New life for the FT-ONE (Part 2)

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The second part of this series is not about solving a problem, but is about a very useful enhancement. It consists in the implementation of a panoramic adapter or *Panadapter*, based in a SDR, in a simple and economical way. (See "a SDR *dongle* primer" at the end).

The FT-ONE already has an IF output, one from the second IF at 8.98 MHz, but this output is taken after all the selective filters so the bandwidth is really small and in no way it is adequate for a *Panadapter*. I can't guess the use that Yaesu intended for this output, maybe they had planned a FSK or SSTV demodulator, but I have no notice of any accessory marketed to be connected there.

After studying several possibilities, the place that I considered ideal for taking the signal was at the beginning of the first IF, just before the roofing filter. This filter has a bandwidth of about 20 KHz and taking the sample after it would limit the spectrum bandwidth in a non-desirable way.

The advantages of taking the IF sample at this point can be resumed as:

- Great bandwidth, because the FT-ONE only have before it the input passband filters, which are quite wide.
- Low amplification is applied to the signals, only 10 dB from the antenna, which is good for reducing intermodulations and saturations in the SDR *Panadapter*.
- An IF frequency of 73.115 MHz, which allows the use of a DTV *dongle* for the SDR at an unbeatable price, about $9.

Design

The original idea was to install a FET buffer just at the IF sampling point, to avoid loading the circuit which could cause sensitivity loses in the FT-ONE receiver. Once the adequate point was found in the RF pc board, I made a first test soldering there about 60 cm of RG-174 coax through a small capacitor. The cable has a connector at the other end that is mated to the *dongle* antenna input. For my surprise the FT-ONE didn't lose sensitivity, so I forgot about the buffer and its installation issues.

Another choose to be made was to install a coax connector in the rear panel for the IF output and use an external *dongle* (or other SDR), or install the *dongle* internally. Each option has its own advantages and I first choose to use the internal option so I installed a USB connector in the rear panel. Later I used the coax connector option for an external SDR on a second FT-ONE.

The selected SDR (Software Defined Radio is a USB *dongle* intended for DVB reception on a PC. This can be purchased by $9 in China. There are several models available, but I strongly recommend using one with a R850T2 (or R850T) tuner chip and a RTL2832U TV signal processor. It is also very convenient to purchase one with a MMX antenna connector and an antenna. The antenna is not used in this project, but the cable and the attached connector are.

Fig. 1. A typical DTV *dongle*

One additional advantage of this project is that the SDR provides a complete second receiver. You can tune it and listen to any other station that lies within its spectrum window, simultaneously with the main receiver. This receiver includes all the advantages of the SDR technology such as continuously variable filters, noise suppressors, audio and baseband recorders, etc., frequently with better specs than the main receiver ones.

Installation

The IF pickup point in the RF Unit is marked with the red arrow in the partial schematic of figure 2.

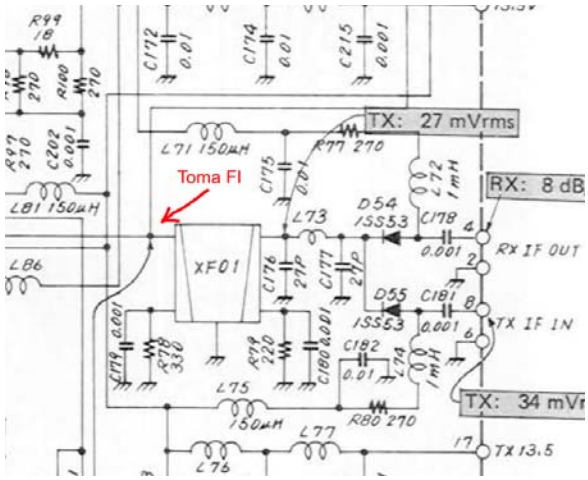

Fig 2. Schematic, IF pickup point

The connection is made with the antenna cable that comes with the dongle through a 15 pF capacitor, as can be seen in the figure 3. The cable is routed to the upper side of the module through an existing hole, and exits to the outside of it using a ventilation slot in the module case, as can be seen in figures 3, 4 and 5.

