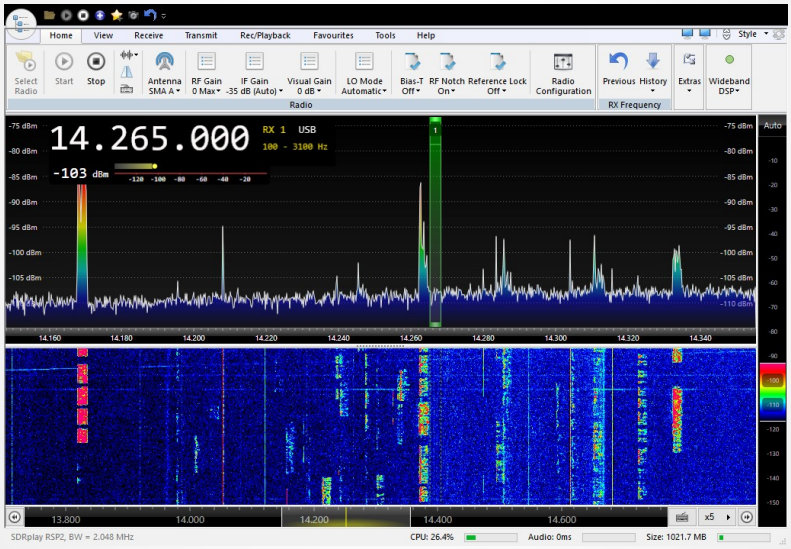
Using a Software Defined Radio As a Panadapter



by Dave Core, K8WDA

Presented to the Northern Kentucky Amateur Radio Club by Dave Core, K8WDA, on Oct. 9, 2017.

What Is a Panadapter?

- Panadapter aka:
  - Panoramic Adapter – developed around WWII
  - Spectrum Scope
  - Spectrum Analyzer – high end; test equipment
  - Bandscope
- Similar to an oscilloscope but displays signals in frequency domain rather than time domain*

* You may encounter the term "fast Fourier transform" or FFT which refers to an algorithm used to convert time domain data to frequency domain.

“Bandscope” has become the popular name.

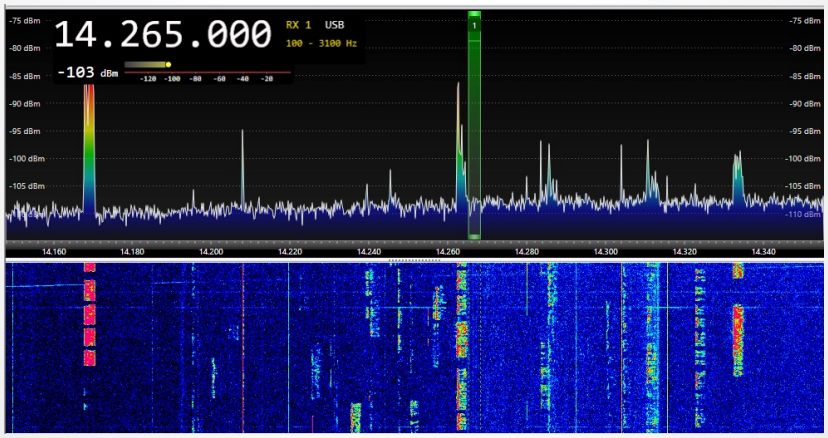
Why Would You Want a Panadapter?

- **See** all band activity at a glance
  - Find signals without constantly tuning up & down the band
  - Find pileups or open spots on the band quickly
- Evaluate received signals; bandwidth, splatter, etc.
- Monitor one band/mode while operating on another
- RFI and/or noise floor study
- Test equipment – spectrum analyzer
  - Check your own transmitter for spurs, splatter, etc.

A very useful tool. Once you use a panadapter or bandscope you'll probably wonder how you got along without it.

