# Inside the Icom AH-4 Tuner

This paper describes the Icom AH-4 wide range antenna tuner. It attempts to compensate for a rather sparse instruction manual by providing information on how to interface the AH-4 with any HF radio. In addition, it also provides recommendations regarding antennas for fixed locations. An overview and description is presented as well. Those who are interested in antenna tuners (the AH-4 in particular) and those who just plain like to look into the guts of hardware and see how things work will want to read on.

Chris, K9EQ

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# 1. Overview

The AH-4 is a wide-range antenna tuner capable of matching a 50 ohm feed line to an antenna feed impedance in the range of 10 to 5,000 ohms. The tuner is designed to operate with up to 120 watts of power. It incorporates 22 relays that switch combinations of inductance and capacitance to achieve tuning – typically within 1 to 3 seconds.

The AH-4 is enclosed in a weatherproof housing and is capable of being permanently installed outdoors. It interfaces to the radio with the coaxial feed line and a 4-conductor control cable. The cable carries the 12 volt power and ground, and the KEY and START control lines. The peak current demand is less than one amp, but typically requires less than 300 ma for operation.

The tuner consists of a microprocessor control system, a power divider, impedance and power measurement circuitry, and the matching network. The RF can be switched between straight thru (power off state or disengaged state); through the power divider network, measurement circuitry, and tuning network (tuning mode); or just thru the tuning network (normal operation).

I feel that the AH-4 offers advantages over other tuners on the market for the following reasons:

•During tune the radio always sees a low SWR, typically 1.1:1 or less. This is because the RF is switched to a 10:1 power divider during the tune operation. Only approximately 350 milliwatts of power is used during tuning. 50 ohm resistors swamp the remaining power so that the radio never sees a high SWR.

•The tuning relays are never switched under power. This results in long relay life since you don't have to worry about arcing while tuning.

•The microprocessor is shut off except when tuning. This means that you won't hear digital noise from the AH-4 while listening.

•Weatherproof enclosure.

•Low cost – typically in the $330 price range.

• Well designed – filters on all control lines, protection circuitry, mechanical construction, solid electrical design, etc.

•Works better than Icom says – with the right antenna it will operate on 160-6 meters.

The AH-4 has some disadvantages of course. They are:

•Only works with certain Icom radios out of the box.

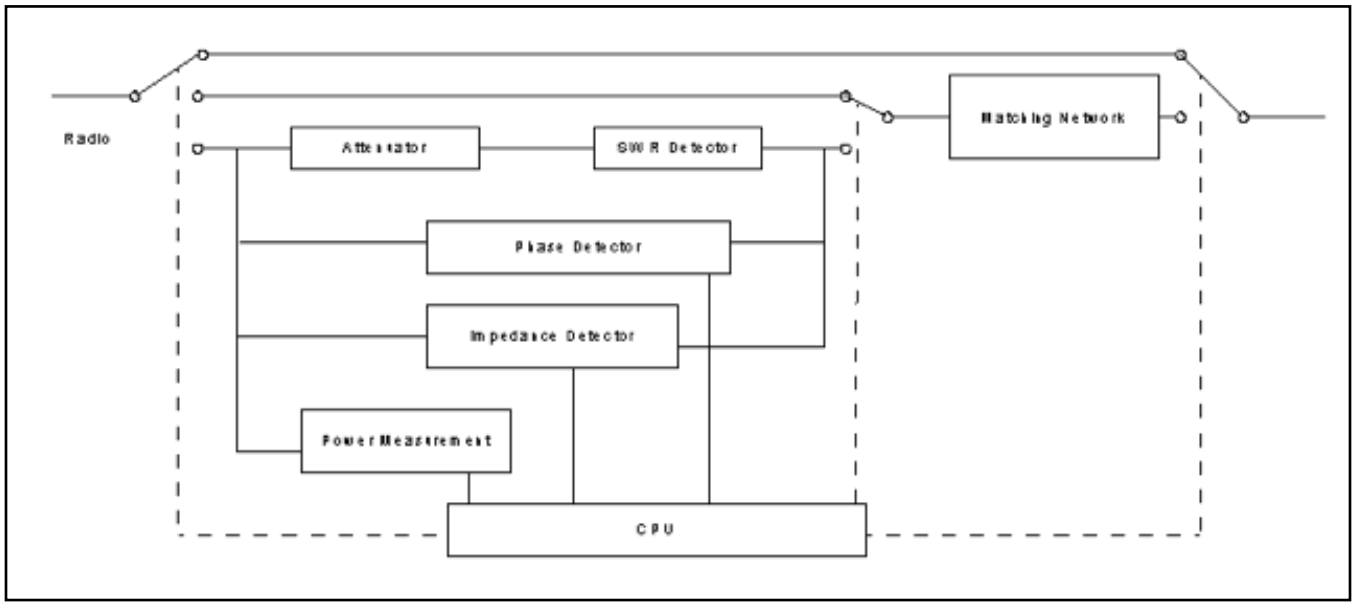
•The instruction manual is badly done. It offers very little information about the tuner and gives bad suggestions regarding the best antennas to use with the tuner.

