning is safer than a toggle switch.

Key features of the 7000 SCREWDRIVER Control are:

- Works with the 7000 TUNE Control (required) and the Icom IC-7000 radio
- Works with any screwdriver antenna (except Yaesu ATAS series antennas)
- Finds resonance with the push of the TUNE button
- Completely automatic operation integrated directly with the IC-7000
- All operations done from IC-7000 controls – No extra buttons or speakers
- No RF connections to the 7000 SCREWDRIVER Control
- No modification of your screwdriver antenna
- No modification of your IC-7000 radio
- SWR visible on the IC-7000 during tuning process
- Handles even the largest screwdriver antennas
- Automatic control of amplifier during tuning
- Internal polarity setting
- SWR targets are settable for each 2 MHz frequency segment through 54 MHz
- Automatic stall current setting and detection
- Over current detection
- Easy antenna parking

What's in the Bag

- 7000 SCREWDRIVER Control
- Cable, 2.5mm - 2.5mm, stereo - for hook-up to the 7000 TUNE Control
- Cable, with a coaxial connector - for IC-7000 chassis ground (has spade lug attached) and 3 ampere, fused 13.8 volts
- Cable with a coaxial connector - for hook-up to antenna motor leads
- Plug, green - amplifier keying line bypass
- Ferrite, mix 31, 3/4 inch ID, snap-on - for RF suppression on antenna motor leads
- This manual

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Some Things You Should Know

- The BetterRF automatic screwdriver antenna controller consists of two separate, and interactive devices: The 7000 TUNE Control and the 7000 SCREWDRIVER Control. Each device is sold separately.
- The TUNE Control, which plugs into the back panel Tuner and CI-V Ports of your Icom IC-7000, contains a microprocessor with on-board firmware and non-volatile memory. It receives its logic circuitry power from the Icom IC-7000 and communicates with the IC-7000 over the CI-V data port.
- The SCREWDRIVER Control interconnects with the TUNE Control by way of a 2.5 mm stereo cable (supplied), which provides power to operate logic circuitry. It contains relays which activate the antenna motor, a PWM (Pulse Width Modulator) which is used to slow the motor when required, a linear amplifier lockout relay, and a jack for the antenna motor. The DC power for the antenna motor requires a fused, 3 amp circuit.
- These two devices, the TUNE Control and the SCREWDRIVER Control, should be viewed as a system. While the TUNE Control can be used as a stand-alone device, the SCREWDRIVER Control cannot be used as a stand-alone device.
- The Icom IC-7000 provides the necessary transmit power by utilizing the RTTY mode with reduced carrier (about 30 watts). It also supplies the TUNE Control with a SWR readout, and acknowledgement of the required button pushes for setup and operation.
- It is important to understand that the TUNE and SCREWDRIVER Control system is not an antenna tuner; it is an antenna controller.
- Some method must be used to assure that the SWR of the antenna, over the spectrum it operates, is relatively low (<1.7:1). The best way to achieve this is to use a base matching coil. Instructions for making one is detailed later in this manual.
- The motor (and reed switch if so equipped) operate above RF ground. In other words, the leads are RF hot anytime transmit power is applied to the antenna. This means RF bypassing (choking) is required to keep the RF off of the motor control

leads. A snap-on, 3/4 inch ID, mix 31, ferrite is supplied with the SCREWDRIVER Control. The motor leads are wound through the ferrite. Instructions for doing so are included later in these instructions.

- It is important to understand how the TUNE Control/SCREWDRIVER Control system responds to the user with beeps and icons. You need to know how it operates before any installation and setup is attempted. You should read this entire manual before starting installation and Setup. For ease of reference, we'll refer to the TUNE and SCREWDRIVER Control System as the "TC/SC" system.