Panadapter Display

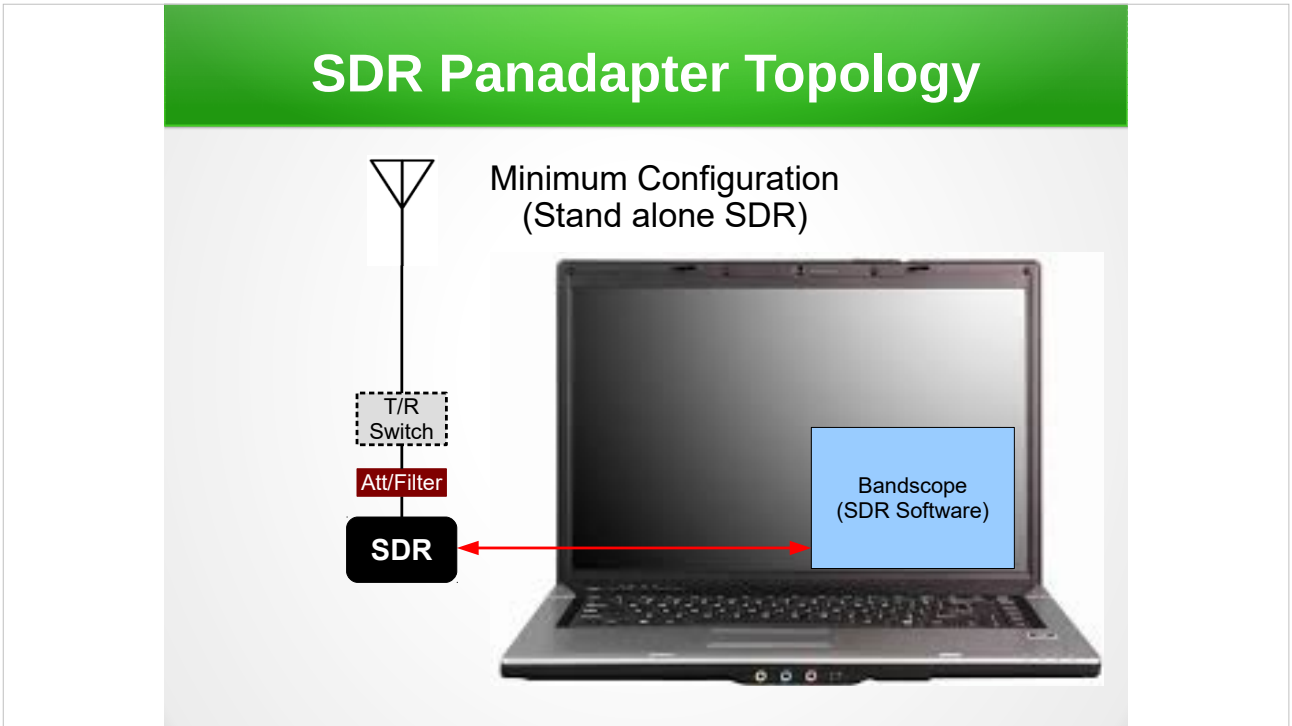
- Modern panadapters provide:
  1) Spectrum display
  2) Spectrogram or "waterfall" display



- The spectrum display (top) shows real time signal amplitude (y axis) over the selected frequency range (x axis).