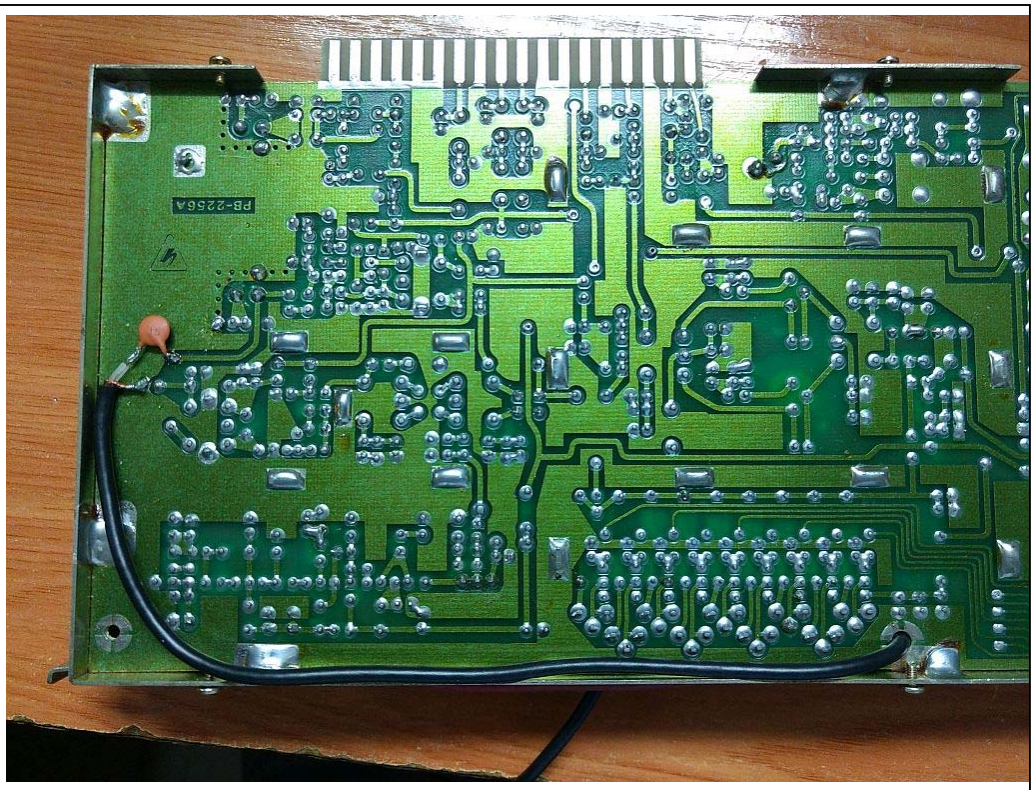

Fig. 3. RF Unit bottom, IF pickup point

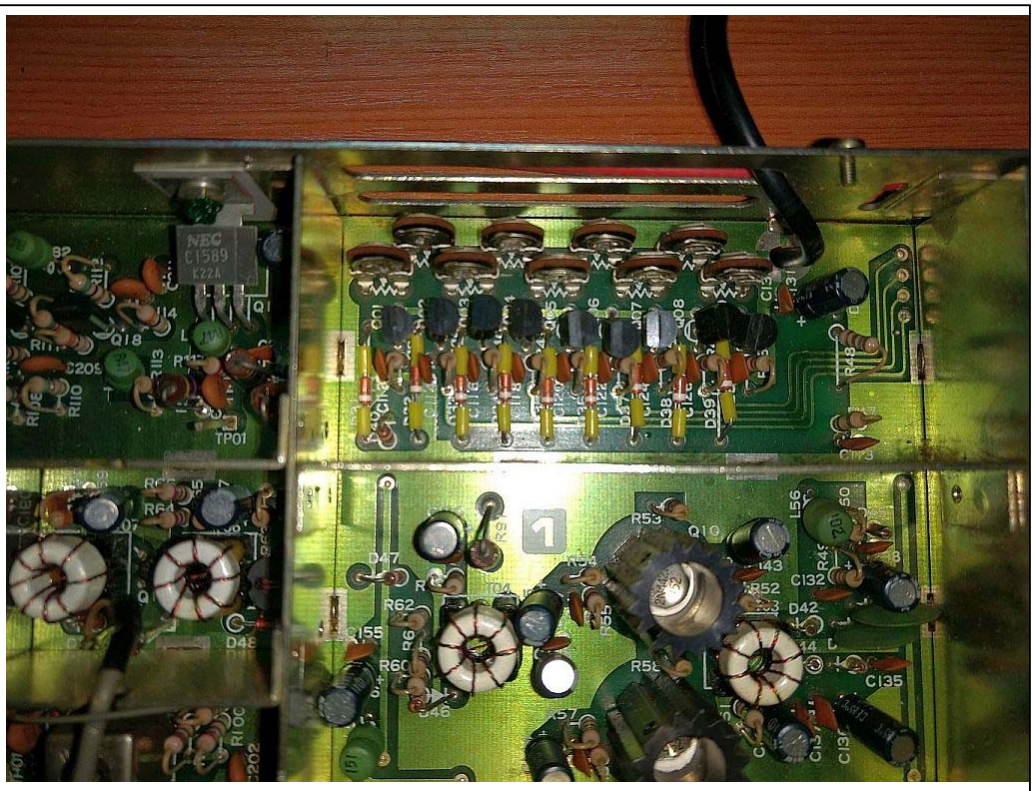

Fig. 4. RF Unit top, IF cable exit point

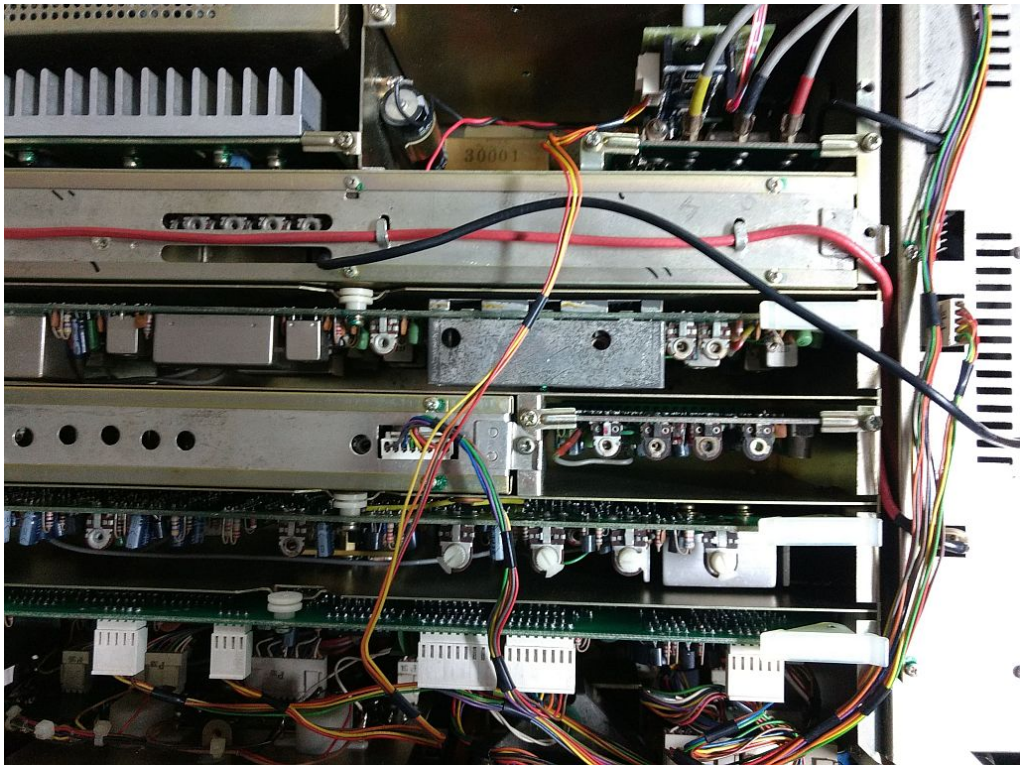

Fig. 5. RF Unit, IF cable exit point. Behind the ALC Unit is the Arduino / Si5351A 53.280 MHz synthesizer, described in the Part 1 of this series.

I placed the *dongle*, along the cable slack, in a space that is between the PA and the BPF Unit. It was not necessary any support.

