Tipe and tricks for the TH-F6 / 7 transceivers

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This post is an extension of some great advice offered a couple of springs ago by 'The Horse's Mouth.' The guidance and wisdom in that posting should be sought out, read, and understood. However, there were many things unsaid and a few things were misunderstood; this posting will humbly attempt to answer those additional questions. Most comments apply to both the TH-F6A and TH-F7A.

Posted by: The Horse's Other Alimentary Orifice.

Q1. My buddy's TH-F6/F7 came with a 13 volt charger, but mine only came with a 12.6 volt charger. I want to charge my battery in the shortest time possible, but I haven't been able to locate a suitable 13 volt supply yet. Locating the connector is also a problem. Where can I find these parts?

A1. You don't want one. Stay with the 12.6 volt (or whatever) charger. It will charge just as fast as a higher voltage one.

The radio charging circuits begin to charge when the external supply is above 10.3 volts. Any additional voltage above that will produce heat in the radio. Heat? Remember how warm the radio gets while you are charging? A 13 volt supply will produce more heat in the radio than the 12.6 volt supply will. Sure, if you want a hotter handwarmer, go ahead and use 13 volts. Go ahead and use all the way up to the maximum 16.5 volts input if your hands are really cold. Expect to pay the price in greatly reduced reliability, however. For the price of the radio, you could buy a lot of gloves... After you burn up your TH-F6/F7, I'll glady accept it as a gift for parts, and won't say 'I told you so.'

Q2. How can that be? How can a lower voltage charger be better?

A2. The radio has a charging chip (LM3420-8.4) that operates on a current limit from the external source. This charging chip is pretty smart. It knows and understands lithium batteries. The chip operates like any other well-designed lithium battery charger: It sets the output voltage clamp to a constant value for full charge, then just limits the current until that voltage is reached. Any voltage difference between the input and output for the charging chip is just converted to heat. Higher input voltage = more heat; see previous question.

Q3. How does the charging system work, then?

A3. Before the battery terminal clamp voltage (8.4 volts) is reached, the chip will permit only 280 ma to enter the battery. Any amount of voltage above the clamp voltage plus the charging chip overhead will produce heat. This clamp+charger chip overhead voltage is approximately 10.3 volts. Thus, the higher the external voltage, the hotter the radio gets. The battery, however, doesn't charge any faster, regardless of the external voltage supply.

Taking this to an extreme, if you charge the radio from your car battery during normal vehicle operation, the voltage could reach 15 volts or higher in cold climates. This will produce a tremendous amount of heat in the radio, and the internal thermal sensors may shut down the radio for a while, until it cools off. This includes the charging circuits.

Heat is the enemy of electronics, so don't use a higher voltage than prescribed to charge the battery.

Q4. If that is so, why didn't Kenwood provide a 10.3 volt wall wart to reduce the heat, or 11 volts, or (insert your favorite number here) volts, or...

A4. I don't know. Perhaps Kenwood made a fantastic deal with the power supply company. Maybe they already had 100,000 of these in stock that they wanted to use. Maybe to keep inventory costs low, the same supply was already in use by a Icasuwood XY-Z radio. Some voltage overhead is necessary to

accommodate low line voltages perhaps and expected fluctuations in the mains. Your guess is as good as mine.

Note that any voltage between slightly above 4 to 10.3 volts will permit the radio to continue to operate, but just won't activate the internal charging circuit. I have successfully operated the radio from a 9 volt transistor battery. It didn't charge the lithium battery, but did operate the radio.

From another test, the internal charger chip will supply 280 ma to the lithium battery (if it needs it) when the external supply is anywhere above 10.3 volts. As you gradually reduce the input voltage down from 10.3 to 8.5 volts, the charge current linearly reduces in response. Once the input voltage falls below 8.5 volts, charging stops. Simply increasing the voltage again won't restart the charge process. You must completely remove the external power to reset the charger chip. See page x in the manual. Also, applying any voltage less than 10.3 volts won't activate the charger. That is how I got away with operating on a 9 volt battery.

