# An Experimental Tuning 'Assistant' for Yaesu FT-897 and FT 857 Transceivers

**by**

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**WARNING: IF YOU TRY THIS CIRCUIT YOU DO SO AT YOUR OWN RISK!**

For a couple of years I've been using a home-designed and built 'tuning assistant' in conjunction with my Yaesu FT-897D transceiver. I hope to soon acquire a Yaesu FT-857D for mobile communications, and I just built another tuning assistant for it. Both the FT-897D and FT-857D are operationally very similar. When constructing the second tuning assistant it occurred to me that my design may be of interest to other amateur radio operators who have either a FT-897 or FT-857. Although my kind of device is sometimes referred to as a 'tuning aid', this term describes various types of devices for tuning amateur radio transmitters. So I call mine a tuning assistant.

My tuning assistant is a transmitter accessory used when adjusting an antenna tuner for lowest SWR prior to making transmissions for communications. The tuning assistant does two things:

1. temporarily lowers transmitting power to the smallest amount necessary for antenna tuning purposes (further, at reduced power the operator can transmit - in SSB or other mode - his / her call sign and query if frequency is clear), and

2. causes transmission of a CW carrier to allow adjustment of an antenna tuner's inductor and capacitors while the forward and reflected power are observed for lowest SWR.

Tuning at reduced power is important to minimize interference with other amateur radio communications, and to eliminate the prospect of transmitter damage from significant reflected power due to mismatched antenna / transmitter output impedances (i.e. high SWR) prior to tuning.

This article describes my tuning assistant circuit design and portrays the two devices I built. In designing my tuning assistant I did not refer to any other tuning aid devices so I do not know if my assistant is particularly unique, but at the least this article presents a unit that is easy and inexpensive to make, and simple to use. I did not investigate whether my design would work with other radios. *I will be pleased to receive advice and comments regarding possible improvements and applicability to other radios.*

As explained in the box below, my FT-897D is a bit weird so I do not expect the voltage parameters of its tuning assistant to be the same as that made for a (properly working) FT-857D. My design is adaptable, however, to adjust for a transceivers' idiosyncrasies. Moreover it is a very uncomplicated circuit and easy to build and modify.

**Circuit Design Philosophy**

My tuning assistant plugs into transceiver's ACC (accessory) Jack. The underlying principles of the tuning assistant's design can be found in the FT-897D and FT-857D operator manual descriptions of their ACC jacks, under the headings Linear Amplifier Interfacing and Rear Panel Connectors. These descriptions are very similar and are paraphrased or quoted as follows:

**My Weird FT-897D**

The ALC control voltage at the ACC jack in my transceiver does not conform to the specification in the manual. Transmitter power is not reduced at all until -4 volts is reached, and full power cutoff occurs at a -0.7 volts more. (Thus the reason for my tuning assistant voltage output going to -5 volts.)

When new my FT-897D was afflicted with mis-adjusted transmitter bias current, which I corrected following instructions posted on the Internet by other hams, for example:
http://members.cox.net/w1aex/897idle.html

I suspect there remains a mis-adjusted ALC voltage threshold, that I have not yet found how to correct.

Linear Amplifier Interfacing

The FT-897/857 provides the switching and drive-control lines required for easy interfacing to most commonly-available amplifiers sold today. These include a T/R control line (open circuit on RX, closure to ground on TX); and a negative-going ALC (automatic level control) jack, control voltage range: 0V to -4V DC.

The ACC jack is a miniature stereo type, with external ALC input capability on the tip connection. The main shaft is the ground return. The ring connection of the ACC jack, when closed to ground, places the FT-897/857 into the transmit mode, and sends a steady CW carrier for amplifier (or antenna tuner) adjustment purposes.

