

Helpful Test Equipment & Tools for the Ham Shack

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What do you really need?

Troubleshooting Needs

Is your signal clean ?

Check your antennas ?

Wattmeter ?

Power supply requirements ?

Voltmeter ?

Dummy Load ?

Soldering station ?

Measure receiver sensitivity ?

Locate shorted or open coax cable ?

Spectrum measurements ?

Do you have a clean signal ?

Are you driving a linear ?

If so how do you adjust your drive level ?

In the 1970s I just guessed !

Heathkit or Kenwood monitor scopes are old.

Modern used scopes are affordable.

Hamfests are a good source of equipment.

Almost all my equipment is second hand.

My Lab - You don't need all this !



\$100 eBay

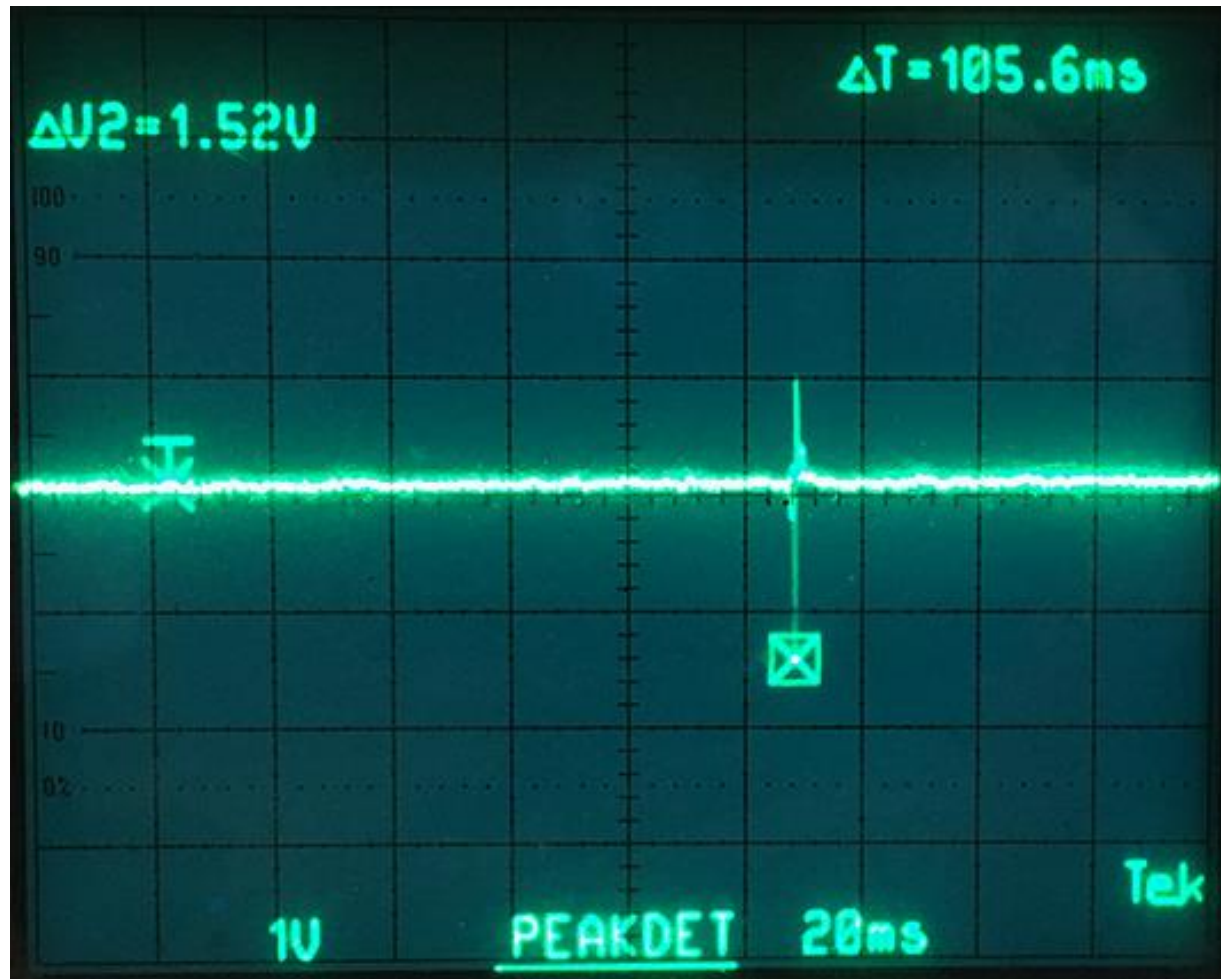
Used 100 MHz Storage CRT Scope



Set key down carrier to slightly over 6 divisions on scope.
When speaking don't exceed 6 divisions = No Flat-topping !