Theory of Operation

- The TC/SC System communicates with the IC-7000 radio over the CI-V port. It writes into nonvolatile memory the last used frequency. When you transmit on a new frequency it knows which way to move the antenna.
- The System reads the SWR from the radio during the tuning process. When the SWR drops below the preset threshold, the TC/SC stops the antenna motor, quickly, using dynamic braking, and rechecks the SWR. If required, the TC/SC reverses the motor at half speed using PWM, and repeats the process. It does this up to three times. This assures the SWR will be below the preset threshold on every band.

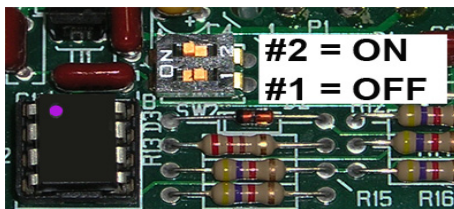
Prepare the TUNE Control

If you've been using the TUNE Control as a stand alone product with the motor control leads connected with a cable to the antenna's motor, disconnect the cable and discard it. It is no longer required for operation with the SCREWDRIVER Control.

- Change the switches in the TUNE Control. The two dip switches in the TUNE Control are shipped from the factory so the TUNE Control will work as a stand alone product. They must be changed to work with the SCREWDRIVER Control.
 - » Remove the two cover screws of the TUNE Control.
 - » Orient the TUNE Control as shown in the photo.
 - » Move the top switch (#2) to ON and the bottom (#1) to OFF

Make sure the switches are completely seated

 - » Replace the cover



Prepare the IC-7000 Radio

In the following steps some familiarity with the various menu functions of the IC-7000 is required. If you don't know what they are, please refer to the IC-7000 Owner's Manual. Where appropriate, page numbers have been listed for your convenience.

- Turn on the IC-7000 and push the **AF** button momentarily. This places the IC-7000 in Setup mode.
- Push the **F-4** (OTH) button.
- Use the **F-1** and **F-2** buttons to select menu item #18 (PTT Start). Make sure it is set to OFF.
- Use the **F-1** and **F-2**

Note: When the IC-7000 is removed, the separation cable (OPC-1443 or OPC-1444) comes with a very small (2 mm x 6 mm) phillips head screw. It is very important that this screw be installed as it grounds the shield of the separation cable. If this screw is left out, all manner of RFI problems will occur. Refer to page 16 in the Owners Manual, center drawing, Figure 2.

- buttons to select menu item #48 (CI-V Baud Rate). Make sure it is set to AUTO.
- Use the **F-1** and **F-2** buttons to select menu item #49 (CI-V Address). Make sure it is set to 70h.
- Once the above values are set, push the **AF** button twice to return normal operation. *These functions are explained on page 120, 131 and 136 of the IC-7000 Owner's Manual. Please note: If the values are not set to OFF, AUTO, and 70h respectively, the TC/SC will not function.*

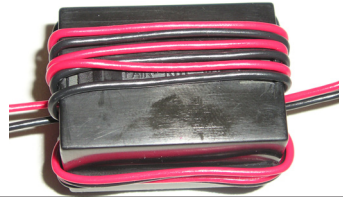
Install the TUNE Control

- Make sure the IC-7000 is turned off.
- Plug the short 3.5 mm jumper cable into the CI-V port on the IC-7000. *It is labeled #5 on the diagram of the IC-7000 Owner's Manual, on page 11.*
- Plug the 7000 TUNE Control into the tuner port on the rear apron of the IC-7000 radio.
- Plug in the other end of the short 3.5 mm jumper cable into the bottom port on the TUNE Control.

Make sure the jumper cable is properly seated in both the IC-7000 and the TUNE Control. If it is not properly seated, the TC/SC will not work.

Prepare the Ferrite RF Choke

A snap-on, 3/4 inch I.D., ferrite choke is supplied with the 7000 SCREWDRIVER Control. It is mix 31 ferrite material. This ferrite RF choke is inserted in the leads to the antenna motor as close to the antenna as practical. The purpose of the choke is to keep RF from getting to the SCREWDRIVER Control. You will need extra wire (not supplied) to prepare the choke. Size 18 gauge is adequate.



If a ferrite was supplied with your antenna, don't use it; it is not mix 31.