Rear Panel Connectors

"ACC Jack - This 3.5-mm 3-pin jack accepts external ALC (Automatic Level Control) voltage from a linear amplifier on the tip connection, and accepts a "Transmit Request" command on the ring connection. The main shaft is the ground return. The "TX Request" connection, when shorted to ground, puts the FT-897 into the transmit mode, and sends out a steady CW carrier, for linear amplifier or manual antenna tuner adjustment."

* * * *

For the functioning of a tuning assistant the important characteristics of the ACC jack are:

- the sleeve ( main shaft in Yaesu's manuals) of the jack is the ground connection.

- grounding the ring of the jack causes the transmitter to send a CW carrier.

- putting a negative voltage (with respect to ground) on the tip of the jack reduces the transmitter's power; the larger the voltage (to – 4 volts) the less power will be transmitted.

From the perspective of circuit design these mean:

- put a switch between the ring and sleeve of the ACC plug.

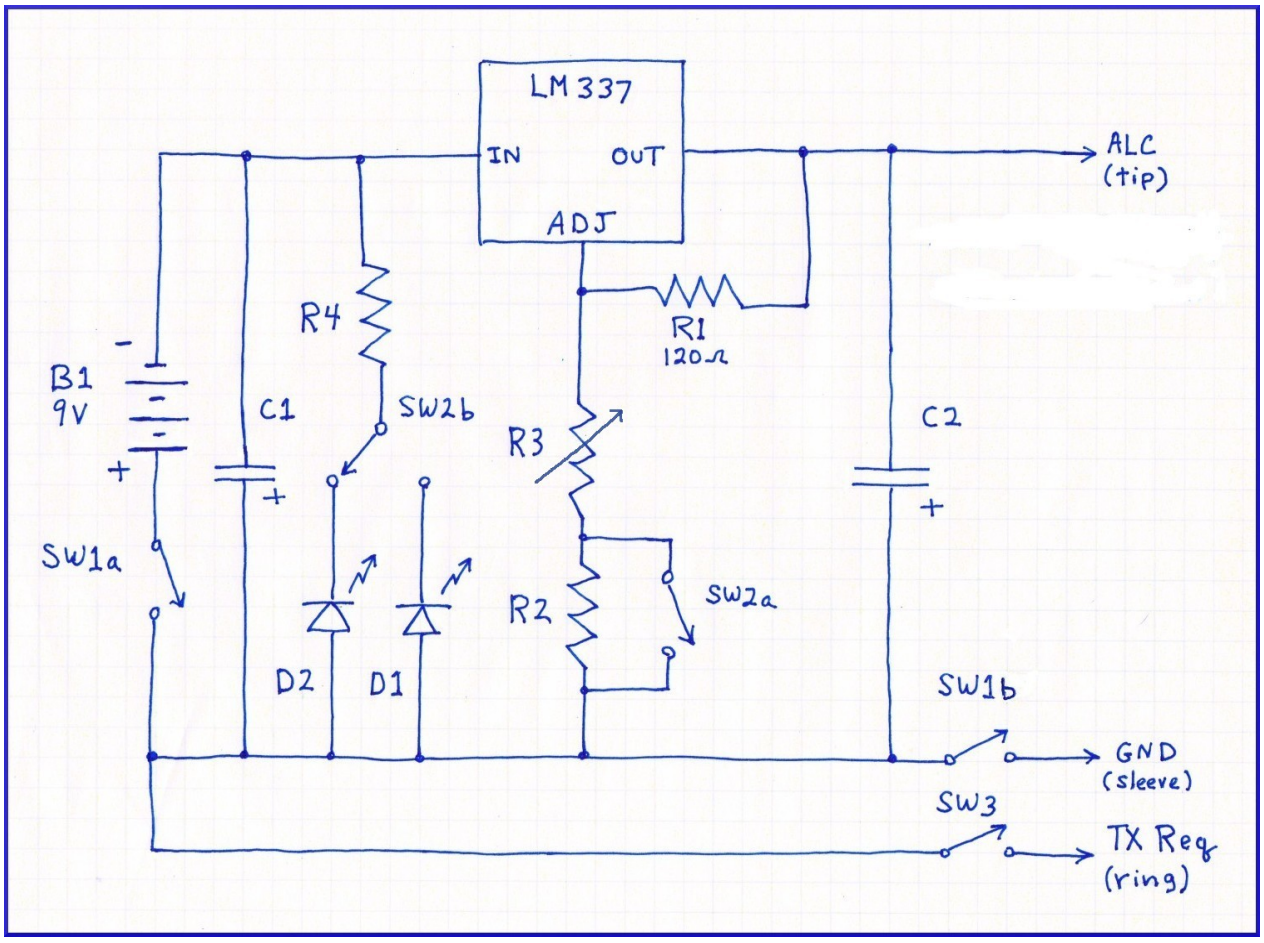
- have a way to deliver a stable, controllable negative voltage to the tip of the ACC plug.

