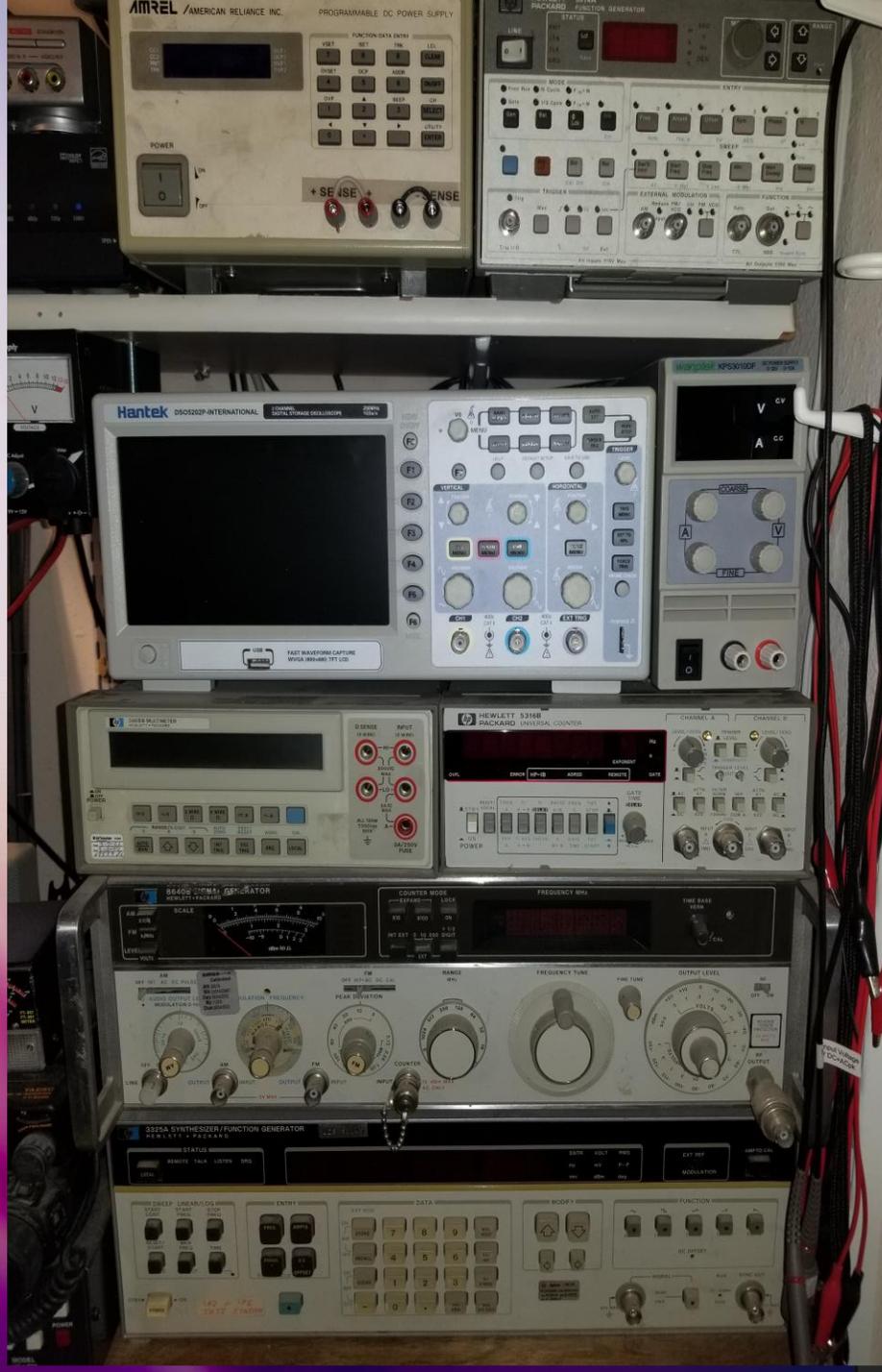


Test Instruments for Hams

- EoU – Ease of Use, 10 - very easy, 0 – bad
- Value – Usefulness, importance to the average General Class, 10 – very, 0 - Not so much
- Priority – 1 – Every Ham should have, 5 – very specialized

Chip Fleming
K0CHP
Test Instrument Junkie



Multimeter

- \$10-100s, EoU 8, Val 10, Pri 1
- Test 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 1/2 - 1999, 4 1/2 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 and expensive



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



- \$50-100s, EoU 9, Val 10, Pri 2
- 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 built in meters

- \$100s-1000s, EoU 9, Val 10, Pri 2
- 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 +++

- ~\$60, EoU 10, Val 10, Pri 2
- 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