•Is limited to 120 watts.

In this paper, I hope to minimize the cons by providing the reader with additional information about the tuner as well as some suggestions of antennas that can be used with the AH-4.

# 2. AH-4 Design

**FIGURE 1: BLOCK DIAGRAM OF THE AH-4**



# 3. Inside the AH-4

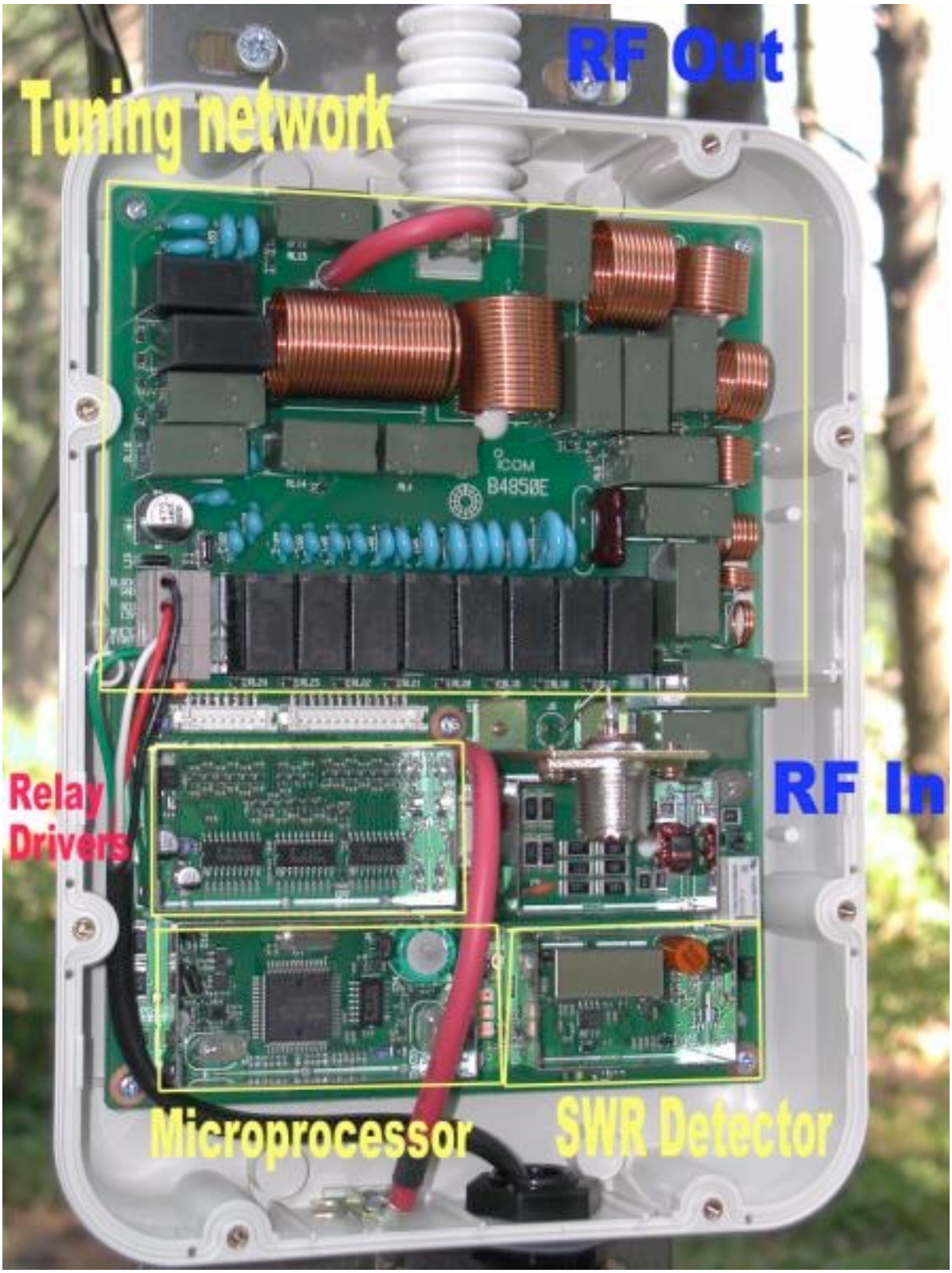
I use the AH-4 primarily to feed balanced antennas. I've modeled a number of antennas using EZNEC and I never seem to have good luck when the antennas are unbalanced. An example of an unbalanced antenna is a long wire connected to the RF out port and the ground connected to, well, ground. I much prefer feeding either a loop, with the AH-4 right at the feed point, or a flat top via ladder line. In both these cases the AH-4 works extremely well.