- Loop the wire through the snap-on ferrite 10 to 12 times. Be neat - overlaying the wire reduces reactance and is not desirable.
- Connect one side of the choke to the antenna motor leads as close to the antenna as possible
See the photo for an example.

Secure Reed Switch Wires

Some antennas have a reed switch internal in the body of the antenna. These are not used with the 7000 SCREWDRIVER Control. However, when transmitting, RF is impressed on the wires attached to the reed switch and need to be secured.

- Attach the reed switch wires to the mast of the antenna (not to vehicle ground).
Usually, you can find a screw to secure the wires under.

Install the SCREWDRIVER Control

- Locate the 7000 SCREWDRIVER Control in a convenient location.
- Make sure the IC-7000 is turned off during this operation.
- Plug the 2.5 mm stereo cable (supplied) into the SCREWDRIVER Control.

The stereo cable between the units supplies operating power to the SCREWDRIVER Control's logic circuitry. Accidentally shorting this cable to ground could damage the TUNE Control.

- Plug in the other end of the 2.5 mm stereo cable to the TUNE Control.
Please make sure the cable is fully seated. If an extension is needed, be certain to use a shielded, stereo cable, such as Mouser part number 172-2535, or equivalent.
- Connect the power cable (supplied) to a fused, 3 amp, source of 13.8 volts.
- Connect the power cable ground (it has a spade lug) to the chassis of the IC-7000 radio.
See diagram on page 11 of the IC-7000 Owner's manual. This is done to assure that the stall current is properly detected during Setup and operation. Failure to do so will cause erratic behavior.
- Plug the power cable into the port labeled +13.8 volts.

Please use caution when doing so. If you attempt to force the power cable, into the motor port, the fuse could blow and possibly damage the motor relays.

- Connect the antenna motor cable (supplied) to the free side of the RF choke.
One wire of the motor control cable has a dashed line down one of the conductors, this lead is the center pin of the connector. The dashed lead (center pin) should be connected to the antenna's red motor lead through the RF choke. If you're using a HiQ antenna, connect the dashed lead (center pin) to the antenna's black motor lead. If you get the polarity wrong, don't worry, it can be reset in software during the Setup procedure.
- Plug the antenna motor cable into the Motor jack on the SCREWDRIVER Control.

Setup, Check Polarity (motor travel)

Once you've completed the installation, you may proceed to the actual Setup of the TC/SC which follows. To reiterate, the antenna must be properly matched (reasonable SWR on all bands); the antenna's motor control leads must be properly bypassed with the RF choke; the interconnect to the TUNE Control must be in-place, and the connection to 13.8 volts and the ground lug to the IC-7000 chassis must be completed. Carefully recheck your wiring before proceeding with Setup.

As you proceed through Setup, each step may be repeated as many times as necessary. If you lose your place just turn off the IC-7000 and start over. However, depending on which operation was aborted, the RF power out may remain at 30 watts. This will require you to reset the SSB output power level.

Please refer to the IC-7000 Owner's Manual, page 38.

1. Turn on the IC-7000.
The next three steps will cause the IC-7000 to switch to the RTTY mode. The RTTY mode will be used for setting the motor polarity, establishing the stall current threshold, and setting SWR thresholds.
2. Hold the **SPCH/LOCK** button on the IC-7000 until the KEY icon appears on the IC-7000 screen
Refer to the IC-7000 Owner's Manual, Page 37.
3. Press the **TUNER/CALL** button. The IC-7000 will respond with three beeps. If you cannot make the TC/SC enter Setup in this manner, there are five items to check.
 - » Make sure the TUNE Control programming switches are set correctly as described under Prepare the TUNE Control, above. The top switch should be ON, the bottom switch should be OFF.
 - » Make sure the Icom menu items are correctly set as described under Prepare the IC-7000 Radio, above.
 - » At the radio, make sure the short 3.5 mm jumper is securely plugged into the

CI-V port and into the TUNE Control.