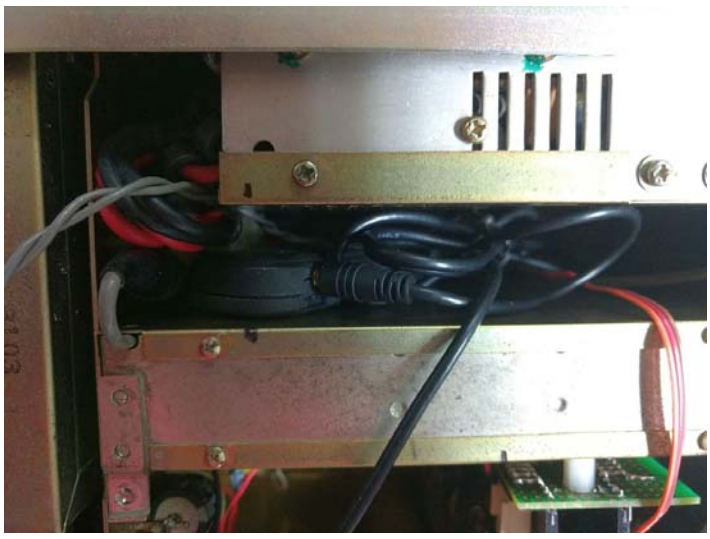

Fig. 6. The dongle on its place

To connecto it to the PC, the *dongle* is provided with a “Type A” USB connector. The way that I used to make the cabling was to repurpose an USB male to female extension cable that I cut to the necessary length, about 20 cm from the female connector.

I made a square hole in the rear panel for installing a female “Type B” connector, in the space between the ground nut and the auxiliary connectors plate.

Fig. 7. USB connector from the outside

I soldered the wires from the free end of the USB cable to this “Type B” connector, fixed it to the rear panel using hot glue, and also used the same glue to insulate and protect the rear part of the connector, as seen in figure 8. For the connection to the PC, I use an USB cable of the type commonly used for printers.

Fig. 8. USB connector from the inside

Software

There are several free SDR programs that can be used with this dongle. In my case I have installed HDSDR, SDR# and SDR-Console and I use them with the different SDR hardware that I have. I choose the one that I feel more adequate for each situation.

For this *Panadapter* project I have opted by HDSDR, configured to use a RTL-SDR *dongle*, and an IF output connection. I have entered 73.115000 as the IF value and set to zero both the LO and Tune dials. I also selected in the ExtIO window a sample rate of .96 Msps and 15.7 dB as the tuner gain.

With these settings the scale indicates 0 for the signal at which the FT-ONE is tuned, and the SDR receiver can be tuned up and down using the mouse wheel or just clicking over the desired signal.

The figure 9 shows the program in operation, with the FT-ONE tuned to 7.100 MHz so most of the 40 m band is shown, from 7.0 to 7.2 MHz.