This is a photograph of my AH-4. It is feeding a 30 meter flat top. The antenna is about 20 meters high and is fed with 450 ohm ladder line.

Note that the RF output is on top and the RF ground is on the bottom. I'm not sure why they did this. It makes one believe that the tuner cannot work with a balanced feed. Nothing could be further from the truth. It works great. Note that the metal mounting brackets are not grounded.

**FIGURE 2: AH-4 IN OPERATION CONNECTED TO BALANCED ANTENNA**

**FIGURE 3: A VIEW OF THE INSIDE OF THE AH-4**



# 4. AH-4 Radio Interface Operation

The AH-4 interfaces to the radio with a two-wire connection. A START signal is issued by the radio to start the tuning operation. A KEY signal from the tuner indicates when: the tuning has started; the tuning has failed; or the tuning has been completed. The tuning operations works as follows:

1. A tuning operation is requested by the radio – the radio asserts the START line.
2. The AH-4 microprocessor is reset and begins running its program after approximately 300 ms. When the AH-4 is ready, it asserts the KEY line (AH-4 routes the RF through the power divider, measurement circuitry and tuning network).
3. The KEY signal causes the radio to transmit a carrier at about 10 watts of output power.
4. The AH-4 verifies that the power is between 5 and 15 watts. If not, the AH-4 aborts the tuning operation.
5. If the power is between 5 and 15 watts, the AH-4 begins the tuning operation.
6. Approximately 250 ms after the AH-4 starts tuning, the radio removes the START signal.
7. When tuning has been achieved, the AH-4 removes the KEY signal and switches the RF to pass only through the tuning network. The microprocessor is then halted. The radio stops transmitting when the KEY signal is removed.
8. If the AH-4 was unable to achieve tuning, it removes the KEY signal for 20 ms, asserts it again, waits 200 ms, then finally removes the KEY signal. This causes the radio to indicate a “not tuned” condition.
9. If the band is changed on the radio, the tuner is reset. This causes the tuning network to be removed from the circuit.