Measured with \$100 Tektronix

Receive Latency Flex 6600M



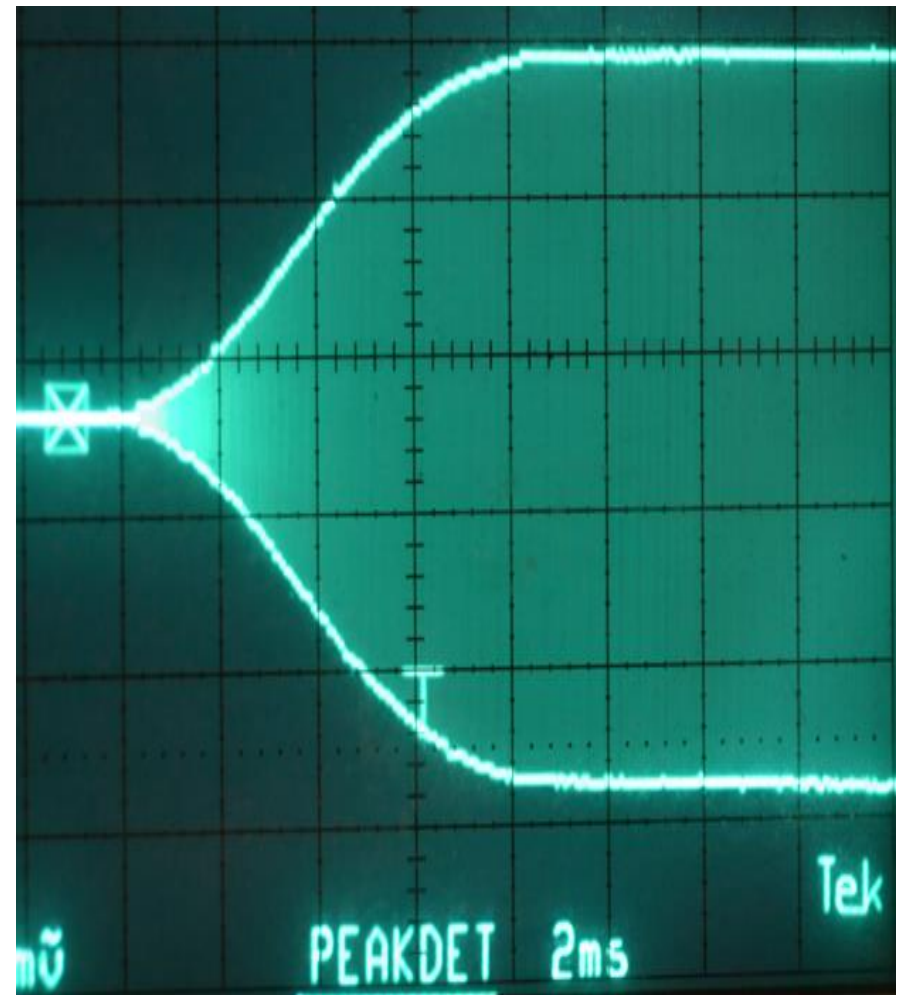
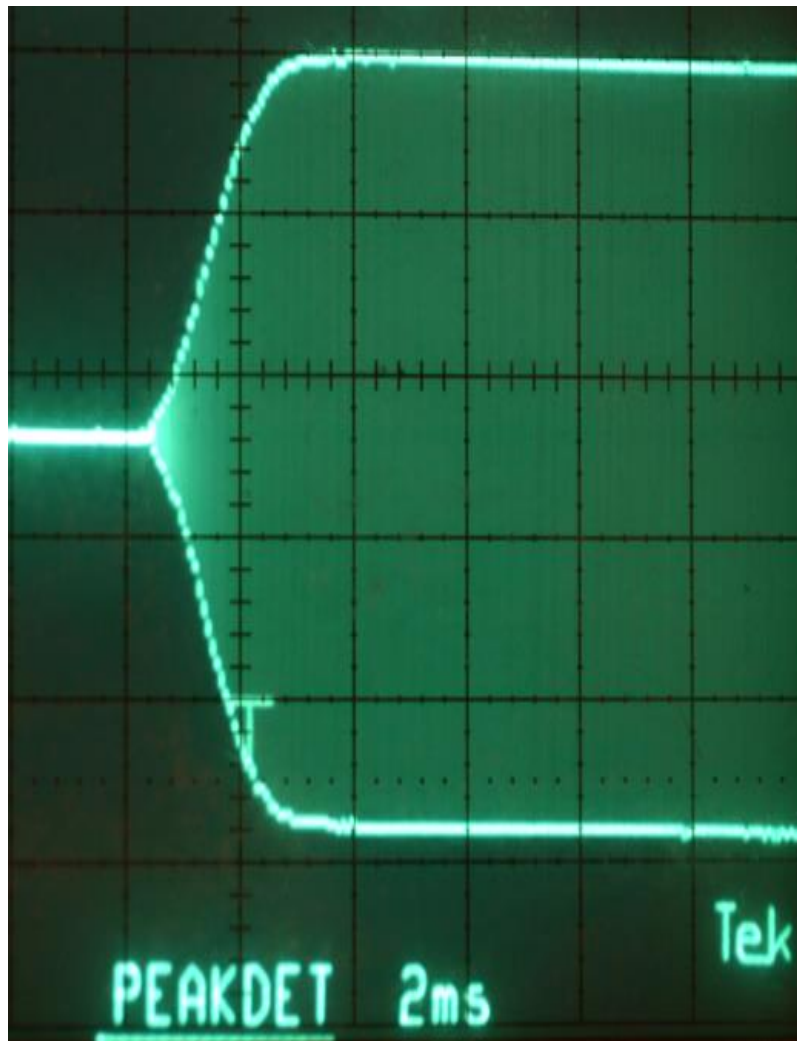
Latency of analog & SDR radios is all over the map from 2ms to 170ms.

Flex 6600M varies from 58ms to 170ms

This test also requires a pulse generator.

