Developing a PAN-adapter with an RTL-SDR Dongle

by
Stu Beyer (KJ4CYV)
Ray Sommer (W2AUS)

A **panadapter** (panoramic adapter) is simply:

- A receiver that lets you *see* a wide slice of spectrum centered around your radio's tuned frequency.
- It displays:
  - Signal peaks
  - Noise floor
  - Band activity
  - Adjacent signals
- Offers a high-resolution waterfall display, but it does **not** replace your transceiver — it just adds visual spectrum awareness.

A panadapter requires three things:

1) **RF Signal Source**
   - Somewhere to sample RF from:
   - IF (Internal Frequency) tap (used on older radios and was $$$)
   - RF tap at antenna (more modern approach)
   - External receive antenna (least integrated)
- 2) **Common SDRs used in panadapter configs**
   - RTL-SDR
   - Airspy HF+
   - SDRplay RSP1A
- 3) **Software turns that digitized RF into a spectrum display**
   - SDR#
   - HDSDR
   - GQRX
   - SDR Console
   - OmniRig (CAT) (For Transceiver Integration)

Most basic implementation:

- Technically this is a panadapter
  - There's no HF Transceiver involved
- Limits:
  - Some older versions were based on TV tuner technology
  - Receive only
  - Frequency range limited - ~24 MHz to ~1.766 GHz
  - No traditional HF HAM Bands – and only reliable on VHF/UHF bands

Improved basic implementation:

- Technically this is also a ***full-coverage*** panadapter
  - There's no HF Transceiver involved
  - BUT, an upconverter is installed to access the lower frequencies
- Improvements in new SDRs
  - Access to 160m (1.8 MHz). 80m (3.5 MHz), 40m (7 MHz)… and up.
  - AM broadcast band
  - Shortwave broadcast
  - Utility stations
  - Even longwave (with a good antenna)
- Some new SDRs like the RTL-SDR V.4 have an upconverter already built-in. Older versions rely purely on Direct Sampling for accessing the HF bands. It works, but not as efficiently as V.4 models.

Full-featured panadapter requirements:

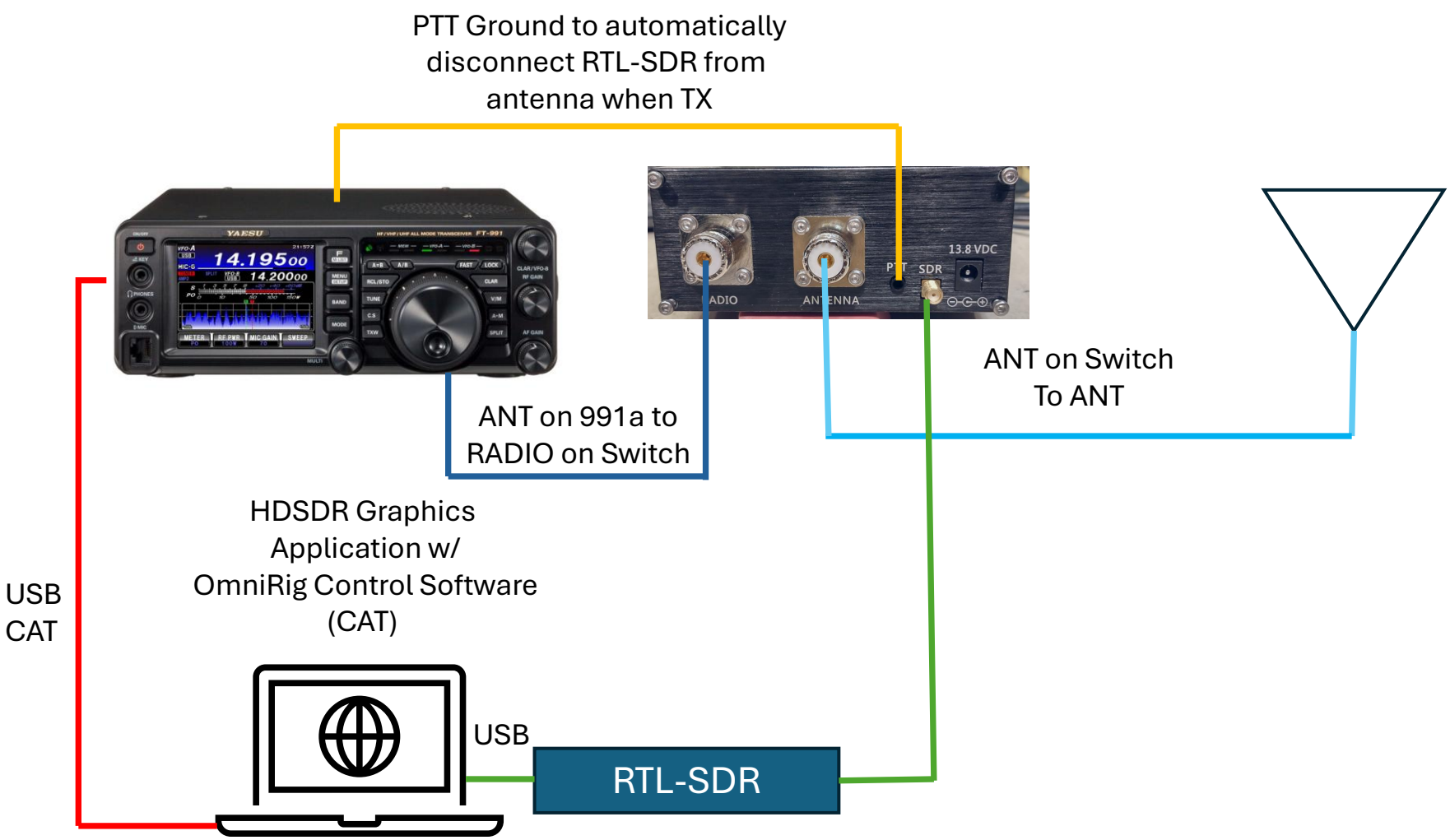
- For any radios **without** a built in external panadapter display – i.e., FT-991a, FT-891, TS-590s, etc..(but with CAT control capability)
- Augment the external RTL-SDR dongle's sampling capabilities with the highly specialized HAM transceiver signal processing, decoding, and tuning capabilities.
- Use the combination of these two devices (HAM transceiver and RTL-SDR dongle) to create a TX/DX capable external display using CAT control to automatically keep the transceiver and the RTL-SDR dongle frequencies synchronized.
- Protect the RTL-SDR dongle (which is inline with the antenna) from a circuit destroying TX power surge.

This last bullet is the most important requirement for a panadapter

Protect the SDR from TX:

- Since keying up on the HAM transceiver would destroy the inline SDR radio dongle, we need to protect it. To that end, we need a switch to automatically disconnect and isolate the SDR dongle from the antenna whenever the radio PTT button is pushed.
- We do that with a TX/RX Switch.

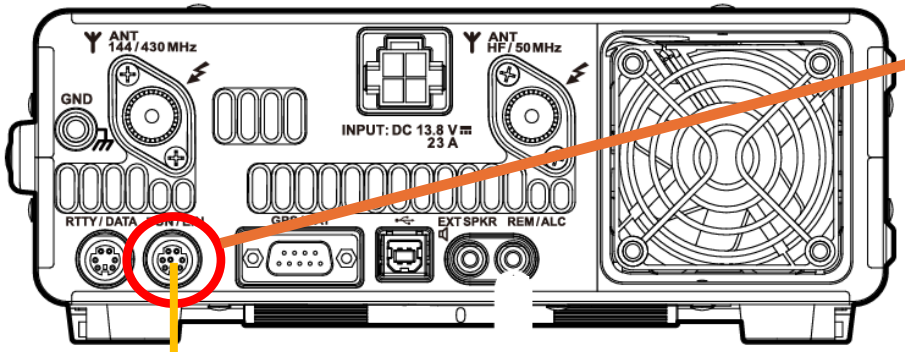
Full-Featured panadapter design:



What the TX/DX Switch Does:

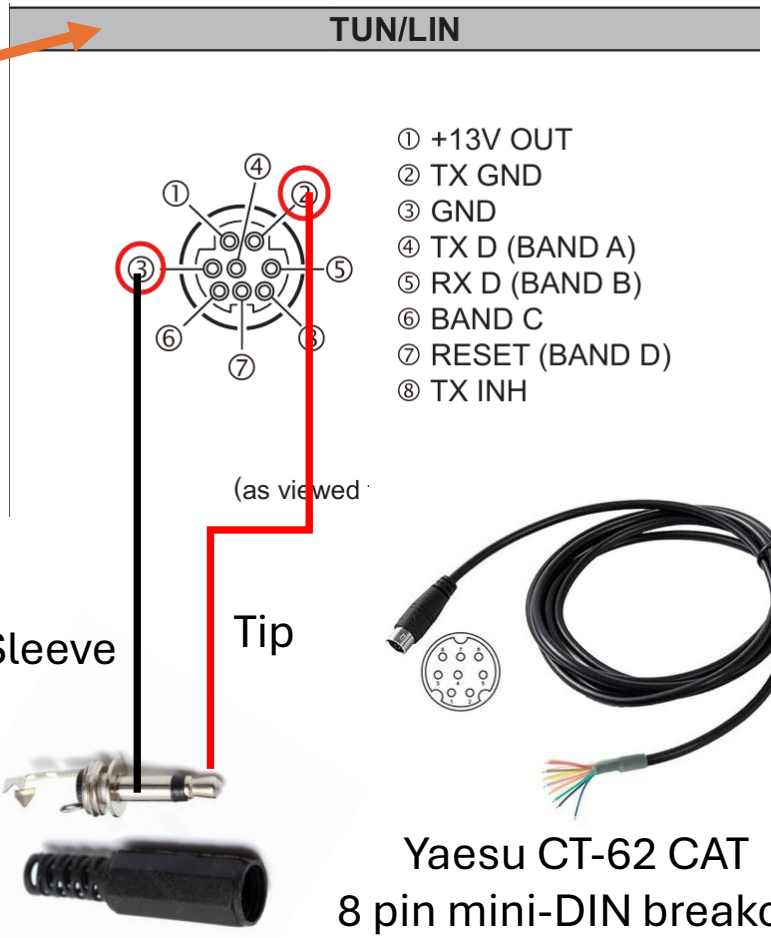
- When you transmit:
  - You ground the TX control line
  - The relay switches
  - RTL-SDR is disconnected
  - FT-991a gets full antenna access
- When receiving:
  - Relay connects antenna to both FT-991a and RTL-SDR
  - RTL-SDR monitors same RF
  - HDSDR display software tracks frequency via OmniRig

FT-991a TX/DX Interrupt Connect



TX/DX SDR Switch

NOTE: Internal Jumper of TX/DX SDR Switch MUST be set to "OPEN"



Yaesu CT-62 CAT
8 pin mini-DIN breakout cable (Amazon)

Conclusion:

- New inexpensive SDR dongles like the RTL-SDR (about $40) are fantastic devices that can provide good performance for visualizing the spectrum. They are good entry level devices, BUT…
- … they are not high performance SDRs. Hence, they can have bugs and develop some faults during operation.
- Dedicated SDRs from companies like SDR-Play, and Rig-Expert have much better broadband capability and dynamic range. The cost is in the hundreds of dollars.

List of Materials:

- TX/DX SDR Switch (Amazon) $65
  - TX/RX SDR Switch
- RTL-SDR Radio Dongle (Amazon) $39
  - RTL-SDR Dongle
- 8 pin mini-DIN Breakout Cable (Amazon) $14
  - 8-pin mini-DIN Breakout Cable
- 2-Pack 3.5mm Mono Jack (Amazon) $7
  - 3.5mm Mono Jack
- 2-Pack 3 ft. PL-259 RG8x Patch Cables (Amazon) $15
  - 3ft. PL-259 Patch Cables
- Anderson Power Pole Cable (Amazon) $10
  - 3ft Anderson Power Pole Cable
- 2-Pack 3 ft. SMA Male-to-Male Coax (Amazon) $8
  - 3ft. SMA Male-to-Male Coax
- USB-B 3 ft. Data Cable for Yaesu Radio (Amazon) $10
  - Purchase the USB cable that fits your laptop/notebook USB port configuration, but one end must be a USB B male plug to fit the FT-991a or FT-891USB socket.

Questions & April Workshop Suggestion

- Stu and I would be willing to do a Saturday workshop to help you implement a panadapter solution of your own.
- Workshop:
  - Install SDR Windows OS drivers
  - Install OmniRig (CAT driver)
  - Install HDSDR Graphical Display Software
  - Build the TX/DX 8 pin mini-DIN interrupt cable for the FT-891 and FT-991a radios
  - Test the waterfall display on your own computer and radio.