Refer to the diagram on page 11 of the IC-7000 Owner's Manual. The CI-V port is number 5.

- » Make sure the 2.5 mm stereo plugs are securely plugged in the TUNE Control and the SCREWDRIVER Control.
- » Make sure the TUNE Control is securely plugged into the IC-7000 Tuner Port.

Refer to the diagram on page 11 of the IC-7000 Owner's Manual. The Tuner Port is number 6.

4. Hold the **SPCH/LOCK** button on the IC-7000 until the LOCK icon appears on the screen. Then release the button. The LOCK icon will go out and the IC-7000 will issue one beep which indicates that you are in the check polarity mode.

The LOCK icon is described on page 37 of the IC-7000 Owner's Manual.

5. Press the **AF** (Set) knob on the IC-7000 momentarily to enter the IC-7000 Set Mode.

*You may later return to the normal screen by pressing the **AF** (Set) knob twice.*

6. Press **QS** (Quick Set) to enter the Quick Set Mode.

7. Press **F-1** or **F-2** to select Item 4, "RTTY Shift Width". It should read 200 Hz.

Refer to the IC-7000 Owner's Manual, page 56. The RTTY Shift Width indication is used to manually control the antenna motor. When 200 Hz is visible on the screen, the screwdriver motor is off.

8. Turn the **VFO** knob clockwise. This will change the RTTY Shift Width to 425. This should cause the antenna to extend and move to a lower frequency (if you have a HiQ antenna, the plunger will move down). If it moves in the correct direction, return the RTTY Shift Width to 200 Hz to stop the motor and go to step 10. If it does not move in the correct direction, proceed with the following:

- » Press the **SPCH/LOCK** button twice within a period of 2 seconds. The LOCK icon will appear momentarily with each button press.

- » Do this step (8) again to verify the antenna is now moving in the correct direction.

If, after two tries to reverse polarity, you cannot successfully get the antenna to move in the correct direction, go back to step 7 and try again.

If you discovered the antenna only tried to move or moved very sluggishly, it maybe necessary to increase the "ON" time during PWM (Pulse Width Modulation). PWM is used during the Check Polarity step. It is also used when it is necessary to backup the antenna due to motor overshoot (likely on 75 or 160 meters). It is not likely that you should have to change the PWM "ON" time parameter. If you think you need to change the parameter, go to Setup, Change PWM Time (step 9).

Setup, Change PWM Time

9. The percentage on-time can be changed with the following procedure which may be repeated for a larger effect. You must be in the Checking Motor Polarity mode. Press **F-1** or **F-2** to select Item 3, RTTY Mark Frequency. The value 1615 Hz should be displayed. To increase the percentage "ON" time by 10%, rotate the **VFO** knob clockwise to 2125 Hz. Press **F-2** to return to the RTTY Shift Width display and test the result as described during step 8. This step may be repeated. *Each time you repeat this step, PWM "ON" time is increased 10%.*

Setup, Stall Current Detection

10. The TC/SC has a built-in stall current detection. In order to assure correct operation,

the ground lead for the 13.8 volt cable used to power the antenna motor, must be connected to the chassis of the IC-7000 as outlined above. With the TC/SC in Checking Motor Polarity mode, rotate the **VFO** knob counterclockwise to retract the antenna completely (highest frequency), and then stop the antenna motion by displaying 200 Hz. If you have a HiQ, the plunger should be all the way at the top. If you have a HiQ, or other antenna with a built-in current limiter, wait about one minute before proceeding. Next, hold the **SPCH/LOCK** button on the IC-7000 until the LOCK icon appears on the screen, then release the button. The antenna will extend (move to a lower frequency) for approximately 4 seconds, then retract (move to a higher frequency) for approximately 4 seconds, and then stall for 4 seconds. The motor current is measured under these conditions, and an appropriate stall current threshold is calculated and saved. A successful determination of the stall current threshold will be signaled by double beeps. If you get more than double beeps, then you need to repeat the Setup procedure beginning at step 1.

