Test equipment for Hams

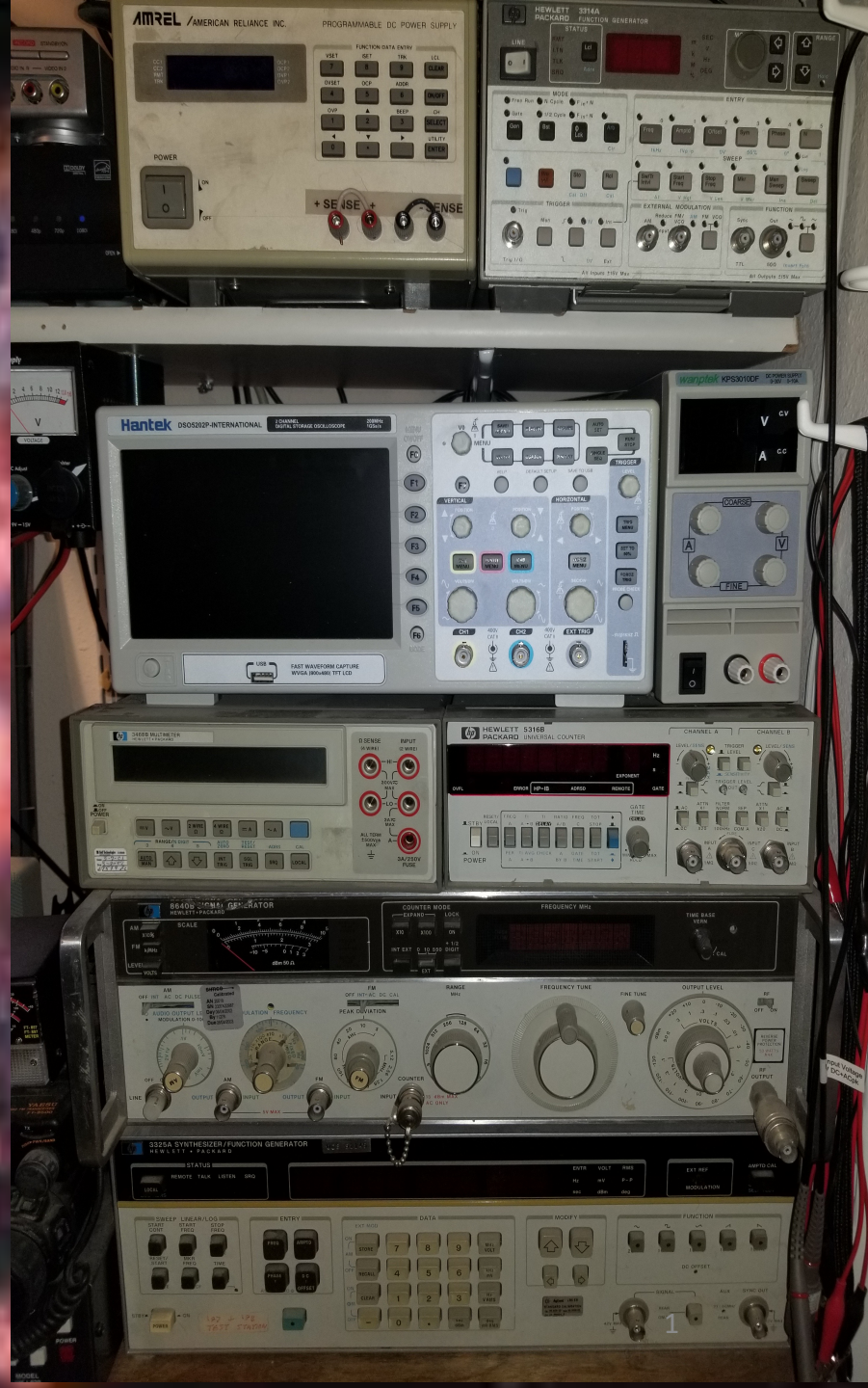
?

- Instruments – detect, measure, analyze, record, report otherwise unknowable realities
- Knowing stuff is going on all around me I cannot sense … annoys me .. greatly - Why I am a Physicist and instrument junkie
- Licenses? VHF or HF or both?? Change presentation on the fly..
- RVers? Battery operation? Mobile?
- Am I actually transmitting, i.e. Is my radio doing what it says it is?

