Wyoming HamCon 2022

Helpful Test Equipment & Tools for the Ham Shack

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NCØB

What do you really need?

Sherwood Engineering

What equipment interests you?

Troubleshooting Needs

Is your signal clean when driving an amplifier ?

Check your antennas ?

Wattmeter vs. SWR meter ?

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 !

Consider a Kenwood SM-230 station monitor.

Modern used scopes are affordable.

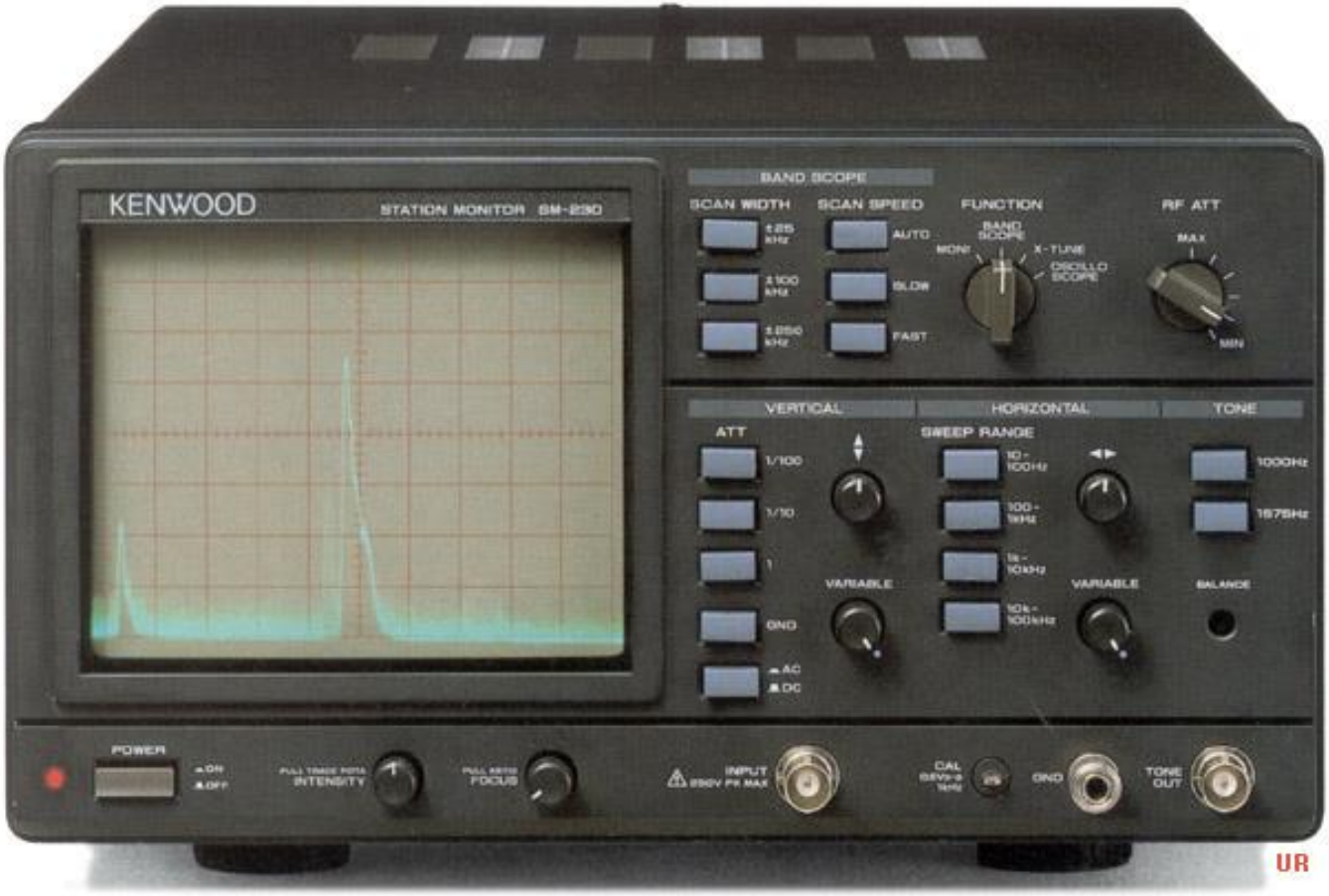
Hamfests are a good source of equipment.

All my test equipment is second hand.

My Lab - You don’t need all this !

May be a rare find, lots of features, $500 ???

Kenwood SM-230 station monitor



Includes 2-tone test generator !