There is no feed-through option in the tuning assistant so when it is plugged into the AAC jack an amplifier cannot also use the ACC jack.

## The Circuit

The schematic circuit of my tuning assistant is shown below.

EXPERIMENTAL
TUNING ASSISTANT FOR YAESU FT-897 / 857
BY ANDREW CORNWALL / VE1COR, (C) 2009
(Use at your Own Risk)




*ALC Voltage*

*-Vout = 1.25 (1 + (R3+R2)/120)*
*Note: when SW2a is closed R2=0*

| | | | |
|---|---|---|---|
| *IC1* | *LM337 adj. volt. reg* | *SW1* | *DPST* |
| *R1* | *120 ohms* | *SW2* | *DPDT* |
| *R2* | *10 ohms ** | *SW3* | *SPST push* |
| *R3* | *~352 ohms pot. (-5v. max)** | | *button* |
| *R4* | *~1K ohm depending on LEDs* | *D1* | *Yellow LED* |
| *C1,C2* | *min. 1 ufd** | *D2* | *Red LED* |
| | | *B1* | *9 volt Battery* |

** see text*

In addition to the requirements already described my design has the following features:

- the device is self-powered by a common 9 volt battery (B1), so it is small and portable.

- there is an on-off switch in ganged SW1a and SW1b. When SW1a is off it disconnects the battery (B1)), and simultaneously SW1b disables the tuning assistant allowing normal transmitter operation – even pressing the CW button (SW3) has no effect.

- there is allowance for two stage tuning by switching ganged SW2a and SW2b. SW2a toggles between low transmitter power (for example one or two watts) suitable for initial antenna tuning, and modest transmitter power (maybe three to five watts) to tweak tuning and to verify the initial SWR meter indication. Depending on whether low or modest power is chosen, SW2b lights the yellow or red LED.

Output voltage is set by means of an LM337 negative adjustable voltage regulator. Electricity into the voltage regulator is negative and so is the output. The value of the output voltage is determined by the relative resistor values of R1 and combination of R2 and R3. The formula is shown accompanying the schematic diagram. R1 has to be reasonably close to 120 ohms (in my units about 122 ohms works OK). The advantage of a voltage regulator is that, within limits, its output voltage remains constant despite changes in input voltage and output load. Thus the tuning assistant's output voltage remains constant as the 9 volt battery loses voltage over time. In my case the tuning assistant will maintain an output voltage of -3 volts, for example, even with a battery as low as 5 volts.

The output voltage of the tuning assistant and subsequently transmitter power is adjustable by variable resistor R3. The higher the value of R3, the greater the tuning assistant's (negative) output voltage and consequently the lower the transmitter power. When SW2a is open R2's (fixed) resistance is added to that of R3 raising the tuning assistant's (negative) output voltage even higher and reducing transmitter power even more. SW2 open is the transmitter low power setting. SW2 closed is the transmitter 'modest' power setting.