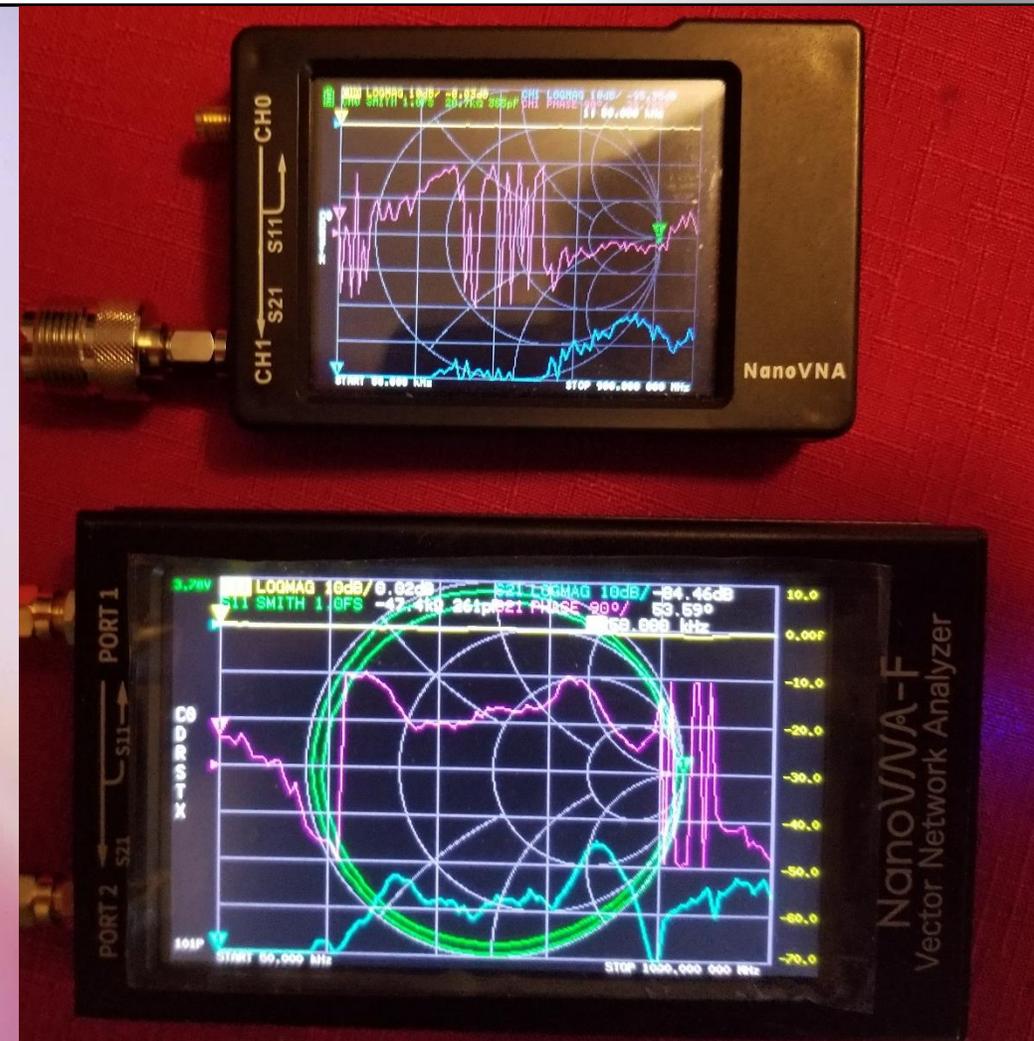
Antenna Analyzer

- \$50-100s, EoU 8, Val 10, Pri 3
- No transmitter needed
characterization of antenna over a frequency range
- Single port – just connect antenna
- Tune antenna while sweeping



VNA (nano)

- \$50-100s, EoU 6, Val 9, Pri 3
- 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
- Not hard to learn, but some curve
- I recommend over antenna analyzer



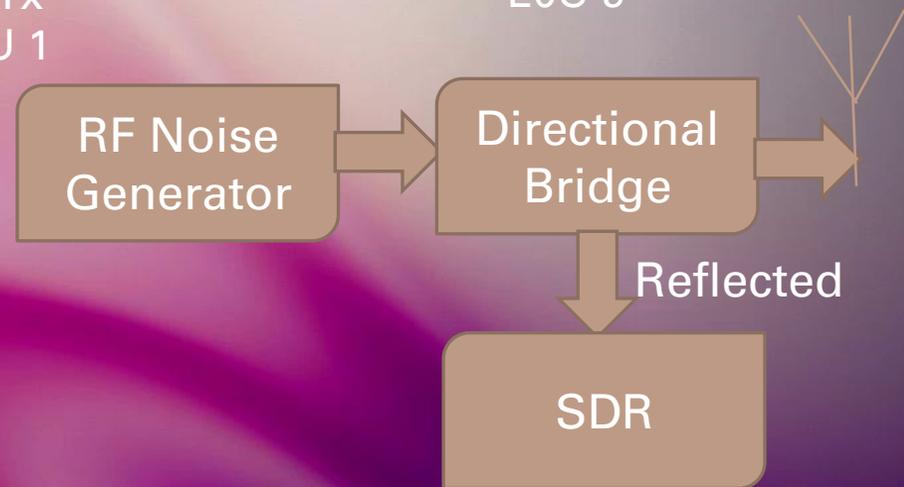
SDR!