Chip Fleming

K0CHP

Test Instrument Junkie

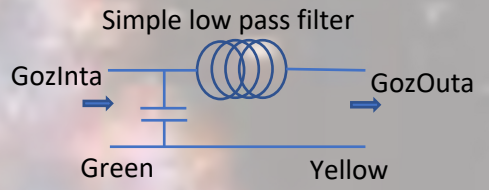


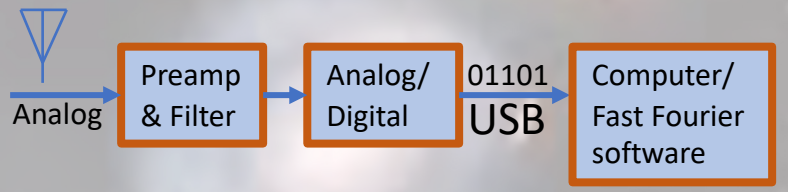
Initial thoughts

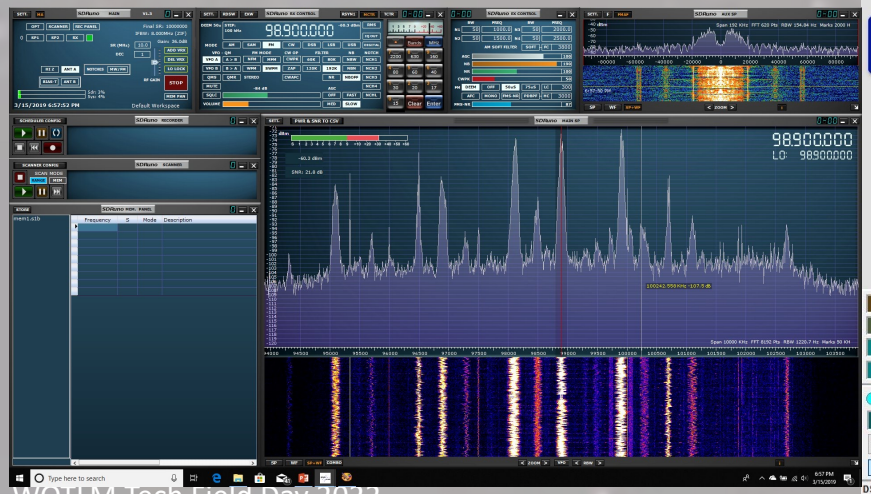
- Above 100MHz (~2m) power beyond ~ 50 watts pointless, assuming reasonable antenna, common ops (not EME). I work PP from 5 watt HT 50 miles all the time.
- Above 100MHz (~2m) generally adjust antenna instead of tuner – WHY? Easy, 1 or 2 bands interesonant, tuner inefficiency. Many HF bands, inefficiency tolerable
- Smith Chart – visual calculator for matching complex impedance, with practice useful for quick load analysis
- Transceiver power requirements (rated xmit pwr/12v) x 1.1 amps – (50watts/12) x 1.1 = ~5 amps
- SWR – makes transmitter happy, for example standing waves can make voltage at output very high
- Resonance – makes receiver happy – efficient transfer energy to/from space
- Antenna tuners – aka dummy load – happy transmitter, but no actual signal, BtW - get a dummy load