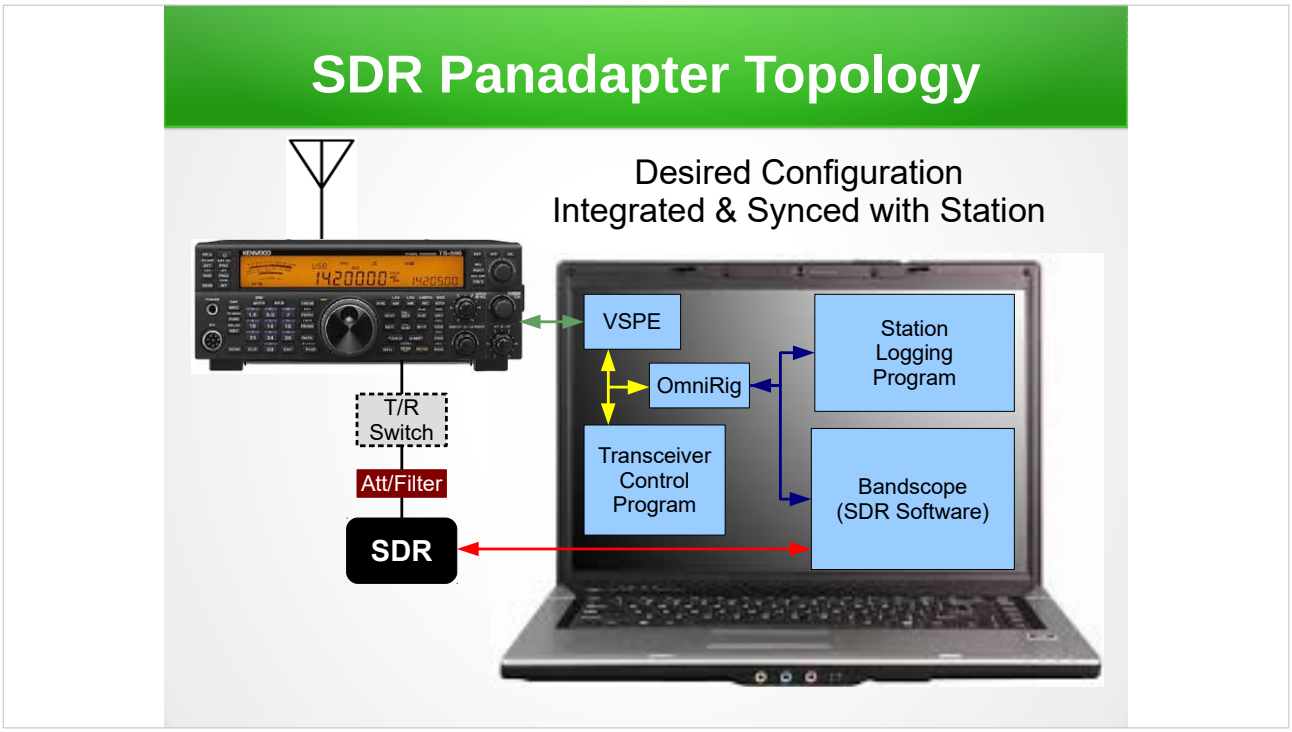
- The waterfall display (bottom) shows the same frequency range with a moving representation of signals, over time, for a running signal history. Color is used to represent signal amplitude.

- In this example the whole 20 meter phone band is visible. The green bar at 14.265 MHz in the spectrum display is the frequency to which the receiver is currently tuned.



- Useful for monitoring a band of frequencies, but totally separate from the station transceiver.

- The T/R Switch and/or Att/Filter may or may not be needed for a minimal configuration.



- Transceiver freq and mode synced to Bandscope and Station Logging programs

- T/R Switch - May or may not be necessary depending on signal source for SDR

- VSPE - Virtual Serial Port Emulator utility software. May or may not be necessary depending on COM interface(s) used.

- OmniRig - COM interface software for Computer Aided Transceiver control.

- Station Logging Program – Optional

- Transceiver Control Program - Optional; may be part of logging program, i.e. Ham Radio Deluxe

Hardware$_1$

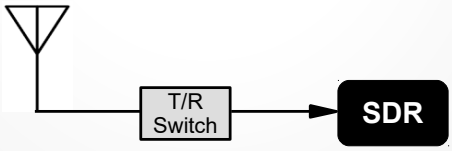
- Signal Source
  - Isolation From Transmitter Output is **Required**
    - SDR **must** be protected from damaging levels of RF by...

      (a) An auxiliary Rcvr out connection from Xcvr, or...

      (b) Connection to Xcvr IF

      Or

      (c) Connect to antenna thru **RF Sensing (Auto) T/R Switch**



Important choice! Influences choice of SDR **and** determines need for outboard T/R Switch.

- Signal input to SDR from antenna
  - Pros
    - Bandwidth only restricted by SDR
    - May be synced with or tuned independently of Xcvr
  - Cons
    - Protection from Xmtr output is required
    - Method to sync to Xcvr is needed

- Signal input to SDR from Xcvr IF
  - Pros
    - Overload damage likely not an issue
    - SDR tuning is set to IF freq and is therefore in sync with Xcvr.
  - Cons
    - SDR bandwidth limited by Xcvr IF
    - IF bandwidth may not be flat
    - Modification may be required on Xcvr
    - Isolation/buffer amp may be needed*
    - Point and click tuning of the Xcvr may not be available from bandscope display

* For a possible source of an IF isolation/buffer amp see www.sdrplay.com/panadapter-if-interface-boards-available-from-kd2c/

Auto T/R Switch Choices*

- Pacific Antenna Easy T/R Switch Kit
  - Rated for up to 100 watts
  - $20 from QRPKits.com

- MFJ-1707 RF Sense T/R Switch
  - $80

- DX Engineering RTR-2 Modular Receive-Transmit Interfaces
  - $229

* This is for information only and is not an endorsement of any of these products.