With R3 set to zero and SW2a closed (switch set at low transmitter power setting) the tuning assistant's output voltage approaches -1.25 V (-1.38 V in my unit), and transmitter power should be (mostly) unmitigated. For low transmitter power setting I've chosen a maximum output voltage of -5 V for the tuning assistant, requiring R3 to go up to 352 ohms. (Three hundred and fifty-two ohms is not a common variable resistor value, so I modified an approximately 500 ohm potentiometer by paralleling it with a 1.2K ohm resistor.) According to the FT-897 and FT-857 specifications, at -5 volts the ALC should cut off all transmitter power. Opening SW2a increases the tuning assistant's negative voltage by another amount, decreasing transmitter power even more. At present the value of R2 has to be determined experimentally, depending on the sensitivity of the transmitter's ALC. For the time-being I've included 10 ohms in the schematic diagram which adds about minus 0.3 volts to the tuning assistant's output. *I welcome suggestions on what value of R3 might work for various changes in transmitter power, to include in a future update of this article.*

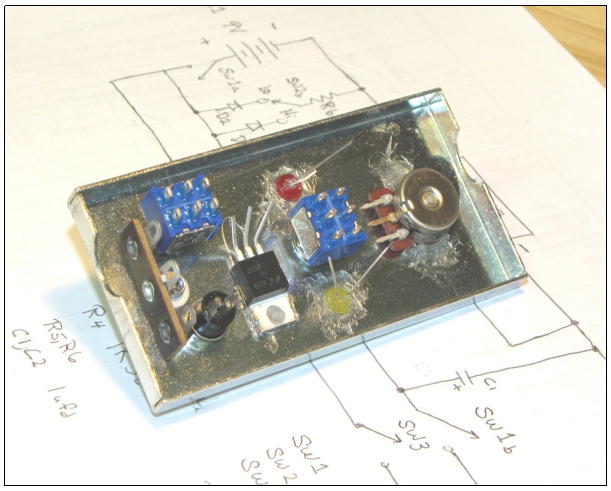
The ACC jack's current drain on the ALC pin is negligible so there is no loading to consider on the voltage regulator. Regarding battery drain the only current needed is to feed the voltage regulator, the R1| R2+R3 network, and light one of the LEDs. My tuning aids draw somewhat less than 20 ma. I did not measure the current nor voltage going through SW3 for transmitting a CW carrier. I assume it is almost zero. Thus, the amperage rating of all switches can be small.

The LM337's applications notes specify a capacitor on the input and output sides of the voltage regulator, with a possible range of 1 uf to 1000 uf for each. These are shown as C1 and C2 in the tuning assistant's schematic diagram. The purpose of the capacitors is to smooth out transients in supply voltage and load. I have not noticed any such transients in either of my tuning aids nor does the circuit design suggest there would be any, but I added the capacitors anyway. In my first unit I used a pair of 9 uf tantalums, and in the second a pair of 47 uf common electrolytics. Both values suffice.

