

## IC-7600 Scope IF tap for RTL-SDRs

Stefan Wagener, VE4NSA

***Warning:*** *This modification might damage your radio, void the warranty, and/or cause personal injury. You are doing this at your own risk and the author does not make any express or implied warranty, or assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information provided within this document!*

### Background:

When I started to use the IC-7600 I really appreciated the nice display and the Spectrum Scope. I also like to use my PC or Mac to control radios and play with SDRs (software defined radios). Now, the IC-7600 does not have an external display connector (like the IC-7700) or an IF output and consequently I was trying to figure out how to get a detailed frequency spectrum from the radio to the PC. Browsing around on the Internet, I found a paper written by Matt (VK2DAG) on a method to access the IF of his IC-756Pro3. He was also looking at using an SDR but at that time most HF-SDRs did not cover the 64.455MHz 1<sup>st</sup> IF of his IC-756. He found a tapping point used for the scope function at 13.345MHz (IC-756Pro3) and made it work. His paper can be found here: <http://www.vk2dag.com/Docs/>.

In 2012, I had the chance to use the FunCube Dongle (FCD) (<http://www.funcubedongle.com>) which at that time was a VHF-UHF dongle only. The newer Pro+ is now covering HF. These outstanding little receivers are made by Howard Long (G6LVB) and support the FunCube satellite project. With the use of special software they can do a lot of cool stuff. While looking at the specs of the FCD, folks mentioned the E4000 chip which is the tuner in the dongle. Interestingly, another set of dongles also use the E4000 and the Realtek RTL2832U chip (which is a demodulator that supports a USB connection). These dongles are used in Europe for DVB-T TV signals. Thanks to [Antti Palosaari](#) in Finland, who actually figured out that the RTL2832U and the E4000 tuner (or other tuner chips) can be computer controlled, the dongle becomes a small SDR.

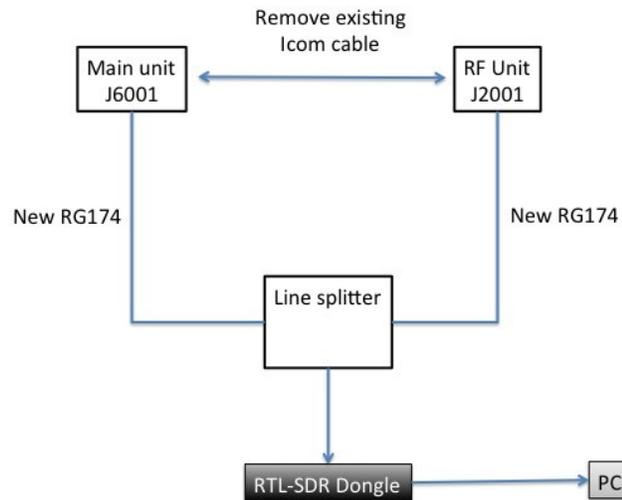
Many folks now use the RTL-E4000 combination or the RTL-Micro R820T (another tuner chip) dongles. The E4000 has a frequency range of 50MHz to 2GHz and the R820T goes from 24MHz to 1.7GHz or so (depending whom you ask). With the right drivers and software they all display frequency spectra and allow you to listen to the audio. Both the RTL-E4000 and the RTL-820T can easily handle the 1<sup>st</sup> IF of the IC-7600 (64.455MHz) if the 1<sup>st</sup> IF can be made accessible. Knowing that the software exists, the dongles are available and the radio has an 1<sup>st</sup> IF that can be displayed, I posted a question on the IC-7600 Yahoo group to entertain the thought of tapping into the radio, specifically the 1st IF used for the internal spectrum scope. Now, for me it was important to find a modification to the radio that was reversible, non-invasive (no soldering within the radio, no drilling holes or any other permanent changes) and reasonably inexpensive. I was also primarily interested in making the frequency spectrum visible and, as such improving and expanding on the scope display of the IC-7600. Shortly after my post on the Yahoo group, Jarek Pawlega (VE3NCD) contacted me and confirmed that the mod actually works.

### IC-7600 Scope IF Tap:

The 1<sup>st</sup> IF (64.455Mhz) of the IC-7600 is used for a number of purposes (main receiver, sub receiver and the scope). Looking at the service manual and the board layout, it becomes apparent that the 1<sup>st</sup> IF signal for the scope is available between on-board coax jacks J6001 (scope display) in the main unit (see page 4-14 of the service manual) and J2001 (RF unit). If you open the radio, you can see that Icom uses an RF cable between those two junctions.