The only reason I mention this is: If you have to use a non-Kenwood external supply, it better be rated for 280 ma, plus any current draw the radio will create when in operation. 500 ma is a safe value, but certainly you could get by with a lower one if you implement power savings settings on the radio, or use only one side at a time. (Solar cell operators take note.) Any transmitting operations will require higher currents. The radio also takes many seconds to react to a change in the power saving mode setting on Menu 17.

As a test, I made several runs as to how long it took the radio to charge the battery from completely dead. Room temp was 72F/22C, both this and the temperature of the rear plate of the radio were monitored.

In all cases, the radio charged the battery in the essentially same time, within a few minutes, regardless of what voltage between 10.3 and 16 volts was used. However, the resultant temperatures were very different, as shown below:

Charging Input Volts	Hours to Full Charge	Ambient Temp (F)	Rear* Plate Temp (F)	Capacity ** after charge, ma-hr	Finishing current, ma ***
10.3	6.8	71	144	1790	0.1
11	6.7	72	146	1810	0.33
12	6.5	70	148	1835	0.28
13	6.6	69	151	1838	0.29
14	6.6	71	158	1832	0.12
15	6.6	72	165	1840	0.19
16	6.6	69	173 (too hot to hold!)	1831	0.29

*** At end of charge. Each run, the battery and radio were permitted to cool down and stabilize at room temperature before discharging the battery and starting the next run. This was usually over night. No carrying case, sitting vertical on the desk with belt clip and antenna connected, both of which act as heat radiators. Reasonably still air, just usual air currents due to furnace operations, and people movement.**

**** Capacity exceeds the published 1550 ma-hr because the discharge rate is much less than the C rate. Look it up.**

***** This is the current provided by the charging chip after the battery has been completely charged. Ideally, it should be zero. The battery was permitted to stay on the charger overnight after a complete charge was indicated, then this value read. Attach no significance to the scatter of these numbers; the final current should be considered essentially zero. This term represents an internal leakage for the battery.**

All voltages and currents were made directly at the battery terminals, as installed on the radio. Minor surgery was required to do this. After each charge cycle, the battery was discharged with West Mountain Radio battery tester to 2.75 volts per cell at a 100 ma discharge rate. This rate most closely matches the normal consumption of the single-receiver mode on the TH-F6A, without power saving enabled. Also, this is the lowest discharge current available on the West Mountain CBA-II.

The capacity was always above the claimed 1500 ma-hr. This battery should be considered a good test subject, repeatable, and indicative of a used battery with considerable service life remaining. For the record, it is over three years old.

Q5. I want to charge my batteries and operate the radio at the same time. The radio works just fine when I do this.

A5. Go ahead. Just don't transmit, per caution on Page 2 of the manual. The supplied wall wart charger isn't rated for such operation. If using any sort of external supply, this will be too much for the fuses inside the radio.

Q6. So I should connect a larger power supply to transmit on the radio while the battery is being charged?

A6. Not the best idea. The radio will be stressed, and it will build up heat, especially if you transmit a lot or on high power. One of the three fuses may blow. You may end up unhappy. Kenwood said don't do transmit, regardless of the size of the external power supply, while charging the battery.

Q7. Can I use an external supply to operate the radio, but not to charge the batteries? Can I remove the lithium batteries and just operate directly from an external supply and transmit?

A7. Sure. There is nothing wrong with this. Also, reading between the lines, if your battery is connected and already charged so it is not drawing any current, you operation will be fine. However, don't use the supplied wall wart while doing this. The wall wart simply doesn't have enough 'oomph' to be considered a fortified external supply for transmitting service.

There is still risk; you need to be aware/monitor your battery state of charge. You can't monitor the battery state of charge with an external power plugged in. I emphasize again, there is risk.

Q8. Does this mean I can't run an external power connection to the TH-F6/F7 and run it from my car?

A8. No, you can do that, but observe these precautions:

Make sure your lithium battery is fully charged before doing so. An alternative is to just remove the lithium battery. Always make sure the external supply is not connected or turned off before plugging in the external power jack into the radio.