- My choice is to use the same antenna as the Xcvr for my SDR signal source. Fortunately, my Xcvr has a “Rcvr Out” jack which is automatically disconnected from the antenna during transmit. Therefore, no outboard T/R switch is necessary. However, for those who may need an auto T/R switch one of these units may suffice.

- Connectors and enclosure are not included with Pacific Antenna Easy T/R Switch Kit.

Hardware$_2$

- Reasonably Fast Computer

- My 5 yr old Intel Core i5 laptop with 6 MB of RAM, running Windows 10, works fine. However, some SDR hardware/software may require more PC horsepower than others.

- Software for Mac, or Linux machines is available, but much more limited.

Hardware$_3$

- SDR Receiver
  - Available "Inexpensive" SDR Receivers
    - RTL (DVB-T) SDR dongle (HF upconverter may also be required)
    - SDRplay RSP1 or 2
    - Airspy R2 w/ SpyVerter or Airspy HF+
    - Many others

-Choice Factors

- Freq coverage and bandwidth
- Dynamic range and image rejection (more important than sensitivity for use on HF)
- A-D converter depth (more is better)
- RF shielding
- CPU and memory requirements
- Supporting software
- Product support
- Cost

Hardware$_3$

SDR Reviews/Comparisons

- Oct. 2017, QST Reveiw: **SDRplay Radio Spectrum Processor 2 Pro** at: www.sdrplay.com/wp-content/uploads/2017/09/QSTRSP2review.pdf
- **Our Review of the Airspy HF+: Compared against ColibriNANO, Airspy Mini, RSP2** at: www.rtl-sdr.com/our-review-of-the-airspy-hf-compared-against-colibrinano-airspy-mini-rsp2-rtl-sdr/
- **Review: Airspy vs. SDRplay RSP vs. HackRF** at: www.rtl-sdr.com/review-airspy-vs-sdrplay-rsp-vs-hackrf/
- **SDRplay RSP2** at: www.rtl-sdr.com/sdrplay-rsp2-release-announcement-and-review/
- **Roundup of Software Defined Radios** at: www.rtl-sdr.com/roundup-software-defined-radios/

Hardware$_4$

- Attenuator & Band Reject Filters
  - Useful to avoid SDR front end overload & resulting intermod interference
    - 10 db SMA attenuator
      - Pacific Tech. Solutions Model PT-ASMF002-10
      - Approx. $10 on eBay.com
    - AM broadcast band reject filter
      - RTL-SDR.COM 2.6 MHz high pass / band reject filter
      - $16.95 at Amazon.com
      - FM broadcast band reject filter also available

- Even with the AM broadcast band reject filter which is built into the RSP2, I found it necessary to add another high pass filter plus a 10 db attenuator to minimize intermod and images from local broadcast stations.

- Step Attenuator – $20 kit available from
http://www.qsl.net/k5bcq/Kits/Kits.html

- Another step attenuator kit is available at
http://www.qrpkits.com/attenuator.html
$60 for kit including enclosure

Software$_1$

- SDR Programs
  - SDRUno by SDRplay
    - Free with SDRplay RSP at www.sdrplay.com
  - HDSDR
    - Freeware at www.hdsdr.de
    - Favored by many SDR bandscope users
  - SDR Console at sdr-radio.com
    - Free for hobby users; donation appreciated
    - **My favorite**
  - SDR#
    - Free from Airspy at airspy.com
    - Widely used with RTL-SDR dongles
    - Many plug-ins available

- The SDR program is what does all the processing of the I/Q, or digital data stream from the SDR and displays the results. For an explanation of I/Q data see whiteboard.ping.se/SDR/IQ.