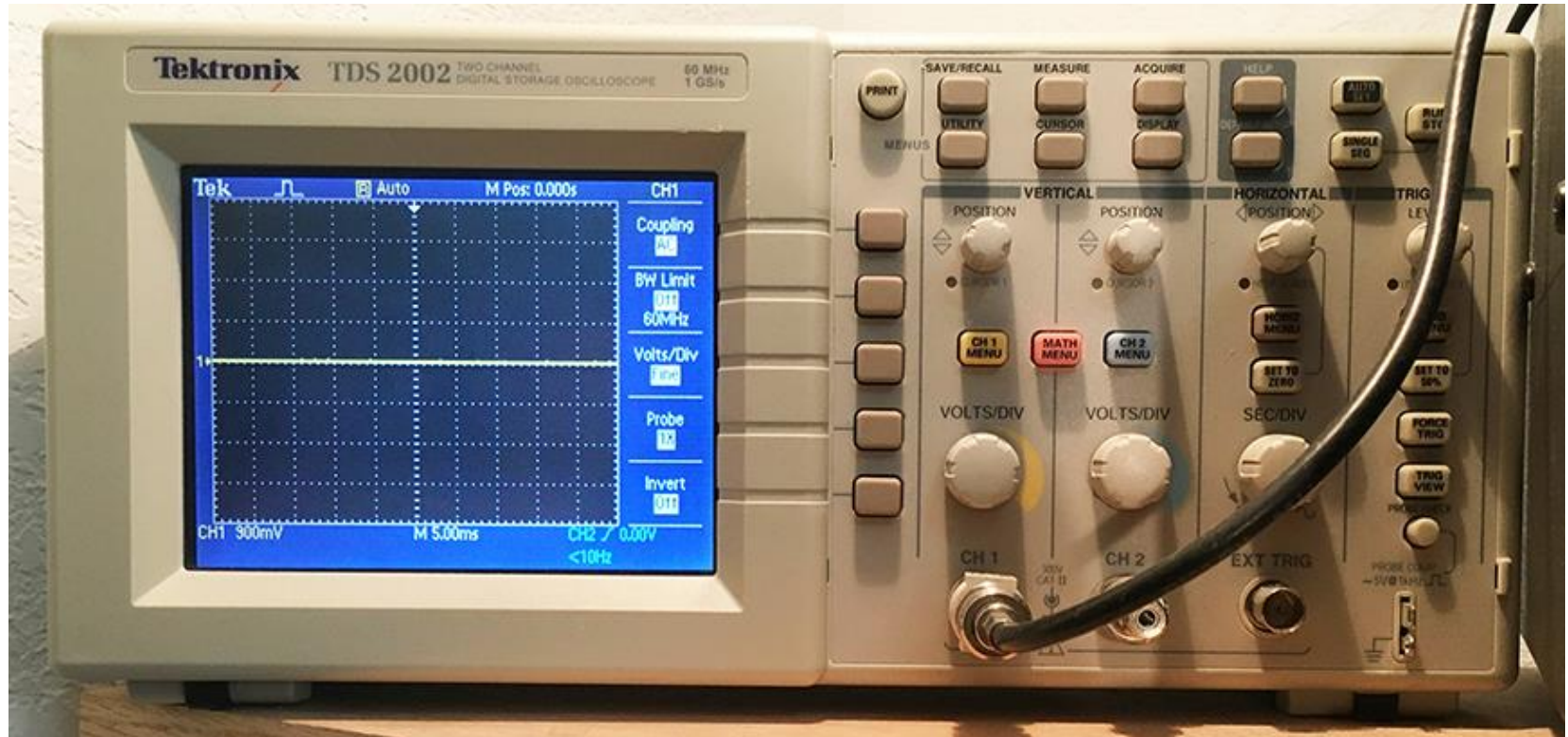
This screen capture is in the time domain

Leading edge of “dit” 3 & 10 msec



\$350 eBay

USED 60 MHz Storage LCD Scope



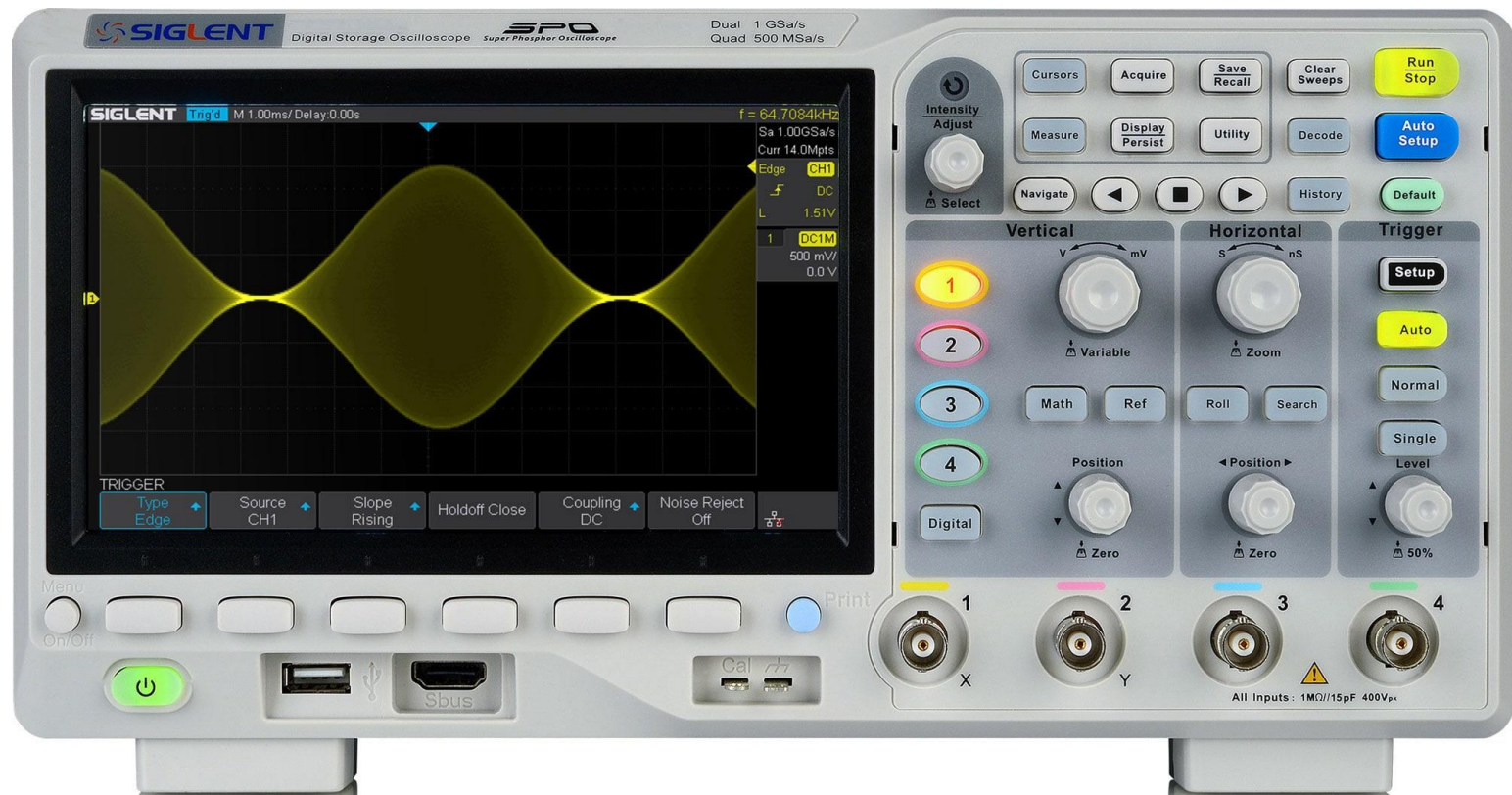
One of my operating positions



New price \$500

Siglent SDS 1104X-E

100 MHz, Storage, 4 channels, other models available



How do you monitor your signal?