Q9. The manual says it takes 6.5 hours to charge the lithium battery, then I should disconnect the charger. Instead, can I leave the charger on for X more hours? (X is between one and infinity.) It's much more convenient for me.

A9. The manual says such may overcharge your batteries if you do. My analysis and measurements on the battery, radio charging circuits, and the data sheet for the charger chip force me to disagree.

I think this is a CYA statement by Kenwood. The charger chip is smart enough to keep a lid on things. There is no 'trickle charge' provided by the charger chip inside the radio. Nor should there be any trickle charge for lithium batteries. Although there doesn't appear to be any harm, leaving the charge connected indefinitely is at your own risk. A defective or worn out battery may change this conclusion, however. The horse's other alimentary orifice takes no responsibility for such operation. However, I do it all the time, and no adverse consequences have been observed or measured so far.

Q10. There is a diode in the alkaline battery case that drops some voltage across it. I was going to short it out/remove it so I can operate longer from my alkaline batteries. What's wrong with extending the alkaline battery life this way?

A10. DON'T DO IT! That diode is there for a specific purpose: To prevent current from flowing back into the batteries when an external power supply is used. If the diode is shorted, any external voltage will activate the charging circuits, and the charger will attempt to push current into the alkaline batteries. This is a no-no, which can cause battery bursting, failures, and a really nasty mess to clean up, notwithstanding the fact that the battery case may be melted and fuses blown. Even the horse's other alimentary orifice won't want the slagged remains of such a disaster.

The charging circuit is always active, regardless of any menu settings or battery chemistry found connected to the radio.

Q11. Convince me.

A11. The diode present inside the shell is a Schottky type with low forward voltage drop of between 26 mv during receive to 0.3 volts during transmit. If you look at the curves, alkaline batteries will not provide any significant increase in capacity if permitted voltage drop is increased by 26 mv. Spread across four AA cells, that's only 6 mv per cell. Not much gain in capacity there. At most, you might get a few more seconds or minutes of receive operation, after many hours of use. It's just not worth the risk.

Note: I have come across two battery cases that have a poor solder connection at the diode. Check the connection, and touch it up with a soldering iron if necessary. Use a 20 to 25 watt iron with a small tip. Any smaller power, and it takes too long to heat up the connection. That will melt the case, and could cause damage to the diode. Use a heat sink on the diode lead in any event. Much more that 25 watts will be too much, and you will have to work very quickly to make the connection. If you wait too long, again you may melt the case and damage the diode.

Q12. Can I use ni-cad or NI-MH batteries in the battery shell, rather than alkalines?

A12. Sure. Still set your battery type on Menu 30 to alkaline, to preserve battery power during transmit. The battery life bars for F + BATT will be out of whack. (They are out of whack anyway when alkaline batteries are selected.) Fully charged nicads or NI-MH will only show one or two bars, but that is the nature of the lower terminal voltage for those batteries. The batteries will not be charged when external power is supplied to the radio. But that's not a big deal, you will have to provide an external method to charge either of these types of batteries.

Q13. Can I short out the diode and charge nicads or NI-MH batteries in the shell from the radio, then connect an external supply to the radio...

A13. STOP RIGHT THERE! Do not attempt this. The radio charging chip is exclusively for lithium batteries. This will cause a dangerous situation. You will most likely cook the batteries, damage the charger chip and transceiver in the process. I won't even ask you to send me this carcass after such folly. There won't be much left to salvage, except perhaps the external microphone and the antenna, such as it is.

Q14. My radio blew F2, a 4 amp fuse, and I had to send it back to Kenwood. It took X months and Y dollars or euros to fix. X is usually between 2 and 5, while Y is usually around 80. Why did the fuse blow? I didn't do anything wrong. I'm miffed Kenwood made such a cheap radio.

A15. You probably don't recognize that you did anything wrong. The manual quite clearly states: Connect the jack into the radio first, then apply external power. If you don't follow this order, the fuse is likely to blow.