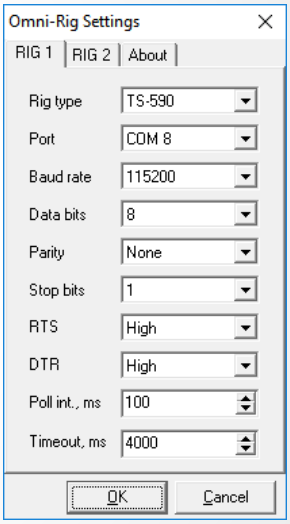
- SDR Console is available at both version 2 and v3. V2 is the current released version, but v3 is well under development and available for use. V3 is very feature rich and performs well as is. The developer, Simon Brown, G4ELI, (original developer of Ham Radio Deluxe) actively participates in SDR forums, such as sdr-radio.groups.io/g/main, answering user questions and offering advice.

- For a good “quick start guide” for using SDR Console v3 with the SDRplay RSP see www.nn4f.com/SDR-Console-V3-SDRPlay-RSP_QuickGuideTips.pdf. A video showing setup steps for SDR Console v3 is available at forums.qrz.com/index.php?threads/sdr-console-v3-with-the-sdrplay-rsp-1-rsp-2.581223/

-At last check, the SDRPlay ExtIO DLL was not compatible with the current version of SDR#.

Software$_2$

- Rig Interface & Control
  - OmniRig
    - A COM interface for Computer Aided Tranceiver (CAT) control
    - Available at: http://www.dxatlas.com/OmniRig/
    - Widely used
    - Free



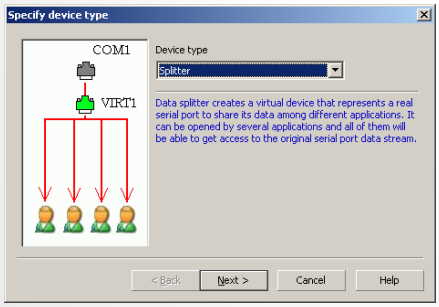
- May or may not be needed depending on other software.

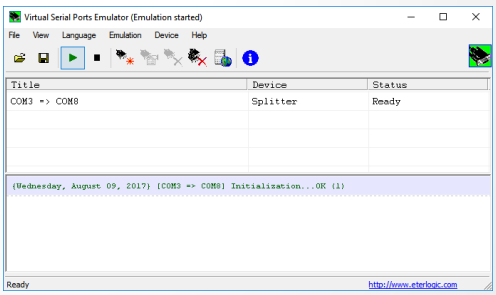
- OmniRig may be configured to interface with 2 different rigs.

- Set Poll int. (poll interval) to 100 ms to avoid sync delays (Default=400).