- Yes, I consider SDRs a primary test instrument
- \$10-1000s, EoU 1-9, Val 10, Pri 2
- 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 fascinating development platform, very “fiddly”
- RTL, others down to \$10



Lime SDR mini
\$250
Rx/Tx
EoU 1

SDR Play
\$120-200
EoU 9



“Panel” meters

- \$10-100s, EoU 7, Val 6, Pri 4
- Mostly volt/amp for DIY
- Remote wired current shunt
- Some with coil for noninvasive installation AC, DC current
- I use a lot in projects and RVs

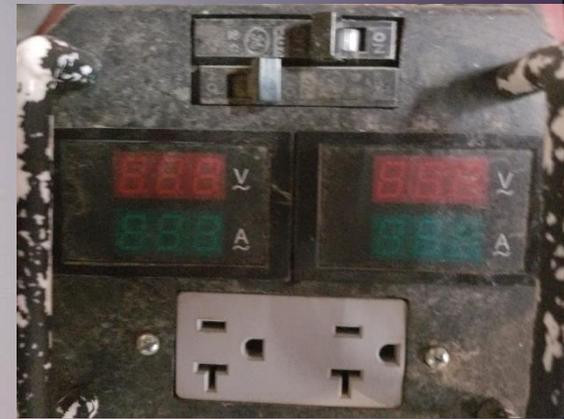


“Cigar”
lighter plug
meter, USB
supply

RV electrical/battery system, Bluetooth remote sender, calibrate for battery capacity



DIY generator distribution box, toroid pickup of AC current



DC Voltage/Current meter bench supply



AC Voltage/Current meter



DC meter with current shunt
AC meter with torroid



Oscilloscope

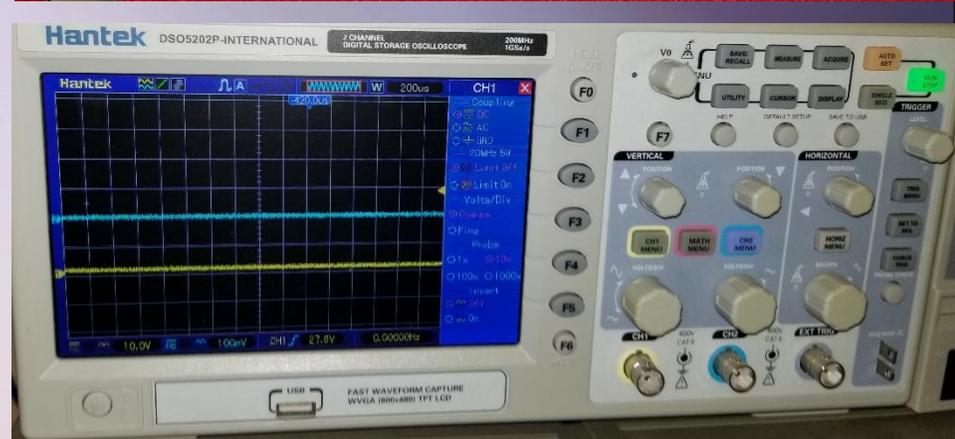
- \$100s-1000s, EoU 4, Val 5, Pri 5
- Displays voltage vs time
- Observe modulation, fidelity of sine waves
- While I love oscilloscopes, not really needed for most hams
- If you want to get into scopes I highly recommend Bitscope
- Modern digitals often have spectrum, somewhat limited
- Key specs: Samples/sec, bandwidth, A/D bits

Bitscope Micro \$145
20MHz, 2 chan,
spectrum,
Logic analyzer, AWG

1Gs/s \$500, 2
chan, spectrum

70s 20MHz analog
\$2000 then

80s 20MHz digital
\$20K then



Engineering Test rack

- \$10,000s, EoU 1, Val 5, Pri 5
- Transmitter/receiver testing, characterization
- Project development, test, tuning

Precision Power Supply/
Arbitrary Waveform
Generator

Oscilloscope-
Spectrum
Analyzer/
Power supply,

4 lead, 5 digit MM/
1.8GHz computing
Frequency Counter

RF Signal
Generator

Precision Audio
(30MHz) Function
Generator