Q15. But I've been plugging and unplugging the charger and external supplies for a long time, with no problems. Why did the fuse blow now?

A15. You were lucky until that last time, and fate ran out on you. You were doing something that Kenwood explicitly warned you not to do. And now you are paying the price.

The reason you may have escaped damage before is due to the type of supply you were using. The charging/power jack on the radio is a closed circuit type. There are a few milliseconds during the insertion or removal of the jack when the external power supply is connected directly across the internal lithium battery. For this brief period, a large uncontrolled current will flow into the battery. This doesn't seem to harm the battery at all, it's pretty rugged and can easily survive momentary overcurrent spikes. However, the balance of the circuit traces and wires can't survive, so that is why Kenwood put a fuse in there.

You probably didn't pay much attention to the type of supply connected to the end of the wire when you plugged and unplugged power. If the internal impedance of the power supply is high, such as a normal wall wart or small power supply, you may survive hot plugging and unplugging. This all depends upon the power supply. Still, this is not a recommended practice.

However, if the internal impedance of the supply is low, or there is a large output capacitance, the current spike capabilities can be extremely large. This is especially true of multi-amp DC shack supplies and also for cigarette lighter/ car battery connections. The radio internal fuse is a fast-blow 4 amp device, and it is possible that your car battery connection could supply 20 to 50 amps of momentary surge regardless of how you have it externally fused. F2 doesn't have a chance, it's a goner.

You will be most unlucky if you hot plug/unplug the radio from an external DC supply or a car battery connection of any kind. Don't do it; do it they way Kenwood told you to do.

It's very important to reverse these steps when done with an external supply: Remove the energy from the external supply first, then remove the plug from the radio. You can blow the fuse just as easily when removing the plug as you can when you insert the plug.

The Horse's other alimentary orifice recommends interchanging steps 4 and 5 on page 2 of the manual. Remove power from the external power source first, then remove the jack from the radio.

Q16. Does this mean I can charge the lithium battery, even though the Menu 30 selection is alkaline?

A16. Yes, and it doesn't harm anything. The battery remaining bars will be incorrect, and transmit powers will be different. But nothing else will be harmed. The charging circuit doesn't know any different. It's just doing its normal job.

Q17. How long should I expect to be able to operate when the battery indicator shows 3/2/1/0 bars left?

A17. There is a drawback when such a simple state of charge indicator is used, as implemented in the TH-F6A. The bars are calibrated for certain battery voltages, but the bars don't give you any clue how long you may be able to operate.

Your only warning is a display that blinks when the voltage drops to the point that the radio is about to quit. No beep. Unless you are looking directly at the display when this happens, the radio simply goes dead. There are only a few seconds between onset of a blinking display, and a completely useless battery. Most times, the radio simply quits without prior warning. How annoying!

Kenwood could have been a little more forthcoming in their manual about this. The most ideal indicator would be a "minutes to empty" type of display, but this would have required more complexity in the already-cramped radio.

In addition, there are two battery types to content with: lithium and alkaline. The setting for Menu item 30 only changes two things: It changes the voltage calibration on the bars displayed when you hit F + BATT, and it also changes the transmit power settingsavailable. It does not, however, do anything to the charging circuits. See A9.

In an attempt to fill this void, the horse's other alimentary orifice has made careful measurements on many radios, over a period of two years. Here is some useful averaged data. Note that when you make a change to the externally applied voltage, it takes over 10 secondsfor the bars on the TH-F6/F7's display to respond.