The figures below show the various commands and responses to the tuner.

**FIGURE 4: SUCCESSFUL TUNING RESPONSE**

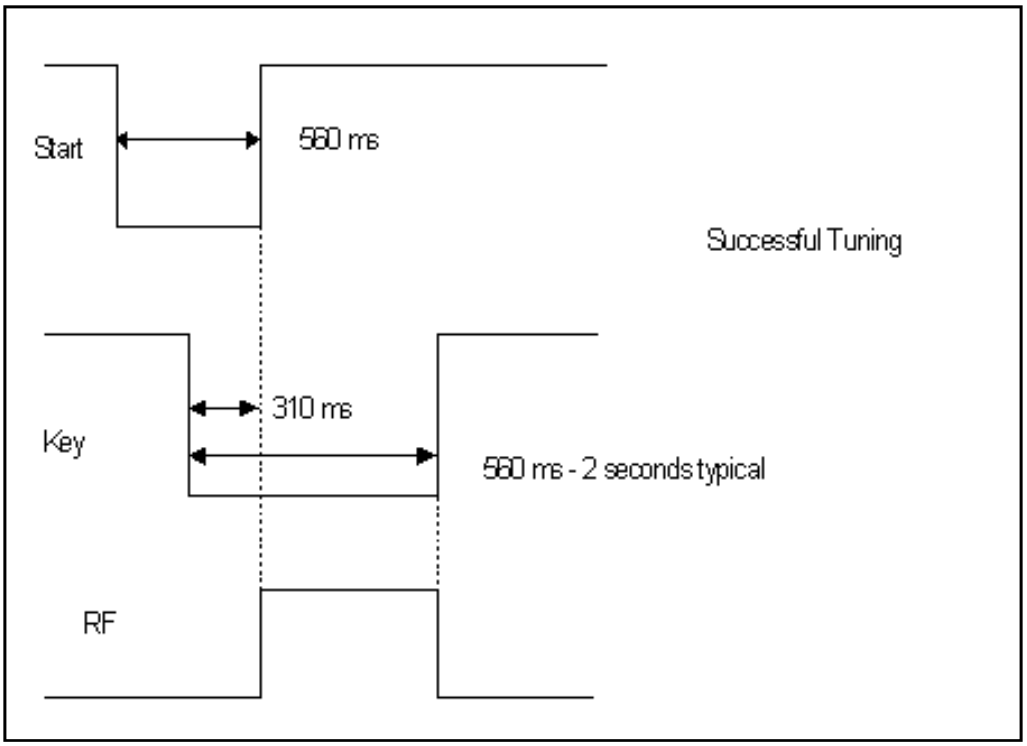
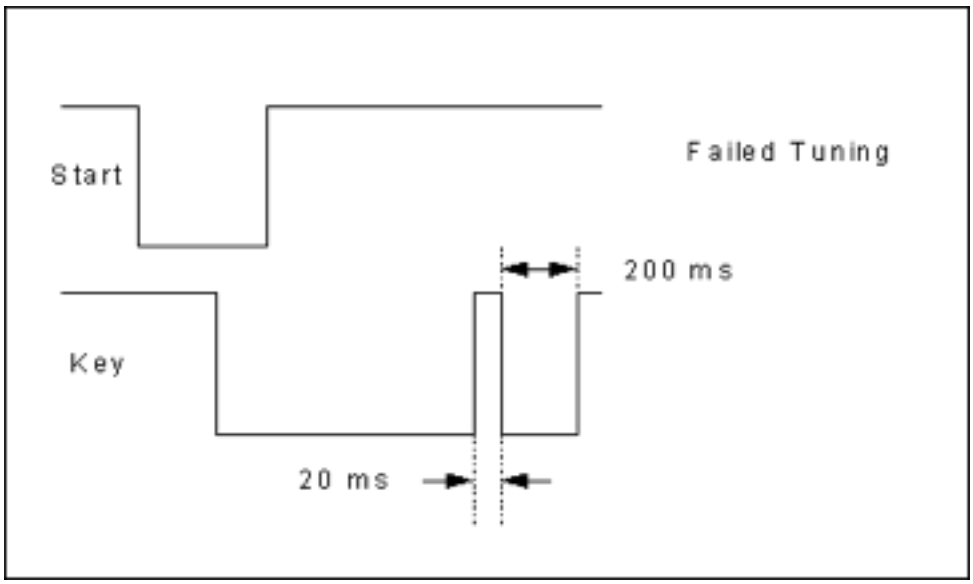
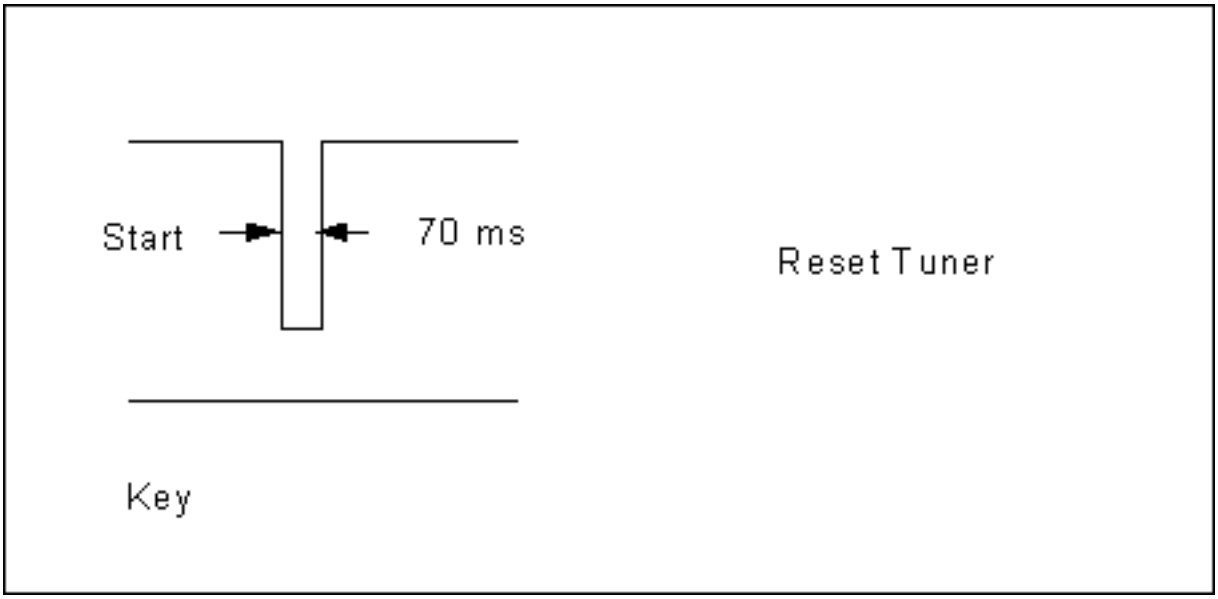


**FIGURE 5: FAILED TUNING RESPONSE**




The command to reset the tuner causes it to pass-thru (tuning network out of circuit).

**FIGURE 6: TUNER RESET**



# 5. Electrical Interface

The AH-4 uses 12 volt inverted logic and an “open collector” transistor to ground to perform signaling. The radio provides 13.8 volts to the tuner. It also provides a START line that is pulled up to 13.8 volts inside the radio. The radio pulls the START line to ground to assert the signal (start the tuning operation). Similarly, the AH-4 pulls the KEY line to 5 volts through a 22 K ohm resistor/diode combination. The radio also pulls this line to 13.8 volts through a resistor. The AH-4 pulls this line to ground to assert the signal (indicate tuning status to the radio.)

# 6. Revision History

| Revision | Date | Description |
|---|---|---|
| **2** | 2019-05-22 | Formatting for PDF presentration |
| **1** | | Original |