Designed and built by Tom W0IVJ, Boulder, CO
Route sampled signal to oscilloscope

Tyler KA0KA CleanRF Sampler



500 kHz to 60 MHz
Legal limit rated
Output attenuation
-26 to -50 dB
\$105

Options for checking your antenna

- Power meter for forward & reflected power
- A peak reading meter can augment a scope
- Antenna analyzer such as MFJ 259B
- NanoVNA is more complex but does more.
- Available from several sources. \$150
- Array Solutions VNAs, several models
- \$1000 range

MFJ 259B antenna analyzer



259B used \$150 and up

259D new \$350

259D covers 100 kHz to 230 MHz

Compare to General Radio 916A



NanoVNA



\$260 QRP to Legal Limit

Peak Reading Watt / SWR Meter



Works on 2200 and 630 meters (136 kHz & 472 kHz)

\$75 eBay

Economical Wattmeter



Drake W-4

Used market only

No direct SWR reading

Removable coupler

200 and 2000 watt scales

Reliable

Accuracy +/- 10% typical

\$200 eBay, HF slugs \$100+

Classic Bird 43 wattmeter

- 450 kHz to 2.3 GHz, Watts to Kilowatt slugs



Be able to monitor voltage and current

Power Supply – Metering Recommended



You need some kind of voltmeter

- VTVMs are likely long gone
- VOM Triplett or Simpson
- Handheld digital
- Bench DVM wide price range

\$100 and up eBay

Fluke Handheld



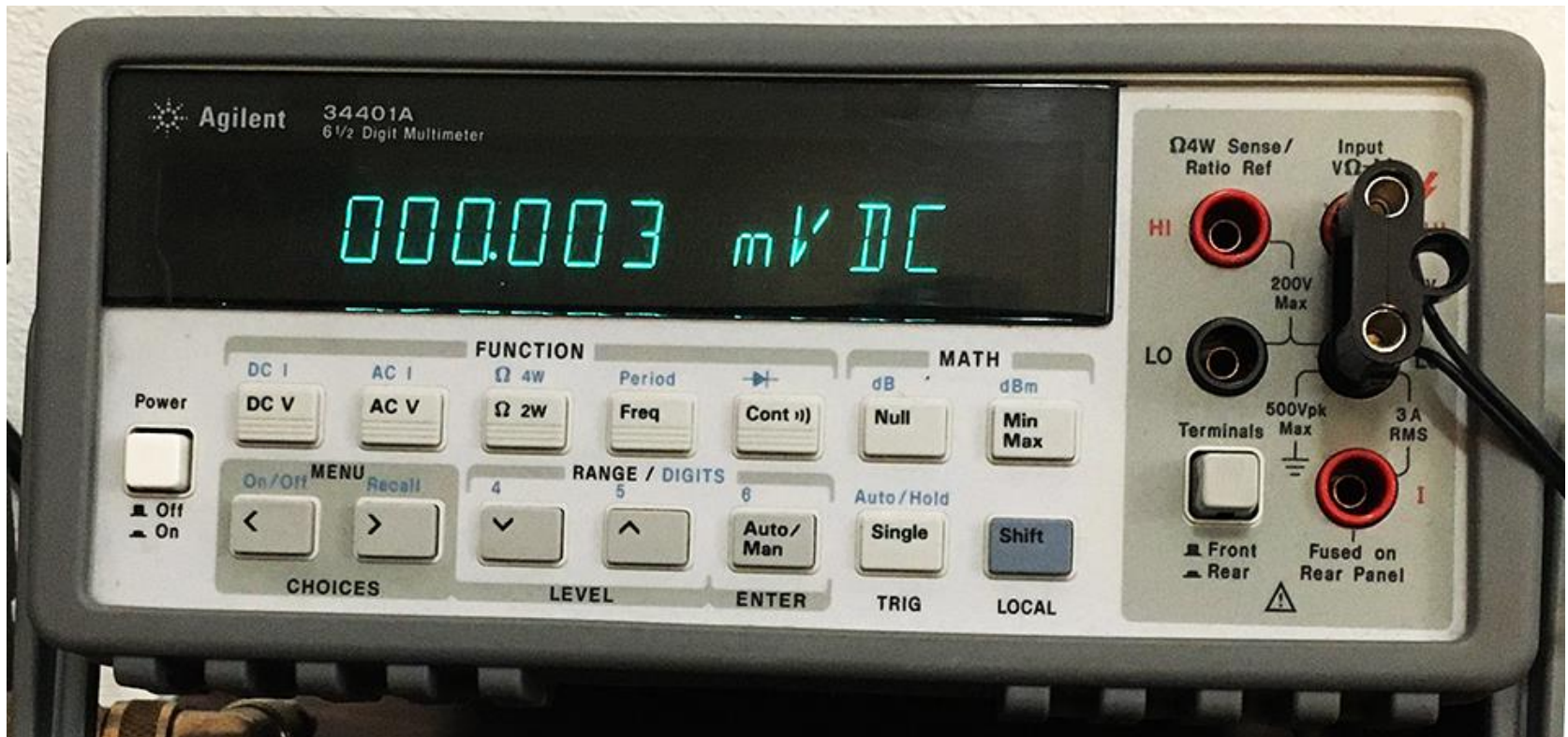
Purchased used on QTH.com

True RMS 2X+ the price but
not likely needed for our use.