Menu Item 30 = lithium (numbers assume factory 1550 ma battery and room temperature)

```
F + BATT bar calibration

  3-2 bar transition voltage:           8.09 volts down, 8.10 volts up
     approximate remaining capacity     1300 ma-hr

  2-1 bar transition voltage:           7.72 volts down, 7.75 volts up
     approximate remaining capacity     890 ma-hr

 *Will no longer transmit on high power at:                   x volts




 1-0 bar transition voltage:           7.43 volts down, 7.50 volts up
     approximate remaining capacity     165 ma-hr

   *Will no longer transmit on low power at:                 x volts
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*Will no longer transit on E-Low power at:                x volts


      Display starts to blink                 4.27 volts

      Display blinks very slowly              4.06 volts

      Cessation of receive operation:        3.96 volts

      Lithium
      Summary:  3 bars means > 1300 ma-hr remains.  High power transmit
                               is available.
                2 bars means between 1300 and 890 ma-hr remains
                  High power transmit may drop out in this range
                1 bar means between 890 and 165 ma-hr remains
                  Low power transmit may drop out in this range
                0 bars means less than 165 ma-hr remains.
                  Low power transmit probably not available,
                  E-Low power transmit will last only a short time.

      Menu Item 30 = alkaline
```

Numbers assume 2650 mahr, Duracell, Energizer, or similar battery, room temperature. Capacity rating is published for discharge to 0.8 volts per cell, but our poor TH-F6A won't operate that low. The capacity to 1.05 volts per cell (the voltage wherethe TH-F6A gives up) is 1855 ma-hr. The remaining battery capacity can't be used by the Kenwood; use the batteries in some other non-critical device to extract the final ~800 ma-hrs from them.

Readings are made at the battery terminals inside the shell, so current must pass through the protection diode.

Reminder again: capacity listed here is only what can be usefully extracted from the batteries, not what actually is left in the batteries.

```
      F + BATT bar calibration

 3-2 bar transition voltage:           5.89 volts down, 5.97 volts up
    approximate remaining capacity     1744 ma-hr

 2-1 bar transition voltage:           5.76 volts down, 5.84 volts up
    approximate remaining capacity     1706 ma-hr

 1-0 bar transition voltage:           5.59 volts down, 5.67 volts up
    approximate remaining capacity     1550 ma-hr

     Display starts to blink                 4.28 volts
       approximate remaining capacity        55 ma-hr


     Display blinks very slowly              4.15 volts
          approximate remaining capacity     12 ma-hr

     Cessation of operation:                4.10 volts
          approximate remaining capacity     0 ma-hr



      Alkaline
      Summary:
 3 bars means > 1744 ma-hr/13.2 hours remains
 2 bars means between 1744 and 1706/13.2 and 12.9 hours remains
 1 bar means between 1706 and 1550/12.9 and 11.7 hours remains
 0 bar means less than 1550 ma-hr/11.7 hours ma-hr remains.
```

As can be seen here, the calibration for the alkaline battery operation is extremely nonlinear. Most of the useful life of a battery will occur with no bars showing on the display. This could lead one to rashly discard or replace cells too early when zero bars are displayed, when in actuality, much useful life remains. Tsk, tsk: Kenwood.

This can be fixed, but it requires the Kenwood service manual, a selection of extremely small and high value surface mount resistors, a lot of practice in cramped quarters of a surface mount device, a

microscope, miniature tools, steady hands and a lot of guts. If you really want to know, post a request response here and I'll show you what I cooked up.

Q18. So what? Too many numbers. Big deal. What does this mean to me?

A18. The lithium portion of the battery bar scale display can be interpreted as follows:

	Almost exact:	Even 30% steps can be interpreted as:	
3 bars	>90% remains	100%	20 hours remain
2 bars	70% remains	70%	14 hours remain
1 bar	40% remains	40%	8 hours remain
0 bars	<10% remains	<10%	<2 hours remain

You have about 20 hours of continuous, useful operation from a full charge. Less if you are doing a lot of transmitting and scanning; more if you crank in some power savings on Menu 17 and use only one receiver. A point of reference, I easily go all week on a single charge, little transmitting, Menu 17 at 1 second, little scanning but both receivers operating, 2-3 hours of operation per day, automatic power off mode enabled. I charge the TH-F6A about as often as I charge my cell phone. Once a week. Of course, YMMV.

For alkalines, the bars provide little useful information. Here goes anyway.