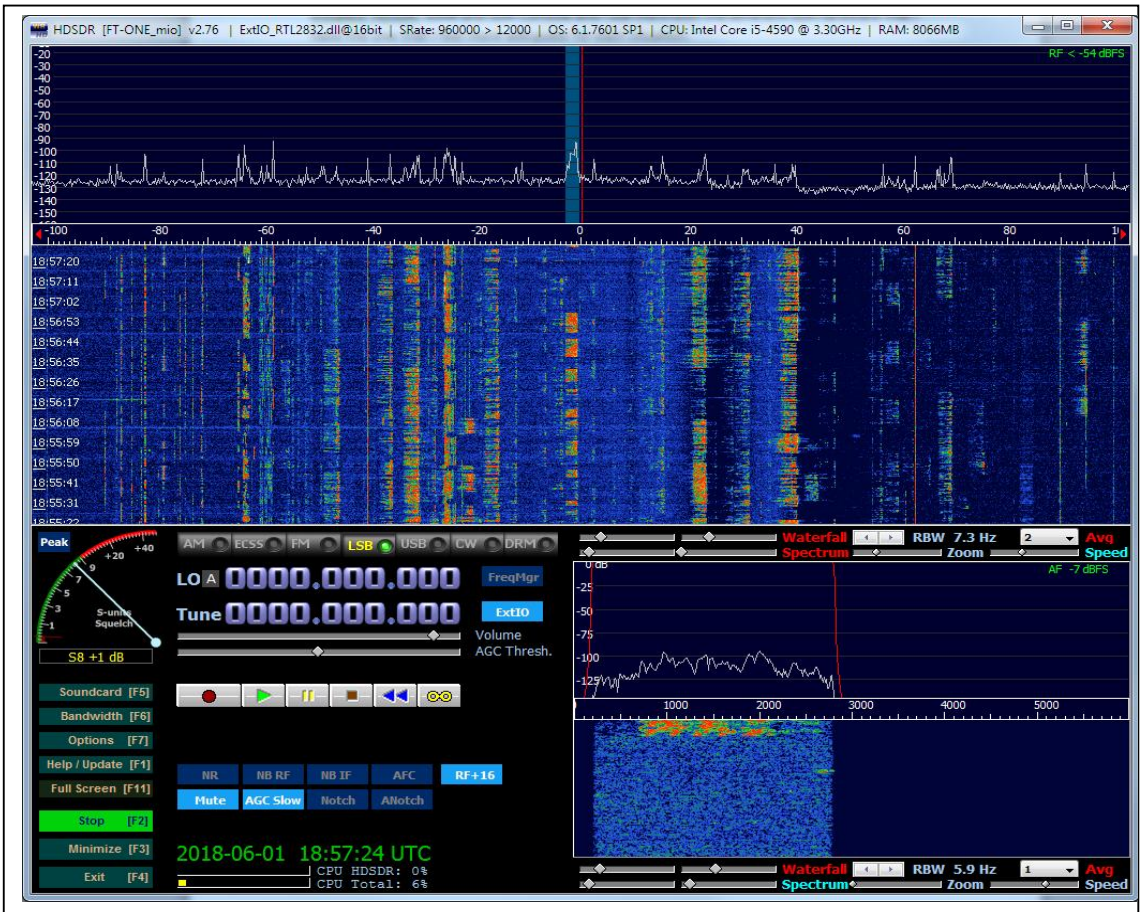

Fig. 9. The 40 m band *Panadapter* – second receiver view

Other than seeing the signals that are present in the band, the *Panadapter* allows observing interferences and deficiencies in the signals. In the figure 10 can be seen one station which is 8 KHz below the FT- ONE tuning, and another two stations that are 11 and 30 KHz above, which have a good amount of splatter, which denote a “linear” amplifier badly adjusted or just overloaded (Fig. 10).