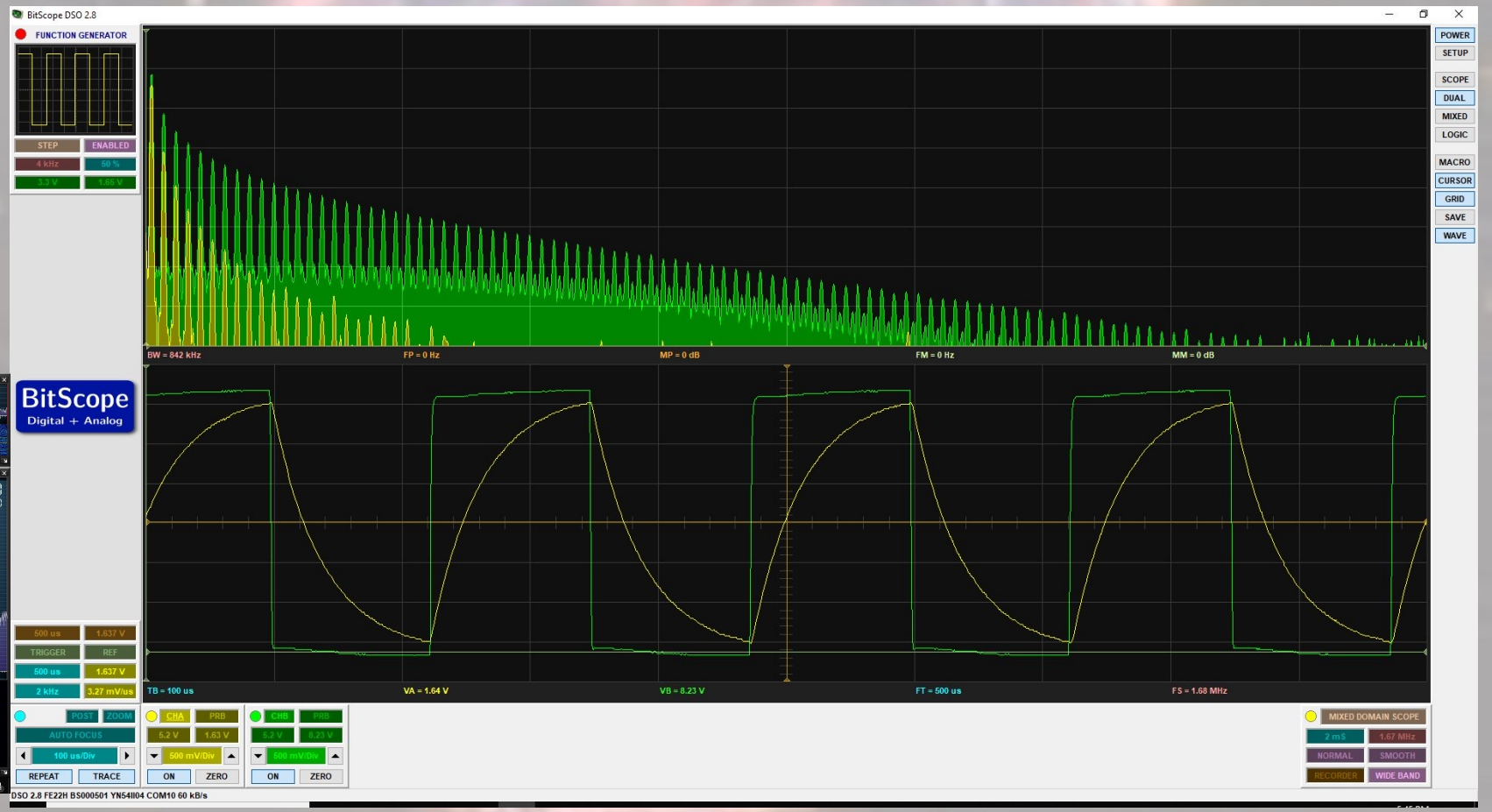
Dual Domain Filter demonstration

- Time Domain (Volts vs Time – Oscilloscope) Frequency Domain (Volts/Power vs Frequency – Spectrum Analyzer)
- Filter – passes or attenuates frequency band: low pass, high pass, band pass, band stop
- Frequency components – ANY wave form is a summation of different frequency sine waves
- Bitscope - $140 40MSPS, 20 MHz, Oscilloscope, Spectrum Analyzer, Logic Analyzer, AWG
- SDR - **AtoD** with front end and **software** – **FTT (Fast Fourier transform)**









Multimeters! All bands

- $10-100s, High priority&EoU
- Check batteries, power supplies, cables, plugs, circuit components
- Two wire leads, parallel voltage and resistance, series current
- Generally your first instrument
- AC/DC Volts, current, resistance
- # digits 3 ½ - 1999, 4 ½ 19999
- Cheap meters are great! I have many. Just be aware.
- Analog meters still very useful, especially for tuning and trends
- Non-True RMS AC voltage only accurate on pretty clean sine wave, True RMS accurate on any AC, like some inverters
- Clamp meters great for noninvasive current, AC common and cheap, DC new

Venerable analog
$10-400 ($343!)
Good for trends

Cheap Digital
<$10
Perfectly serviceable

“Probe” Digital
$20-50
Handy

Clamp Digital
$20-100s
Noninvasive current

Hi-end Digital
$75-100s
4+ digits
True RMS
Computer
Capacitance

Almost any multimeter you get will be useable, addl features: Capacitance, high current range, hold, True RMS, temperature, computer interface, clamp or “blade”, transistor test, audio feedback, more digits, bar graph….

SWR/Power Meter All bands

- $50-100s, Hi priority, High EoU
- Measure reflected Power, Forward Power, SWR
- 2 port – one to transmitter, other to antenna
- Cross Needle, Direct Reading, Digital
- Cross needle, one meter forward power, other reflected, crossing point shows SWR
- Key transmitter to read – remember you must ID!
- Does not tell if antenna actually radiating! Just how “happy” transmitter is.
- Most antennas can be “tuned”, lengthen, shorten, loading coils/caps

Transceiver/Tuner meters HF

- $100s-1000s, High EoU
- Reflected Power, Forward Power, SWR
- Cross Needle, Direct Reading, Digital
- Besides current SWR, many modern HF transceivers can plot SWR/frequency
- Remember you must ID!
- Personally very fond of MFJ digital tuners, I hate "dummy lights" – Forward/Reflected Power, SWR, Frequency, impedance, capacitance, inductance
- Tuner can equal "dummy load"

Frequency Counter+++ All bands!