\$500 and up eBay

Agilent Bench DVM

- Purchased used on eBay



Adjustable temperature and various size tips

Soldering Stations



Dummy load or power attenuator

- 100 watt 1 GHz dummy loads are cheap
- Retired from cell sites
- Confirm transceiver is operating properly
- 100 or 150 watt 1 GHz 30 dB attenuators
- More versatile for more complex testing
- Feed a spectrum analyzer with attenuator
- Measure TX IMD, CW Rise Time
- Transmit composite noise

\$120 and up eBay

Narda 150 watt attenuator



DC to 6 GHz

Doubles as a 150 watt dummy load

Available:

eBay

Hamfests

QTH.com

Attenuator has two ports, In and Out



For transmitter testing

Bird 30 dB 500 Watt Attenuator



eBay \$300

Adequate for Elecraft KPA500
I own this Bird attenuator.

For Legal Limit amps you need a
2000 watt attenuator.

\$2000 and up for the Bird version
Luckily my associate N0QO has one.

\$50 or less typical

Termination / Dummy Load 1 GHz



100 watts

Lots of brands available

Need N to UHF adapter

Hamfests, eBay or QTH.com

Signal Generator

- This is the most difficult at low cost
- Used to check receiver sensitivity
- Needs wide range output attenuator
- Low leakage for MDS measurement
- Elecraft XG3
- FeelTech FY6800 up to 60 MHz
- HP 8657B

\$300 DX Engineering

Elecraft XG3 RF Signal Source



160 through 2 meters

4 signal levels

1 microvolt -107 dBm

-73 dBm for S9 calibration

-33 dBm for S9+40 dB calibration

0 dBm output

\$120 new

FeelTech function generator



FY6800-60

60 MHz highest frequency

Minimum output 1 mV P-P
(No dBm calibration)