In order to tap into that signal and therefore avoid (hopefully) any impact on the main receiver and sub receiver, I was thinking of splitting this signal in two, one branch for the scope and the other for the dongle. To do this, I replaced the existing cable with two new cables that are now connected via a line splitter (see Fig. 1).

Fig 1. Insertion of a line splitter between J2001 and J6001.



Now, the original Icom RF cable between J2001 and J6001 uses a unique set of RF connectors. They are crimp connectors supplied by Taiko Denki with the part number K01X-A1 TMP. I think other radio manufactures use them also since they looked familiar. In order to make two new custom cables a source for these crimp plugs had to be found. Fortunately, the RF Connection (RFC) (<http://www.therfc.com/taiko.htm>) had them in stock (<http://www.therfc.com/>). They are \$1.50 each and can be used with RG-174/U cable.

Finding the connectors is one thing; you still need the matching crimper and the only source I found was asking \$900+. Going back to RFC and talking to Joel he got me one of his HT-336J ratchet crimpers for a fraction of the price and with the different dies (.178, .151, .128) crimping is now possible with the center of the RG-174/U soldered to the tip of the plug. The end result might not win a beauty contest, but for all intense and purposes it works.

As a line splitter (hybrid splitter) I looked for a unit with low loss, matching frequency range, good isolation and small size. My unit of choice became the Mini-Circuits 15542 ZFSC-2-1 (<http://www.minicircuits.com/pdfs/ZFSC-2-1.pdf>). It is fitted with three SMA female connectors, and used ones are available on EBay for around \$20.

Because of the SMA female connectors on the line splitter I needed two new cables (RG-174/U) with SMA male connectors on one end. The other end was to be crimped with the Taiko Denki (TD) connectors. EBay has many cables available, and one of the Chinese suppliers custom-made me a number of 50cm RG-174/U cables with SMA male connectors on both ends. I cut them in half to give me two 25cm cables with the SMA on one end and allowed for the crimping on the other end (Fig. 2).

Fig. 2: Original Icom cable (grey cable) replaced by two new RG174 cables with SMA and TD connectors.

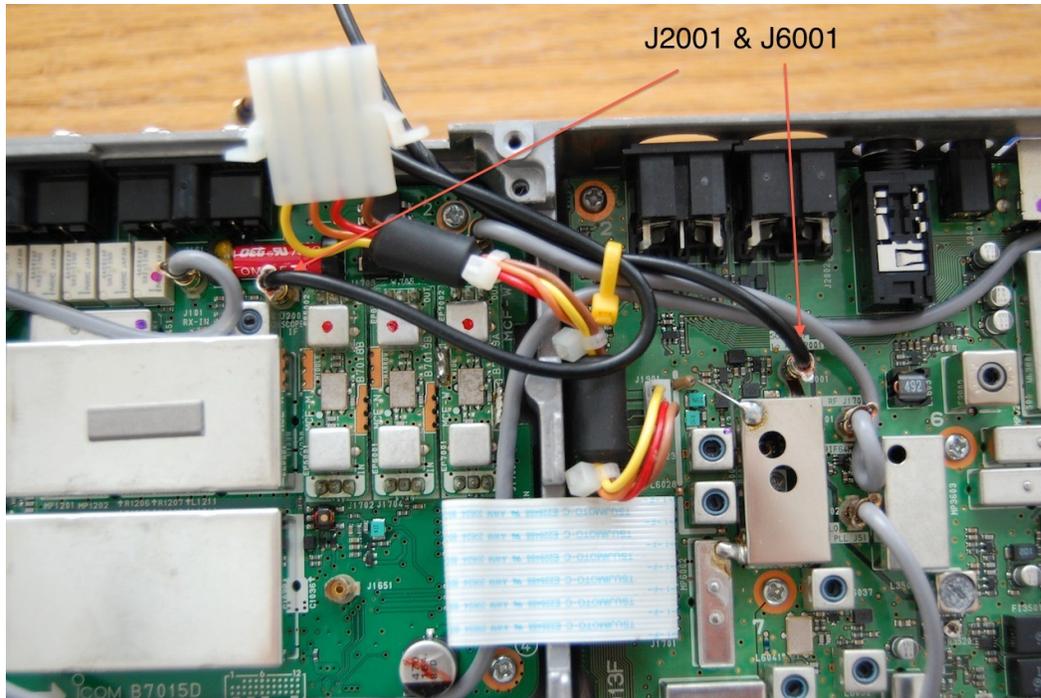


### Installation:

In order to install the two new cables the top and bottom cover of the IC-7600 has to be removed. Once the radio is upside down you need to also remove the cover plate from the main unit. With access to both ports (look for J2001 and J6001), the original Icom cable can be unplugged (and **saved** if you ever want to return the radio to its original condition) and the new cables inserted. I routed both cables under (or on top) of the

Tuner plug in the back of the radio. They will be pinched a little once all plates are back on but in this way there is no need to drill any holes (see Fig 3.).