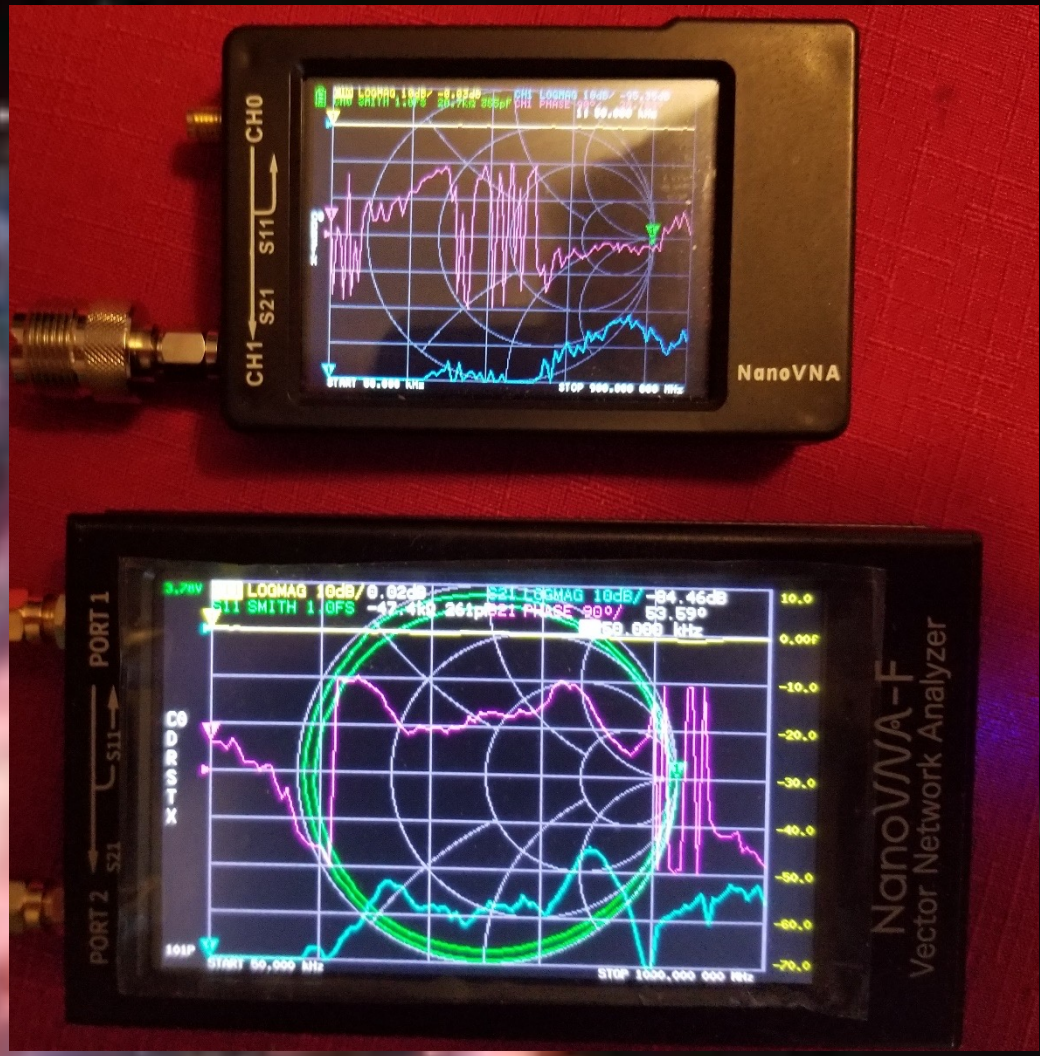
- ~$60, High EoU, value, priority
- RF frequency, CTS/DCS, RF Signal strength within 10 yards of 5 watt transmitter
- Just turn it on, key transmitter, ID!
- Check end product of your system
- Is my transmitter doing what it says it is, what I think it is?
- One of my few specific product recommendations
- Signal strength high enough resolution for antenna pattern characterization

Antenna Analyzer All bands

- $50-100s, High EoU, largely obsoleted by nanoVNA?
- No transmitter needed characterization of antenna over a frequency range
- Single port – just connect antenna
- Tune antenna while sweeping

VNA (nano) ++
All bands

- $50-100s, High EoU, very high value, general purpose test instrument
- 1 / 2 port – antenna, load, cable, filter, amp, network
- Connect antenna cable, select SWR, (complex impedance, Smith Chart, return loss,…), Go.
- Everything antenna analyzer does, plus much more, TDR!!
- Excellent computer software!
- I recommend over antenna analyzer



Mini1300, Amatuer Radio specialized VNA, All band!!