3 bars	>95% remains,	>13.2 hours remains
2 bars	93% remains,	>12.9 hours remains
1 bar	88% remains,	>12 hours remains
0 bars	<85% remains,	<11.5 hours remains

Therefore, if you rely on '0 bars' as the time to change your alkaline batteries, you will grumble that you get poor life from your batteries. You may conclude that either the radio is a battery hog (not necessarily) or your batteries are worthless (again, not necessarily.)

Q19. My usage is considerably different than yours. How can I figure out how long my battery will last?

A19. You need to determine the current consumption for the various modes you normally use. Here are some guidelines:

(Need someone to step up and help supply the data. This horse's other alimentary orifice didn't have the time to do this.)

# Receivers	Menu 17 Power Saving setting*	Current consumption**
0 radio off	-	12 ua (it takes a little to keep the radio alive I guess.)
1	0	25 ma
1	1 second	xx ma
1	2 seconds	xx ma
1	3 seconds	xx ma
1	4 seconds	xx ma
1	5 seconds	xx ma
2	0	37 ma
2	1 second	xx ma
2	2 seconds	xx ma
2	3 seconds	xx ma
2	4 seconds	xx ma
2	5 seconds	xx ma

*** Although there are sub-second settings for the power savings, it makes for the collection of a lot of data. I'll let you do the math.**

**** Averaged over a long period of time. Current consumption will consist of a peak current while the receiver(s) are active, then a long period of rest while the receiver(s) are disabled.**

Transmitting current consumption

```
                  lithium battery:        Alkaline battery:

          2M, H       x ma. PO=x watts        x ma.  PO=x watts
          2M, L       x ma. PO=x watts        x ma.  PO=x watts
          2M, EL      x ma. PO=x watts        x ma.  PO=x watts
          223, H      x ma. PO=x watts        x ma.  PO=x watts
          223, L      x ma. PO=x watts        x ma.  PO=x watts
          223, EL     x ma. PO=x watts        x ma.  PO=x watts
          440, H      x ma. PO=x watts        x ma.  PO=x watts
          440, L      x ma. PO=x watts        x ma.  PO=x watts
          440, EL     x ma. PO=x watts        x ma.  PO=x watts
```

How to convert remaining ma-hr into time for either battery type:

Determine your expected usage for the next hour. Average back any future usage that extends beyond the next hour. Find the receive current consumption for your operation (one receiver, two receivers, power savings selected, scan modes activated, etc.) Choose a transmit duration and power you expect for the next X hours. Find the current consumption for that transmit power.

```
Time remaining             Present battery capacity, ma-hr
(hours)             =  ------------------------------------------
                              1                          1
                          -------------    +    ---------------
                          RCV_ma x hours          XMIT_ma x hours
```

Q20: I just finished charging my radio and battery, and now it's completely dead. Did I blow the fuse? Is the battery toasted? Will this cost a lot to fix?

A20. You may just need a simple fix here. Don't try to reset the radio from the keypad (probably won't work anyway) or anything else drastic.

First: With the power disconnected from you charging source, plug it back into the radio.

Second: Energize your charging source.

Third: Now turn the radio on.

If the radio is now on, the problem is most likely dirt or contamination in the closed circuit contact in the charging jack. Remove the power from the charging source, and unplug the charger plug. Remove the battery.

Using a small drop of contact cleaner of other mild solvent, drop one drop into the charging jack on the side of the radio. Now remove and install the charging plug many times, in an attempt to work the cleaner into the contacts.

Permit the solvent to evaporate, or hasten this my gently blowing into the charging jack.

Leaving the charging plug removed, reattach the battery. Now try turning on the radio. If it still does not spring to life, there may be a fuse blown or other internal problem. Try a reset. Hope you have your memories and settings backed up on your computer.

For contact cleaner, don't use one that attacks plastic or is flammable. Also, don't use a clearner with a lubricant; that leaves a residue that just attracts more dirt or contamination. Test the cleaner on a small hidden place to see if it will attack or dissolve the plastic. If so, don't use it on this radio. Clean alcohol works, even the smallest droplet distilled water can be of some use here.