Setting SWR Thresholds

You may repeat this SWR threshold procedure as often as necessary. It should be performed at periods of low band activity as the procedure involves transmitting on the air. If your antenna is properly matched with a base matching coil, and the SWR is under 1.5:1, you should not reset the default SWR setting of 1.5:1. Setting the SWR threshold too low could cause erratic operation.

11. During programming of the TC/SC, it is necessary to view the SWR readout of the IC-7000. Here is how this is done.

- Make sure the IC-7000 is on.
- Press the **MENU** button for one second several times until the S submenu appears.
- Press the **MENU** button momentarily until the S1 submenu appears. Press the **F-3** (MET) momentarily until the SWR meter is displayed.

This function is explained on page 36 of the Icom IC-7000 Owner's Manual.

12. If you wish to change the default SWR setting, turn off the IC-7000.
13. Turn on the IC-7000, and place the TC/SC in the Setup mode as outlined in steps 1 through 3, above.
14. Select the band and frequency on the IC-7000 for which you wish to set the SWR threshold.
15. Press the **TUNER/CALL** button on the IC-7000 for at least one second. You will hear one beep. The IC-7000 will transmit on the selected frequency in the RTTY mode at about 30 watts. The RTTY Shift Width should be displayed as described in steps 5, 6, and 7, above. If the IC-7000 does not transmit when you push the **TUNER/CALL** button, it means you're in the Stall Current detection mode. If this occurs, turn off the IC-7000, and repeat step 1 through step 3, above.
16. Rotate the **VFO** knob counterclockwise (RTTY Shift Width 170 Hz) or clockwise (RTTY Shift Width 425 Hz), to retract or extend the antenna (go higher or lower in frequency). Watch the SWR meter, and when it dips to where you wish to set the threshold (not necessarily its lowest point), stop the antenna motion by returning the **VFO** knob to its starting position of 200 Hz, as outlined in step 8. Depending on the band, you may have to jog the **VFO** knob back and forth several times to get to the desired SWR threshold. During the procedure, if you hear two sets of double beeps, that indicates the antenna has stalled at the end of travel. You should then reverse the antenna motion.
17. Once the desired SWR threshold is met, press the **SPCH/LOCK** button for at least one second. The IC-7000 will stop transmitting and the SWR threshold will be

stored. The SWR threshold setting procedure may be repeated by choosing another band and frequency. When you've finished, simply turn off the IC-7000.

This completes the Setup of the TC/SC. If the Setup procedure was performed correctly, the TC/SC will give you years of trouble-free service. If erratic operation does occur, refer to the Operational Hints, below.

Resetting to Factory Defaults

If you wish to return the TC/SC to its factory-default settings, here is how to do it. However, doing so will require you to go through the complete Setup procedure, from start to finish. If you do not, correct operation will not be possible. To reset the TC/SC to factory default, turn off the IC-7000. Press and hold the Reset button on the TUNE Control. If your IC-7000 is remotely mounted, this may require help. Next, turn on the IC-7000, and release the Reset button. If the operation was successful, you will hear two beeps. Setup may be started immediately without turning off the IC-7000. Please remember, resetting the TC/SC to Factory Default condition means you will need to reprogram the TC/SC in order to use it.

Normal Operation

- Select the frequency you want to use and push **TUNER/CALL** button for one second. The antenna will move to resonance and stop.
- If you want to fully retract the antenna (park), momentarily (less than one second) push **TUNER/CALL**. The antenna will completely retract.

Operational Hints

What follows are a few anomalies which might crop up.