Useless for S meter calibration

Amplitude at low levels poor

14 bit DDS

uHz frequency resolution

Similar model multiple sources

No specs for phase noise

\$500 eBay

HP 8657B from eBay

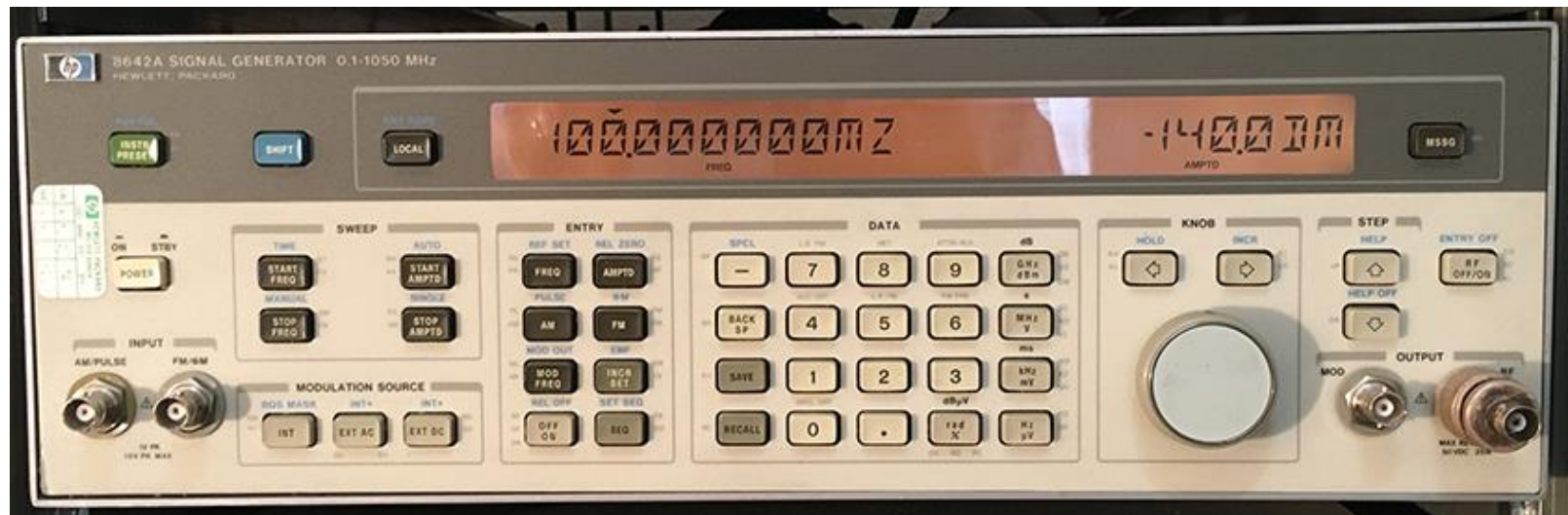


100 kHz to 2.06 GHz, +13 dBm to -143.5 dBm
General purpose signal generator

Not a typical ham choice

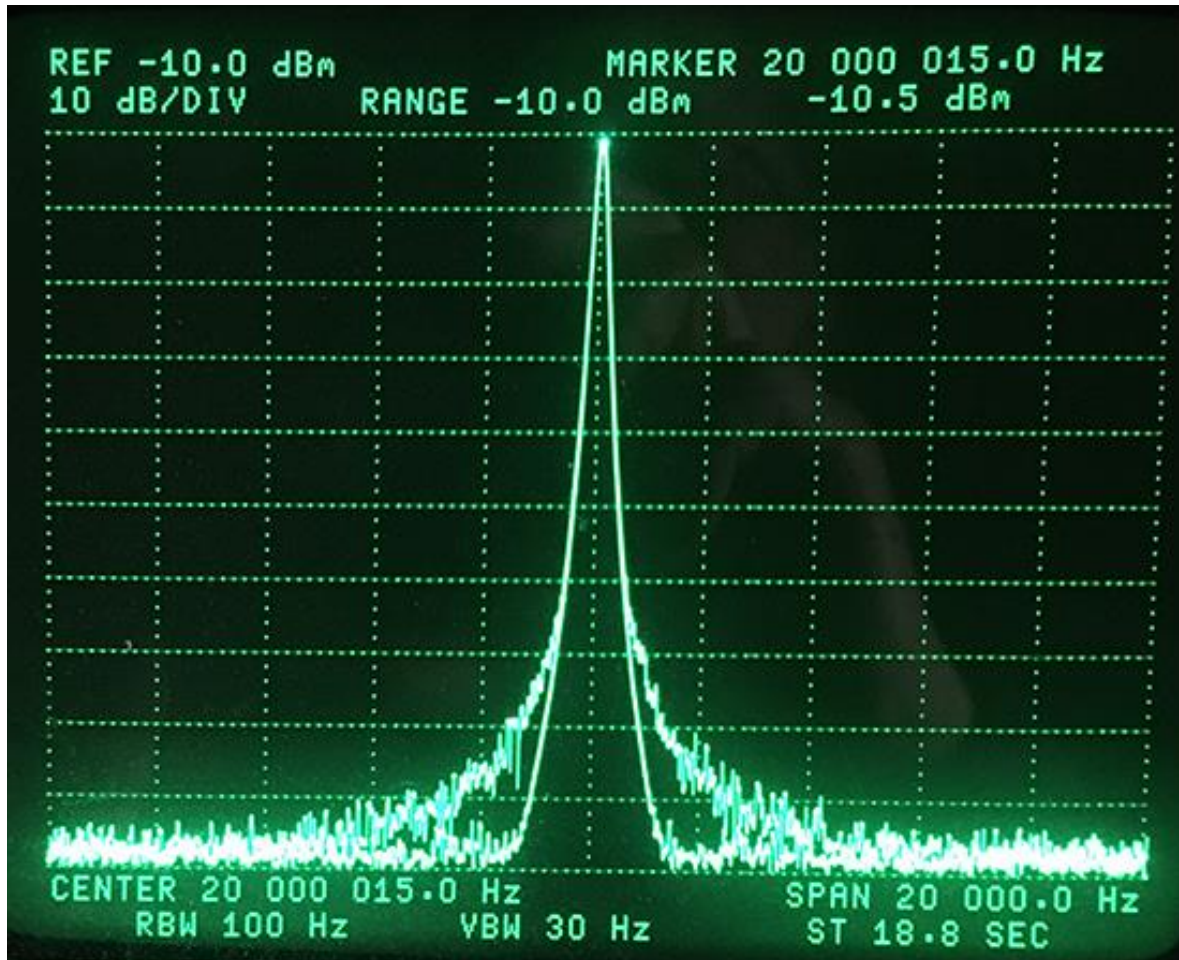
HP 8642A very low phase noise

- Required for testing the latest ham equipment
- Dynamic Range Testing
- RMDR Testing
- Very difficult to repair



Can't do DR3 or RMRD with the 8657B

HP 8657B vs HP 8642A



Phase
Noise
comparison

Time Domain Reflectometer