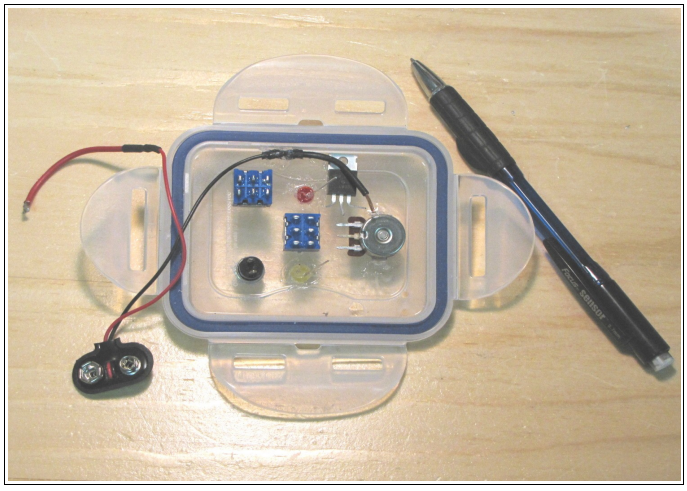
**A Look at My Two Tuning Aids**

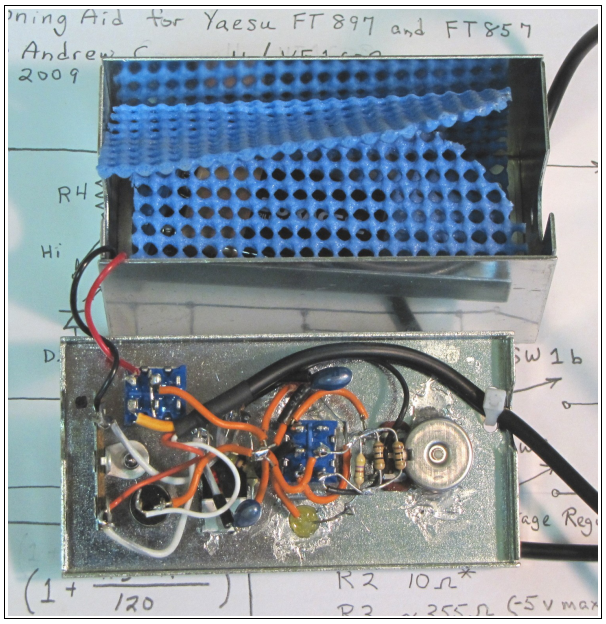
The construction appearance of both my tuning aids is nothing the brag about. I used mostly scrapbox parts. I did not optimize the wiring layout, instead I just followed the schematic diagram going from point to point, which demonstrates that layout probably does not matter. The first tuning assistant was built on the inside top of a small metal box, and the second on the inside top of a small, plastic, food storage container. An important consideration in the metal box is to let the circuit float; that is no part of the circuit makes a connection to the box. This avoids the chance of a short circuit of the TX line if the box comes in contact with the transceiver's metal case. With the plastic container there is no chance of a short circuit as long as no 'live' mounting hardware protrudes to the outside of the box.

Pictures 1a and 1b below show the parts layout of the two tuning aids before wiring. The LM337, potentiometer, and LEDs are secured with Goop glue. In the metal case Goop both holds LM337 in place and, with a thick application, insulates it from the case. *(In my experience dried Goop burns when exposed to open flame, so it may not be appropriate in high amperage circuits where a heavy load or short circuit could make components heat excessively.)* Pictures 2a and 2b show the wiring, and picture 3 shows both completed units.

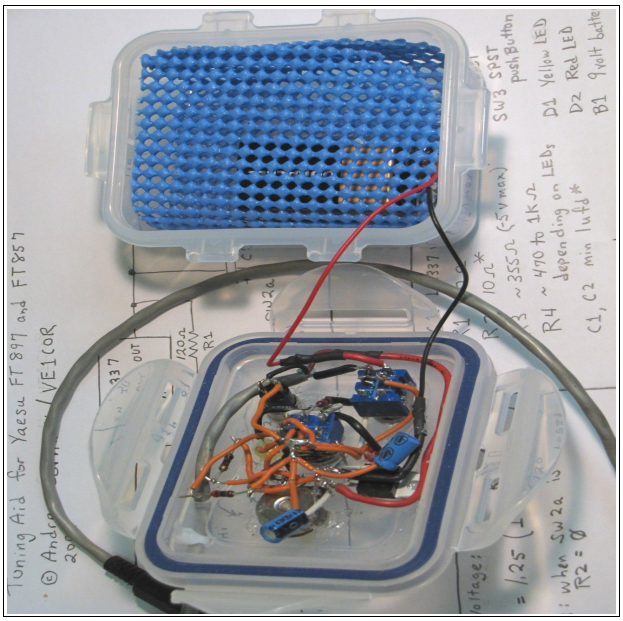


Picture 1a


Picture 1b




Picture 2a




Picture 2b


Picture 3

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