- The single biggest cause of erratic behavior, is inadequate RF bypassing of the motor leads. Please review Prepare the Ferrite RF Choke, above.
- The second biggest cause of erratic behavior is an inadequate image plane under the antenna. This causes RF to flow over the motor leads (even when they are bypassed), on the outside of the coax (common mode currents), and into the vehicle wiring. Additional bypassing of the leads in and out of the TC/SC may be necessary. Ferrite, mix 31 are your best bet. They should be installed on the power and motor control leads and mounted close to the TC/SC.
- Proper antenna matching is a prerequisite for full automatic use of the TC/SC. Although the SWR threshold maybe reset higher than the factory default of 1.5:1, doing so points out the need for better impedance matching. Review Antenna Matching, below.
- If you experience erratic operation at some locations, it is an indication that the threshold SWR is set too low. The input impedance of any HF mobile antenna is partially dependent on the image plane losses which vary from physical location to location. Setting the SWR threshold too low at one location may cause erratic operation at another. This often occurs when you set the SWR threshold while parked atop a steel reenforced concrete driveway.
- Proper DC wiring is a must. You should never connect amateur radio equipment to existing vehicle wiring. Besides inviting RFI issues, it can also cause ground loops to occur. Ground loops are the worst of maladies as they appear to be caused by RFI when they are not.
- Manual operation of the antenna for the purposes of checking its capability of reaching adequately low SWR values can be initiated by executing steps 1 through 3 and then proceeding directly to steps 14 through 16. To check the SWR on another band, press the **TUNER/CALL** button for at least one second, and the IC-7000

will stop transmitting.

*Pressing the **SPCH/LOCK** button will save the SWR value being displayed as the new SWR threshold for the current band as described in the section on Setting SWR Thresholds, above.*

- It is possible to set menu item #18 (PTT Start) to ON (*Refer to IC-7000 Owner's Manual, page 131*) and control the TC/SC by using PTT. However, this will cause the TC/SC to transmit a 30 watt carrier, anytime the frequency is changed more than 1%. This is an undesirable side effect, which should be avoided.
- Aborting some operations could cause the RF power out to remain at 30 watts. This will require you to reset the SSB output power level
Please refer to the IC-7000 Owner's Manual, page 38.
It may also cause the TUNE indicator (upper left hand corner of the IC-7000 display) to appear. In this case, the indication is false.
- The 13.8 volt user supplied circuit used to power the antenna's motor should be fused at 3 amps maximum. Under no circumstances should it be connected to the accessory port, or Tune port, of the IC-7000. These ports are rated at 1 amp maximum (total for both ports). Exceeding this will cause a circuit trace to fail long before the IC-7000's internal 5 amp fuse will blow.
- If you wish to use your TC/SC System as just a TUNE Control (no control of the screwdriver antenna), turn off the IC-7000 and disconnect the stereo cable from the TUNE Control. The next time you turn on the IC-7000 and press the **TUNER/CALL** button the IC-7000 will go into the TUNE mode. It will output 30 watts in RTTY mode and display the SWR. A second press of the **TUNER/CALL** button will turn the TUNE Control off and return you to the previously selected power and mode. If you wish to restore the SCREWDRIVER Control, plug the stereo plug into the TUNE Control with the IC-7000 power off. When you power up the IC-7000, the previously selected operating conditions for the TUNE Control will be restored.

Electrical Specifications

- Current drawn from IC-7000 accessory jacks: <100 mA
- Antenna motor power feed: 13.8 volts, fused @ 3 Amperes (*user supplied*)
- Screwdriver antenna motor running current: 2.5 amperes, maximum
- Motor stall current threshold: 3.5 amperes, maximum (*user settable*)
- Motor over current threshold: 3.5 amperes
- Nominal pulse width on slow motor speed: 50% (*user settable*)
- Amplifier control current: 1 ampere maximum and 120 volts maximum
- Maximum number of resonance retries after target SWR found: 3
- Maximum number of full range searches for resonance: 2
- IC-7000 CI-V address: 70h

Antenna Matching

- The TC/SC is not an antenna tuner; it is an antenna controller. Depending on the antenna, the mounting location, and the mounting itself, the input impedance will vary between 18 and 50 ohms (160 through 10 meters). This represents a SWR between 2.7:1 and 1:1. Some form of antenna impedance matching is required in most cases. The matching device cannot be an external antenna tuner.
- A simple inductor, installed across the coax connections, will provide the needed impedance transformation. Here's how it works. A small amount of capacitance is borrowed from the antenna (the antenna is tuned slightly above true resonance). When combined with the inductance of the coil, a high pass LC network is formed.