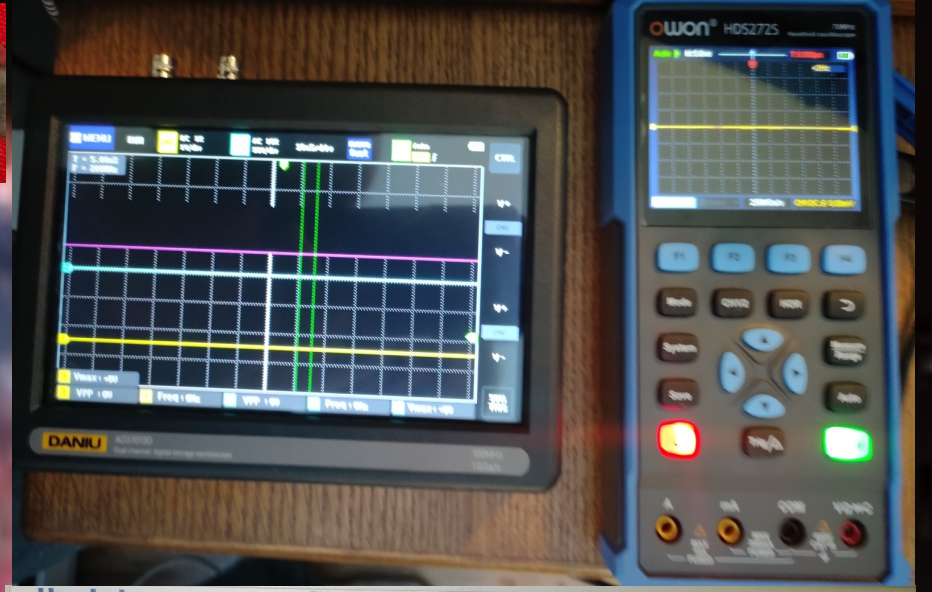
- $200, Very High EoU, value
- nanoVNA hypertuned for hams!
- WSPR, FT8,FT4,JT65!
- Everything antenna analyzer does, plus much more, TDR!!
- No computer support
- After 1 week, my favorite!

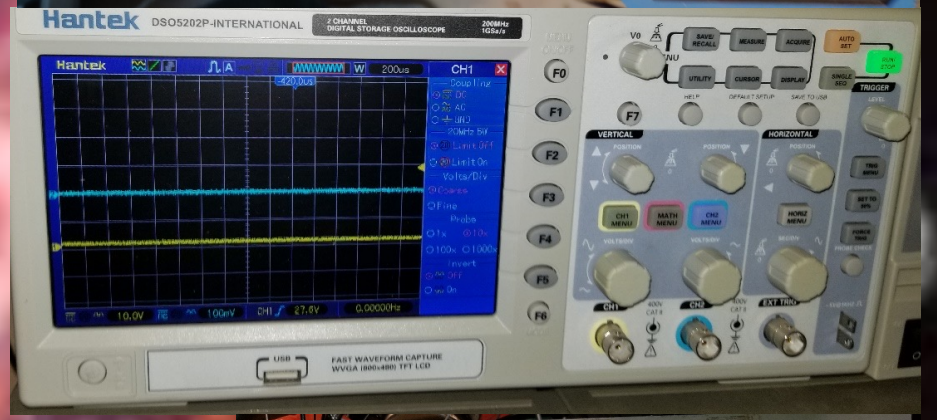
SDR ++ All bands

- Yes, I consider SDRs a primary test instrument – Spectrum Analyzer
- $10-1000s, High EoU, very high value
- See actual system output, modulation, frequency, signal quality. Etc.
- Antenna far enough from transmit antenna to not overload input, do NOT direct connect!
- With directional bridge and noise gen easy antenna analyzer! ~$50
- Personally very fond of SDR Play – easy to use, great software, including full featured SA, modulation analysis
- LimeSDR development platform
- RTL, others down to $10

Oscilloscope

- $100s-1000s, Low EoU
- Displays voltage vs time
- Observe modulation, fidelity of sine waves
- While I love oscilloscopes, not really needed for most hams
- If you want to get into scopes I highly recommend Bitscope
- Modern digitals often have spectrum, somewhat limited
- Key specs: Samples/sec, bandwidth, A/D bits





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