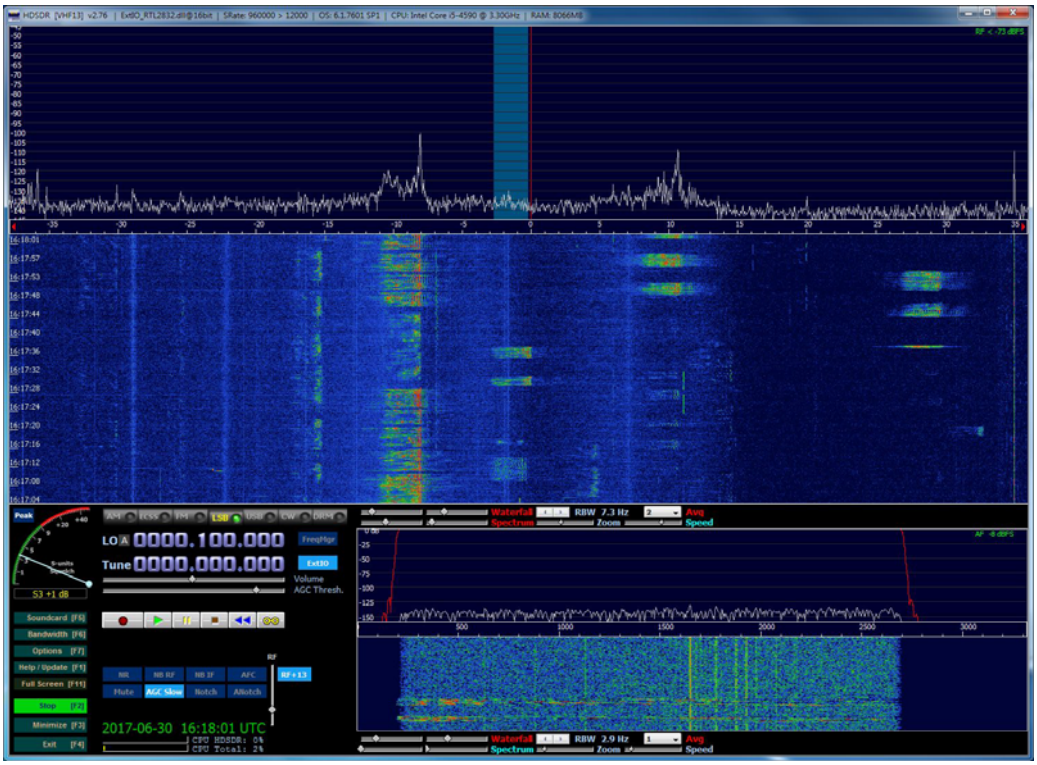

Fig. 10. Splatter producing stations

I must point out an important thing: these *dongles* have an A/D converter with only 8 bit, so its dynamic margin is somewhat reduced. Since the input bandwidth spans several MHz, very low level signals can coexist with broadcast stations with hundreds of kilowatts, it is neccesary to adjust the RF gain of the *dongle* tuner in order to avoid saturations. This is observed very easily, start with the gain at minimum and increase it slowly; when reaching the saturation point suddently a lot of spureous signals appear which amplitude increases faster than the real signals when increasing the gain. The sweet point is just below the spureous apearance, and this point changes with the current band conditions. In fact, it is not realistic to ask to a $9 receiver to do miracles, but for this kind of application probably it is the ideal choice.

The instructions to use this program, as happens with any other SDR program, clearly exceeds the scope of this article. There is plenty of information on Internet and I am eager to help to anybody who want to install this enhancement in his FT-ONE, don’t hesitate to ask.

More information

This project is basically valid for any other high IF transceiver or receiver. Some of them already have factory installed IF outputs, so the installation is a trivial one.

Higher resolution images of this project have been uploaded to the photos section, inside the album “EB4APL Panadapter”.

Any comment or additional info request can be sent in a message to the FT-ONE group, or directly to eb4apl@gmail.com

The original version of this article has been published in the magazine Radioaficionados, of the Spanish Ham Union(URE) some months ago.

A SDR dongle primer

For the ones unfamiliar with this technology, the SDR are receivers (and transmitters) that use a program to implement in software most part of the functions that a conventional radio implements with physical circuitry. All of them need a minimum hardware for digitizing the signals arriving to the antenna so these, once converted to numerical values, could be treated by the digital signal processing algorithms implemented in the software.

There are many models of this hardware and also many SDR programs available. In fact, ***the receiver is the software***, and the hardware involved is just the front-end.

The idea of using a cheap DVB *dongle* as a wide band SDR (24 – 1700 MHz in this case) appeared when a programmer discovered that it was possible to configure these *dongles* in a test mode, bypassing all the TV signal processing, and deliver the digitized RF signal to the USB port. The next step was to write a special driver for the PC, to replace the commercial one used to watch the TV.

Once this driver was available, most authors of free SDR programs have included these *dongles* in the supported front-ends list, so spending just $9 you can have a receiver that covers from 24 to 1700 MHz. It is not the best receiver in the world, but surely it is the one with the best price – performance ratio.

IMPORTANT LAST MINUTE INFO

The manufacturer of the R850T tuner chip, Rafael Micro, has stopped its fabrication and discontinued it. They have replaced it with another chip that is not compatible, so the *dongles* manufactured with these new chips could not work with the curent driver. My advice to anybody who is interested in this project is to buy a dongle right now, don't wait for the new ones because nobody knows what can happen with the software support for them. There is still a lot of them in the usual Internet sites but the price will increase as they will become more and more scarce. Look for something as "R850T- RTL DVB dongle" or "DVB-T USB TV FM+DAB Radio Tuner Receiver Stick Realtek RTL2832U+R820T MCX". The key words are RTL2832 and R850T (or R850T2).