Fig. 3: Two new RG-174/U cables (black) connected to J2001 and J6001 and routed outside underneath the Tuner connector.



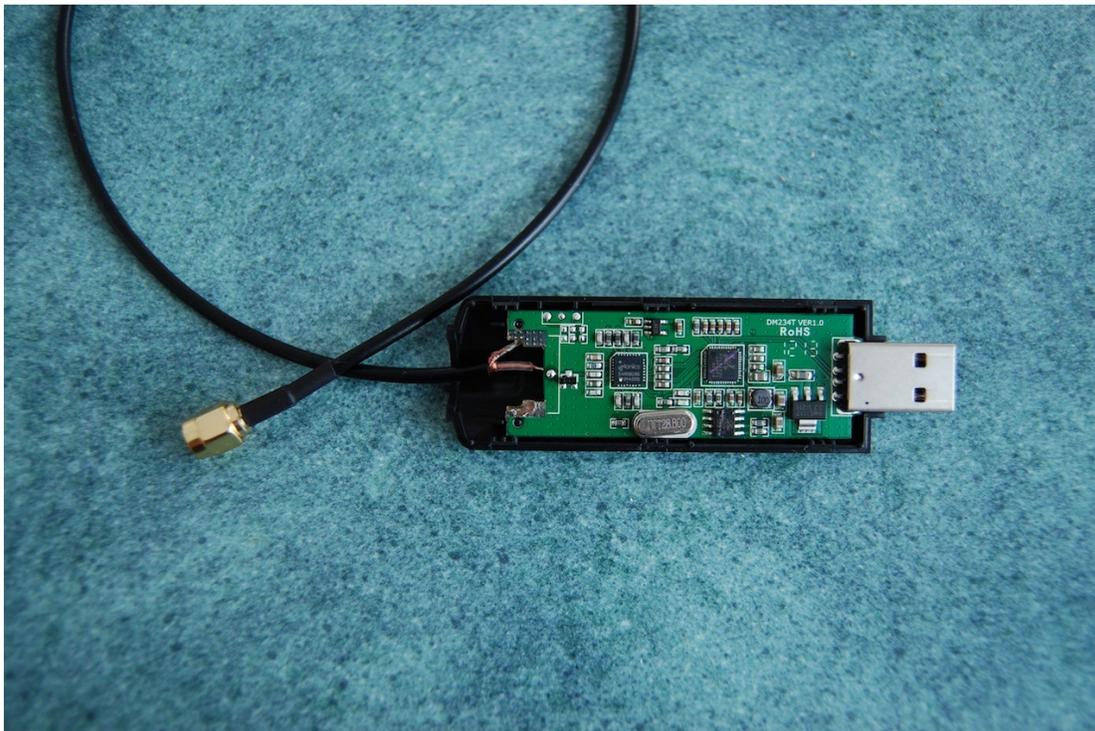
I mounted the line splitter with two cable ties on the outside of the radio (again, no drilling or permanent modifications) and hooked up the two cables. The J2001 cable goes into the S (signal) port of the splitter and the other cable goes to port 1. Port 2 gets connected to the dongle (Fig. 4).

Fig. 4: Outside location of the line splitter.



In order to connect the RTL-SDR dongle to the line splitter, I opened the dongle up and removed the original PAL antenna connector. Instead, I soldered in one of the RG174 SMA cables and hooked it up to Port 2 of the splitter (Fig 5).

Fig 5.: RTL-SDR dongle with new RG174 cable soldered in place of the original antenna connector.



This completed the radio and dongle mod.