Software$_3$

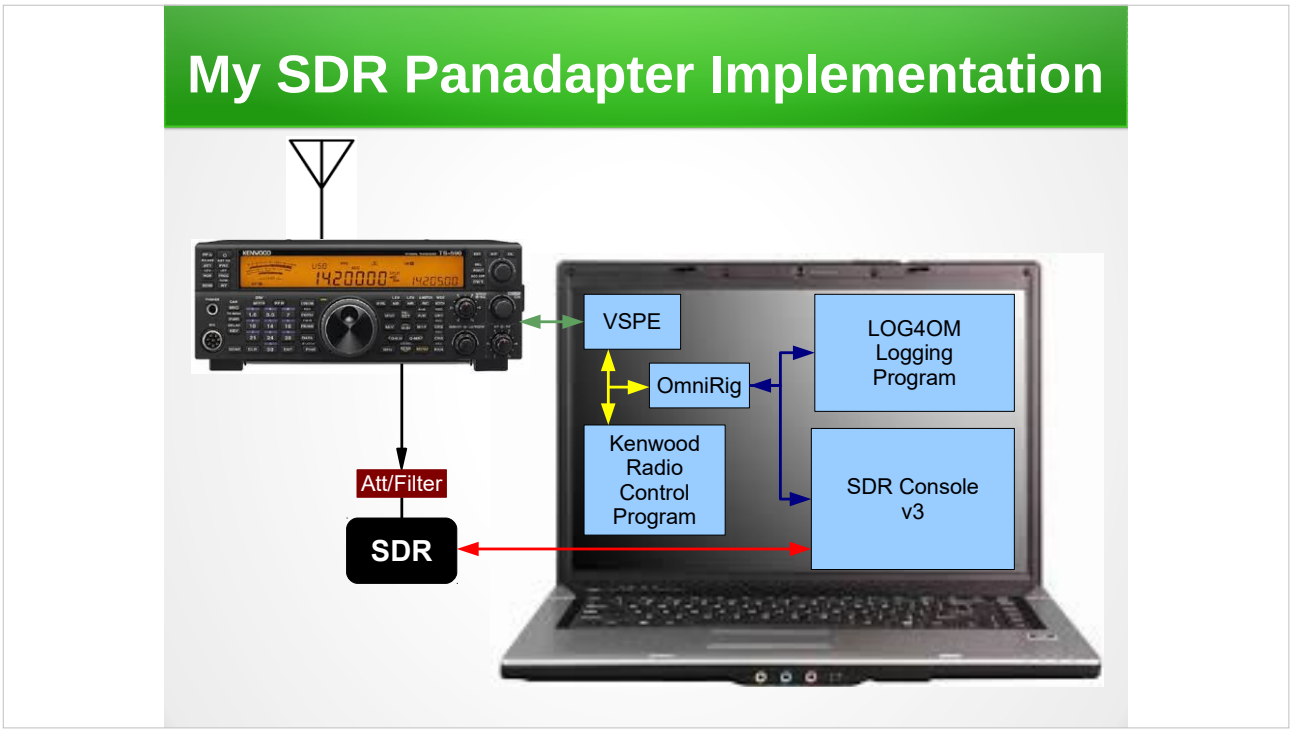
- Rig Interface & Control
  - Virtual Serial Port Emulator (VSPE)
    - Allows multiple software applications to simultaneously connect to a single COM port
    - Available at www.eterlogic.com/Products.VSPE.html





- May or may not be needed depending on hardware and software.

- VSPE is free for 32 bit CPUs, $25 for 64 bit machines.



My SDR Panadapter implementation provides up to a 10 MHz wide spectrum and waterfall view within the RSP2 SDR range of 10 Khz to 2 GHz. The SDR tuned frequency and mode may be synced with my Kenwood TS-590SG Xcvr, or they may be tuned independently. When synced, a mouse click on a desired signal or frequency on the SDR display instantly tunes the Xcvr to that frequency.

The TS-590SG, has a “Rcvr Out” jack which is isolated from the transmit signal so no outboard T/R relay is required in order to use the station antenna for the SDR signal source. However, a 10 db attenuator and AM broadcast band reject filter are used in the antenna connection between the Xcvr and SDR to minimize SDR front end overloading.

Both the TS-590 and the SDR are connected to a Windows 10 PC through separate USB ports.

The Kenwood Radio Control Program, ARCP-590G, requires a direct connection to a COM port (no support for OmniRig). Since Windows only allows one connection per COM port, and since both ARCP-590G and OmniRig (CAT interface software) require a COM port connection in order to communicate with the Xcvr, Virtual Serial Port Emulator (VSPE) is used to create shared virtual COM ports from one physical port. This allows both ARCP-590G and OmniRig to communicate with the TS-590 via a single USB interface.

Both the SDR application, SDR Console, and the logging software, LOG4OM, interface with the Xcvr through OmniRig which talks to the TS-590 through a virtual COM port provided by VSPE.

More Info

- *QST* Article: *A Panadapter for Your Transciever or Reciever* by WA9PYH, Feb. 2017, *QST*
- *QST* Equip Review: *SDRplay RSP1 Radio Spectrum Processor* by WB8IMY, Feb. 2017
- *Introduction to SDR Based Panadapters* Presentation by K3WYC
  - Download at www.w7tbc.org/downloads.php?do=file&id=382
- RSGB RadCom Review: *SDRplay RSP2*, April 2017
  - www.sdrplay.com/wp-content/uploads/2017/04/RadComRSP2review4.pdf
- Many “how to” videos on YouTube, etc.
- This presentation with notes is available at K4CO.org