- As the frequency increases, the effective impedance transformation decreases. This provides a low SWR over the operating range of the antenna (typically less than 1.6:1 from 160 through 10 meters). The coil also DC grounds the antenna lessening static build up.



- The matching coil shown is 9 turns, 1 inch inside diameter, and wound with #14 enameled wire. The coil needs to be about 1 uh, plus or minus, depending on the input impedance of the antenna. The inductance of the coil is changed by adjusting the spacing between the turns. Properly adjusted, the SWR will be less than 1.6:1 over the antenna's operating range (typically, 160 through 10 meters).
- The coil will have the greatest effect on 160 or 80, and 40 meters, so those bands should be used to adjust the coil's spacing. Although the procedure can be done with a SWR bridge, it is much easier to accomplish with an antenna analyzer, such as the MFJ 259B. Once you've installed the coil, here's the tuning method to use. This process is very difficult to accomplish with just a SWR bridge, but it can be done. It just takes about 10 times longer with a SWR bridge and you have to actually transmit to do so.
- Move the antenna to the 160 or 80 meter band. The actual frequency isn't important.
- Adjust the frequency on the analyzer until the $X = \emptyset$, or as close to it as you can (the SWR reading is not important at this point). Read the R value. The objective is to get the R value close to 40 ohms. If it is less than 40 ohms, stretch out the coil slightly and readjust the analyzer's frequency so $X = \emptyset$, once again. If the reading is lower than the first try, squeeze the coil together, and try again. Repeat the process until the R reading is about 40 ohms when $X = \emptyset$. This relates to a SWR of 1.25:1. The only time the SWR readout will be accurate (and significant) is when $X = \emptyset$, and R is approaching 50 ohms.

Why, you ask, set the shunt matching coil for 40 ohms rather than 50 ohms? Basically, it's a compromise. If you use 50 ohms, you'll find the match on 17 and 15 will be over 1.7:1 in most cases. The reason is related to the reactance of the shunt coil (including its distributed capacitance) as the frequency changes. Distributed capacitance is also the reason small closely spaced coils don't work too well in this application, especially when they're mounted inside the antenna's mounting bracket.

- Move the antenna to the 40 meter band (the actual frequency isn't important), and adjust the analyzer's frequency until $X = \emptyset$ and read the R value. In most cases, it will be about the same spot as it was on 160 or 80 meters. If it is not, it may be necessary to compromise between the two bands.
- Once you've completed the 160 or 80, and 40 meter adjustments, move the antenna to the 20 meter band (the actual frequency isn't important). Adjust the frequency

on the analyzer until $X = \emptyset$ and read the R value. It will usually be closer to 50 ohms than it was on 160, 80 or 40 meters. You can check the rest of the bands, if you desire. Typically, they will read very close to the 20 meter R value.

- If a compromise can't be reached between 160 or 80, and 40, or the 20 meter R reading is far removed for 50 ohms when $X = \emptyset$, then chances are there is an inadequate ground plane under the antenna, or there is too much stray capacitance between the antenna and the body of the vehicle, or both.

Customer Service

The BetterRF Company is dedicated to providing superior products to the amateur community. Please contact us if you have any problems, comments or suggestions about the operation of your TC/SC System.

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Other Products from The BetterRF Company

- I-Mate — Send recorded memory on IC-756ProII/III, IC-7700, IC-7800 and the IC-746Pro (CW only)
- 7000 TUNE Control — Stand alone product or works with the 7000 SCREWDRIVER Control. As a stand alone product, it make the TUNE button functional on the IC-7000
- Yaesu TUNE Control — Makes the TUNE button functional on FT-857, FT-897, FT-450 and FT-950
- 706 TUNE Control — Makes the TUNE button functional on IC-706



KØBG HF Mobile. For installation tips, see www.KØBG.com

Hookup Diagram