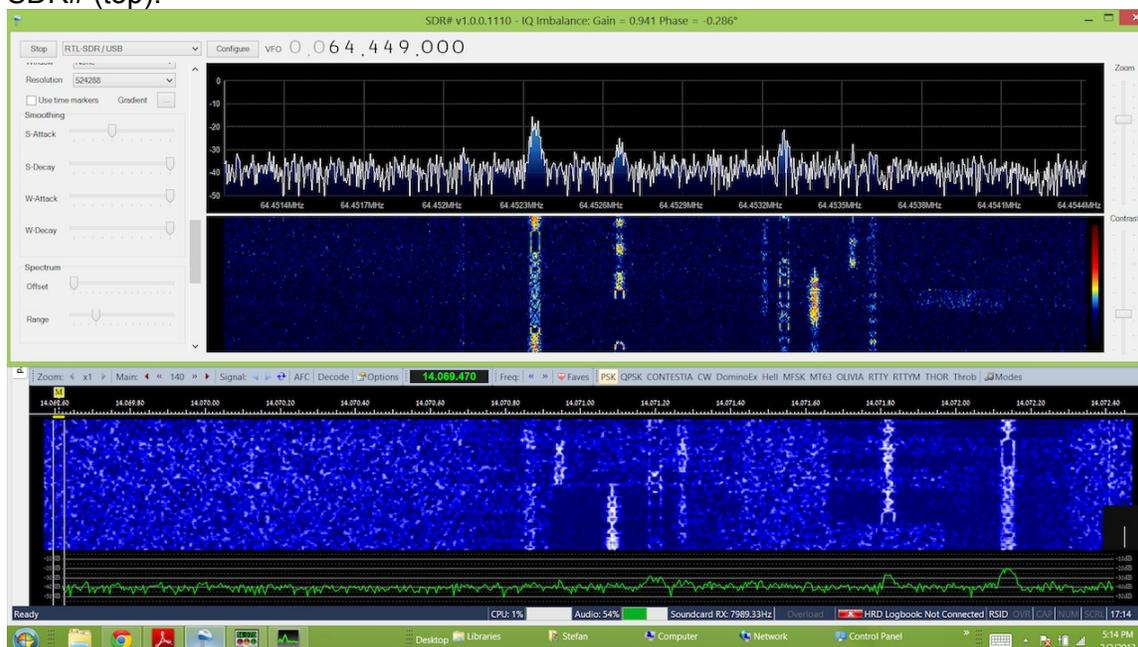
## SDR# software:

*As mentioned in one of my posts on the IC-7600 Yahoo group it is important that you get the dongle working with SDR# first (e.g., listening to FM radio). If things don't work for whatever reason you know that it is not a software, dongle or PC problem.*

Powering on the radio showed the scope display on the IC-7600 working immediately. On tuning to a PSK31 signal, the radio was able to decode and display the text on the screen. My IC-7600 is used a lot for digital modes, and with HRD (<http://www.hrdsoftwarellc.com/default.html>) and the built-in DM780 I do a lot of PSK31.

On powering up the computer and getting started with HRD, everything worked as normal with DM780 displaying a short portion of the audio spectrum on the PC. I use the IC-7600 USB port for this connection. On another USB port I connected the dongle and started SDR#, tuning it to around 64.455 MHz. It now displayed the IF signal on the PC after (see Fig. 6).

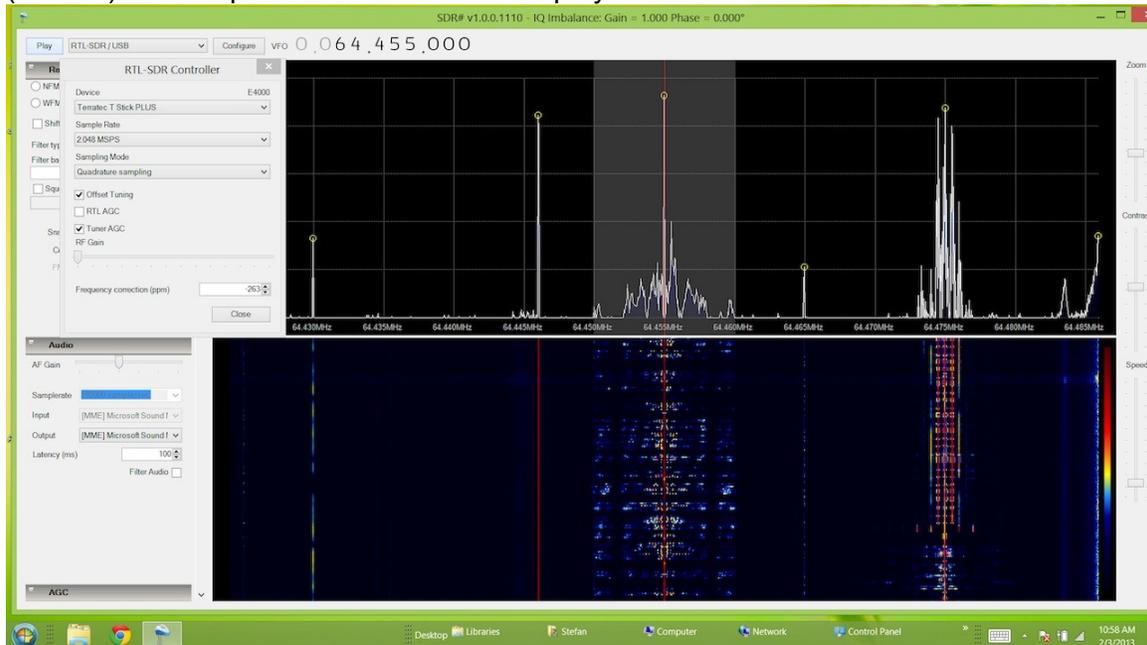
Fig. 6: HRD 6 (beta) and SDR# running simultaneously. The radio is tuned to 14.069MHz and a number of PSK31 signals are tracked with HRD (bottom) and the SDR# (top).