- If you have hardline coax plus flexible RG-8 size coax jumpers at the top of your tower and in the shack, a TDR can be a lifesaver.
- It has saved me multiple times, but isn't a typical ham piece of test equipment.
- Locate an open, shorted or damaged feedline

\$150 to \$300 eBay, I paid \$300 hamfest

Tektronix 1503B TDR



Spectrum Analyzer Options

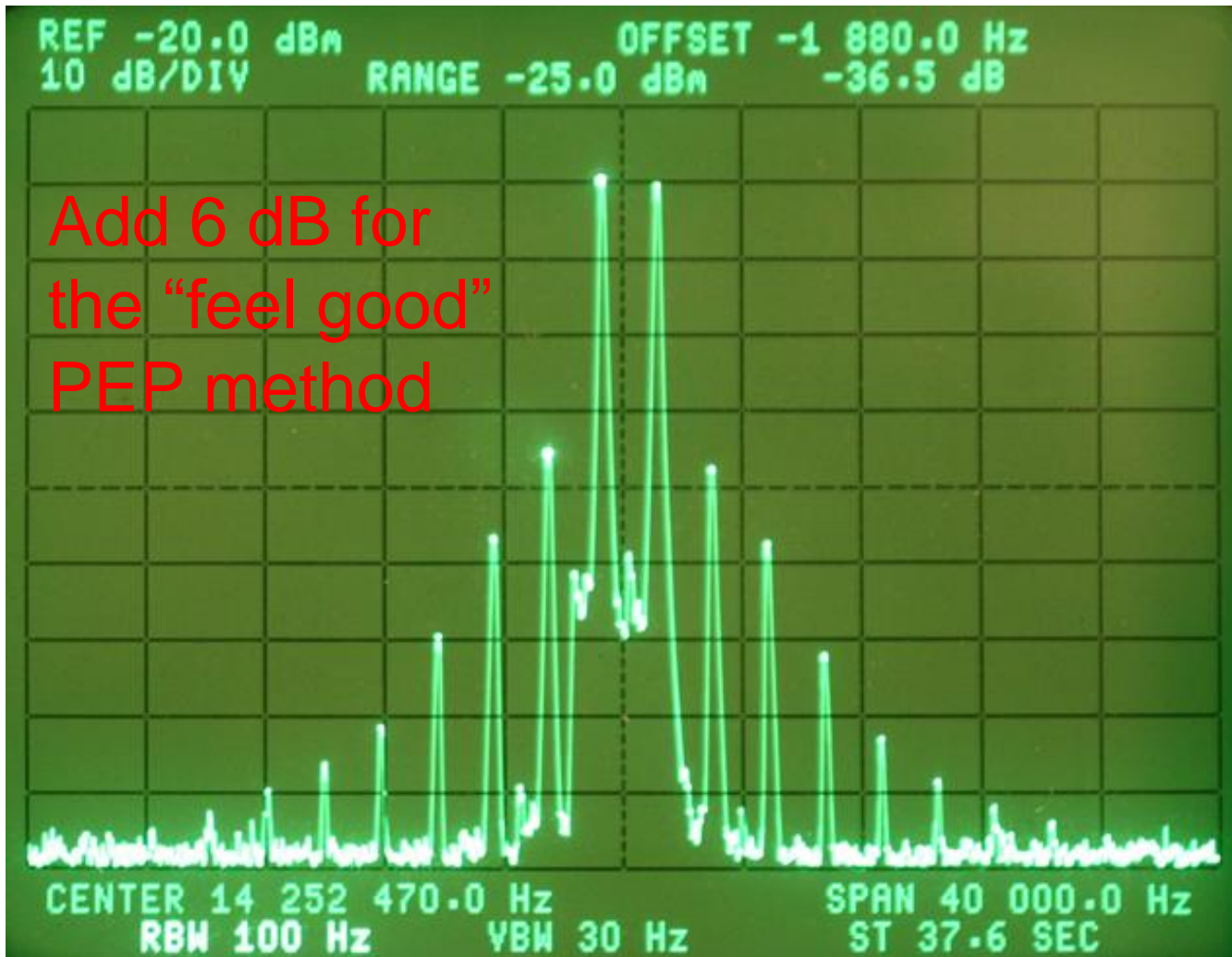
- A regular scope is a time domain device.
- A spectrum analyzer = frequency domain
- Used to measure transmit IMD
- Can also measure transmit composite noise
- Can measure signal generator noise
- Swept analyzers and FFT analyzers
- An SDR radio can work very well.
- Next slide is an odd-order IMD measurement