If you look carefully at the picture in Fig 6, you will see that the image in SDR# is initially mirrored. By checking the Swap I&Q button (in SDR#), this can be undone and any tuning on the radio will move the signal on both (HRD and SDR#) in the same direction.

The full power of the SDR# software comes into play when you use the zoom function and you can see the full spectrum of for example, the 20m band and looking for all kinds of signals (Fig 7). SDR# also lets you decode audio and by selecting the same sideband as the radio and/or modulation you can now listen to the 1<sup>st</sup>. IF frequency of the IC-7600 through your PC. Interestingly, in my case there is a short delay between the audio of the PC and the radio. More to explore, I guess.

Fig 7.: SDR# showing strong AM radio station (middle) with a WWV time signal next to it (10MHz) on the spectrum and waterfall display.



I hope that this zero-impact modification makes sense and helps a few folks to discover using a SDR with the IC-7600. **As mentioned above, you do this mod at your own risk!**

### Other thoughts:

The mod is relatively simple, and just like Jarek (VA3NCD) you can tap right into the scope 1<sup>st</sup> IF next to J2001 by adding another cable next to it. There is a small signal loss caused by the line splitter; however it only affects the scope and the dongle, and not your radio's receiver.

SDR# and other software such as HDRSDR (<http://www.hdsdr.de/>) are very powerful and require some time to explore and for settings to be adjusted. Lots of information is available on the Internet. It's like exploring a new aspect of ham radio all over. Have a great time!

### Parts used:

- 1x RTL-SDR Dongle: RTL2832U - E4000 or  
RTL2832U - R820T dongle (<\$20),
- 1 x Software: SDR# (SDR sharp) see: <http://sdrsharp.com/> (free)
- 1x Line splitter: Mini-Circuits Divider ZFSC-2-1-S, SMA female (used for <\$20)

3 x Cables: 2x RG-174/U cables (~25cm) with SMA male and Taiko Denki RF connectors (K01X-A1 TMP), one cable for the dongle to the line splitter (RG-174/U with SMA male)  
**Note:** *RG-188/U (white, Teflon) is a suitable alternative to RG-174/U.*

So all in all I guess the mod was around \$50, not counting the crimper tool. The biggest expense for me was the crimper (~\$40). I do not know whether I will be using it for other things; however, if you read this, I might still have a few of the RG-174/U cables with the TD connectors left and will make them available for a small cost plus shipping. Just contact me directly at: my callsign (at) gmail.com.

I will post more updates on the IC-7600 Yahoo group and probably revise this document occasionally based on my own experience and feedback from others. Any comments, corrections etc. will be greatly appreciated. I like to thank to Adam (VA7OJ/AB4OJ) and Jarek (VA3NCD) for their helpful comments and constructive feedback on this document.

73, Stefan, VE4NSA

**For more information:**

SDR# Yahoo Group	<a href="http://uk.groups.yahoo.com/group/SDRSharp/">http://uk.groups.yahoo.com/group/SDRSharp/</a>
RTL-SDR Yahoo Group	<a href="http://groups.yahoo.com/group/rtlsdr/">http://groups.yahoo.com/group/rtlsdr/</a>
RTL-SDR Wiki	<a href="http://sdr.osmocom.org/trac/wiki/rtl-sdr">http://sdr.osmocom.org/trac/wiki/rtl-sdr</a>
RTL-SDR blog	<a href="http://www.superkuh.com/rtlsdr.html">http://www.superkuh.com/rtlsdr.html</a>