The cleanest transmitter
I have ever owned.

-36 dBc 3rd Order, -47 dBc 5th Order

Collins 32S-3 on 20m at 100 watts

Add 6 dB for
the “feel good”
PEP method



\$500 to \$1000 eBay

HP 3585A/B Audio to 40 MHz



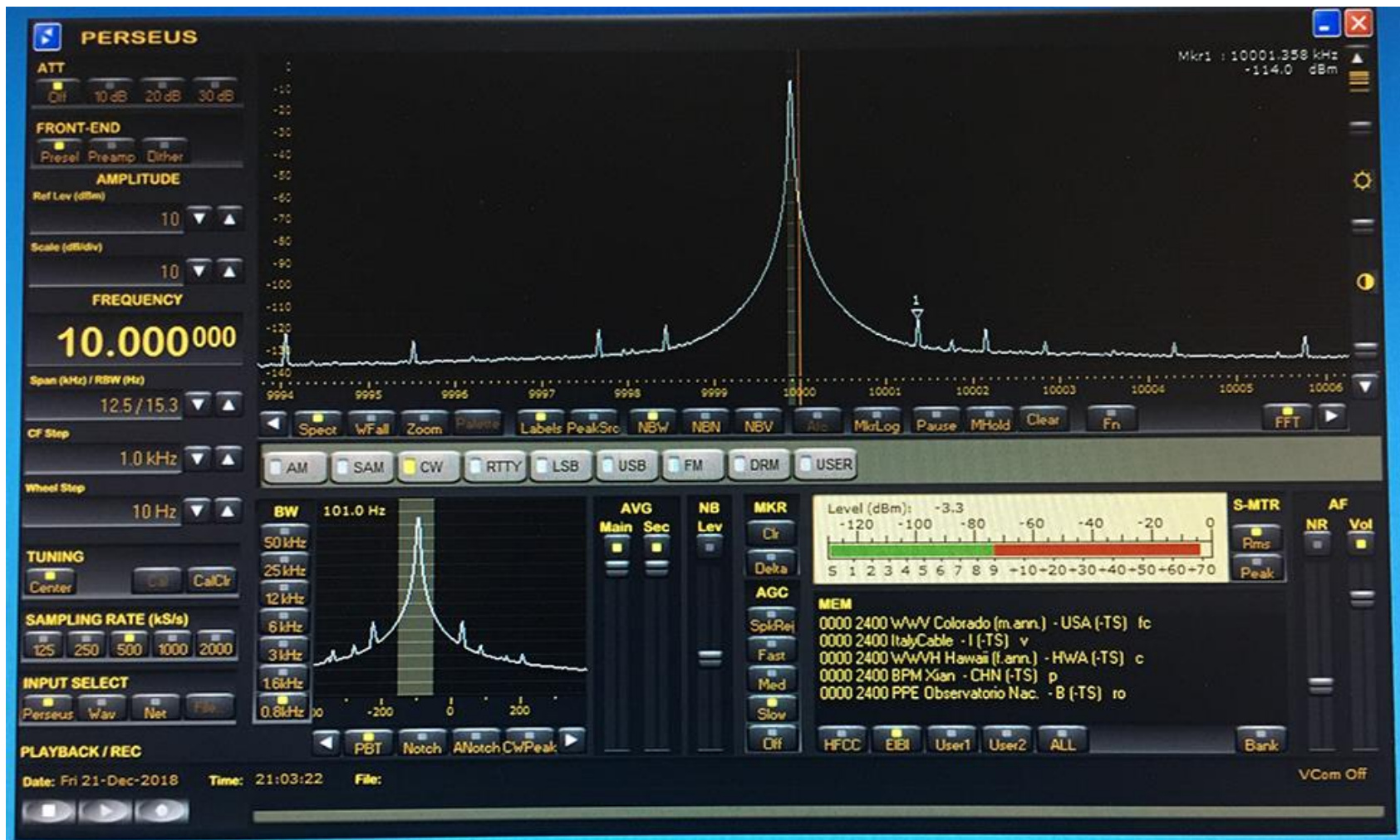
\$770 new HRO

Perseus SDR FFT receiver analyzer

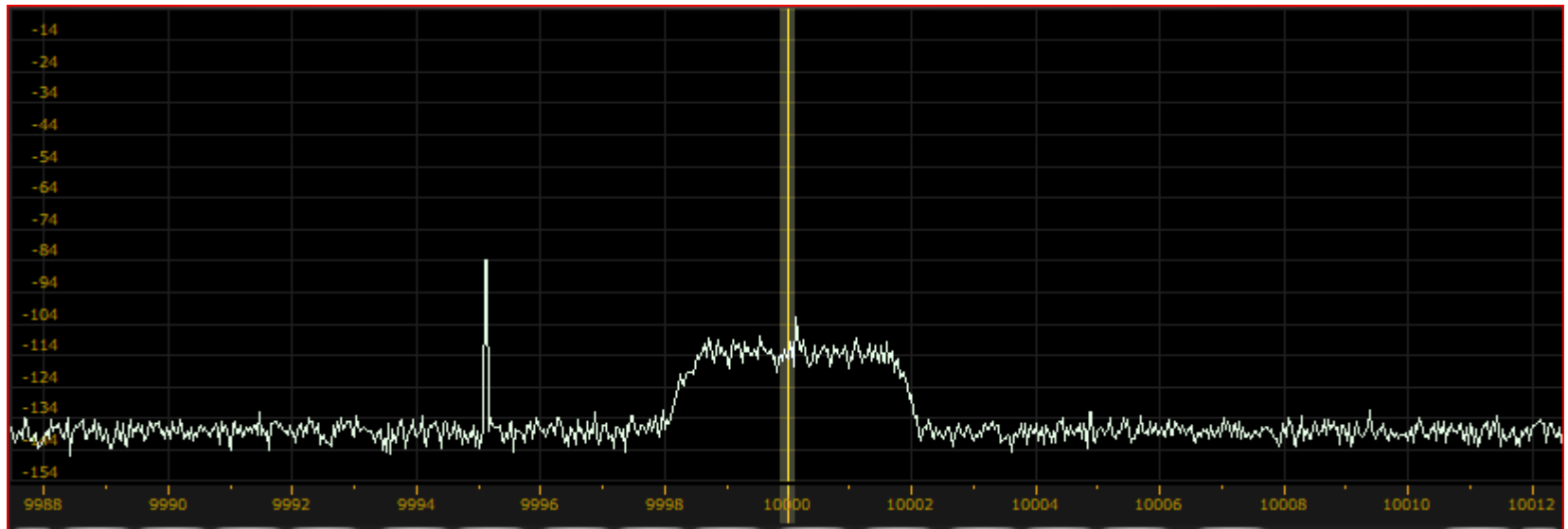


Runs under Windows. 4.1a software recommended
SDR tunes to 40 MHz. **Also measure TX composite noise**
Have down-converted 2m, 70cm & 23cm signals to 20 meters.
Measured the Icom IC-9700 on all bands

Noise measurements to -125 dBc

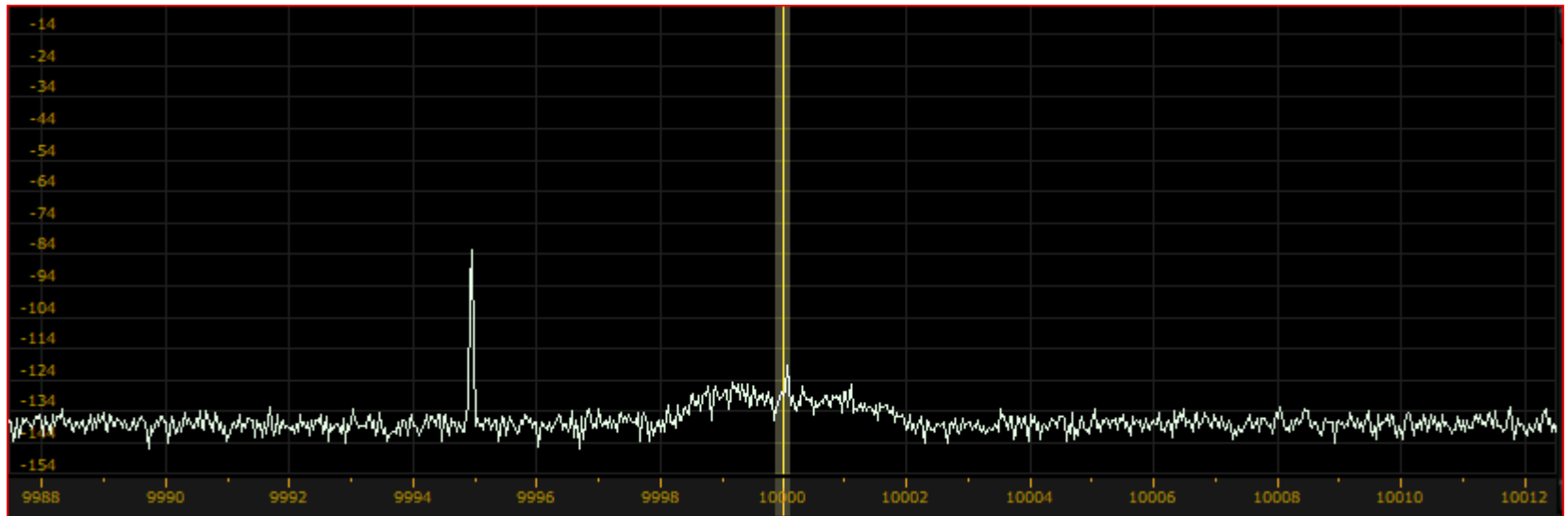


FY6800 phase noise @ 5 kHz Offset



Generator offset 5 kHz below a 10 MHz crystal filter.
Filter extends the dynamic range of Perseus SDR receiver

HP 8640B phase noise @ 5 kHz offset



Generator offset 5 kHz below a 10 MHz crystal filter.
Filter extends the dynamic range of Perseus SDR receiver

Two phase noise screen shots compliments of W0IVJ.
The 8642A is cleaner than the HP 8640B.

<http://www.NC0B.com>



Emails welcome for questions or PDF of presentation