Tektronix 2230 only $100 on eBay

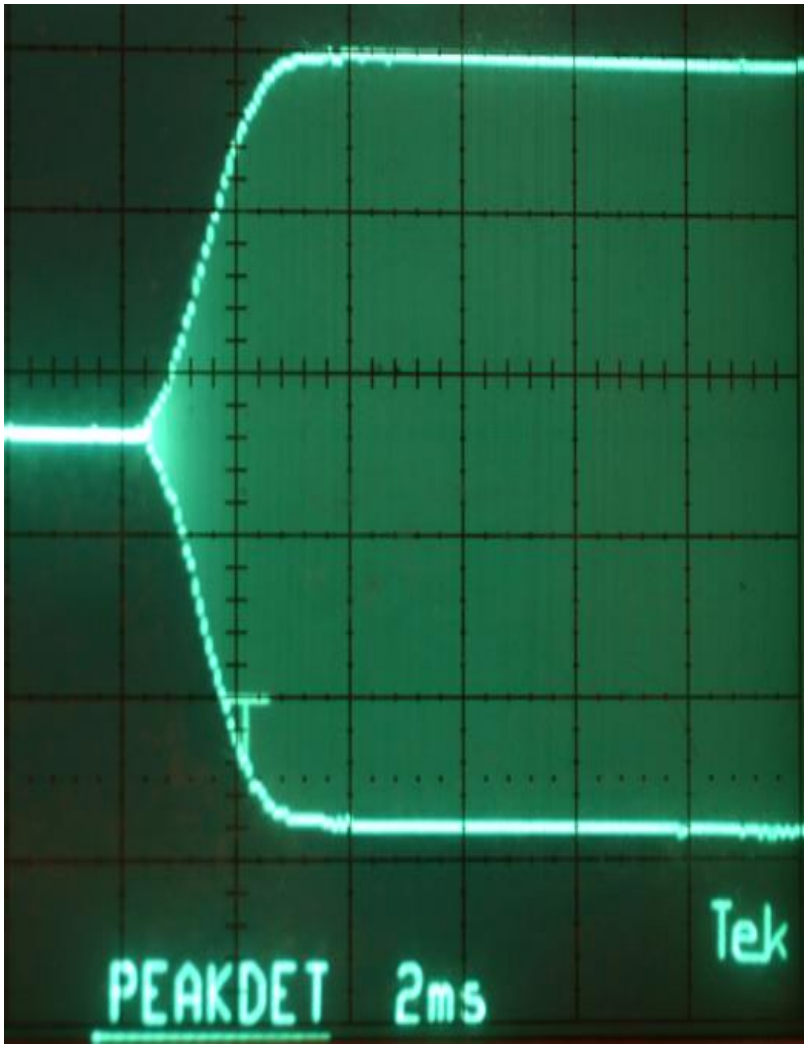
Used 100 MHz Storage CRT Scope

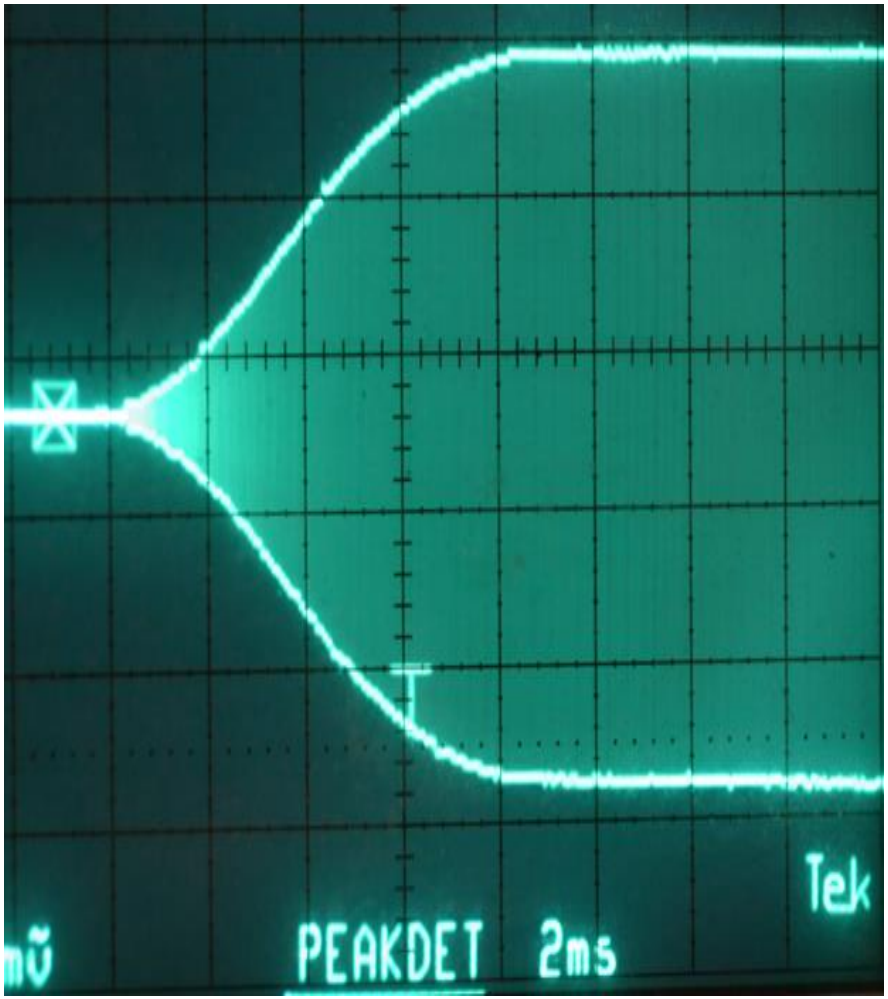
Set key down carrier to 6.5 divisions on scope.
When speaking don't exceed 6 divisions = No Flat-topping !

Capture single “dit”

This screen capture is in the time domain

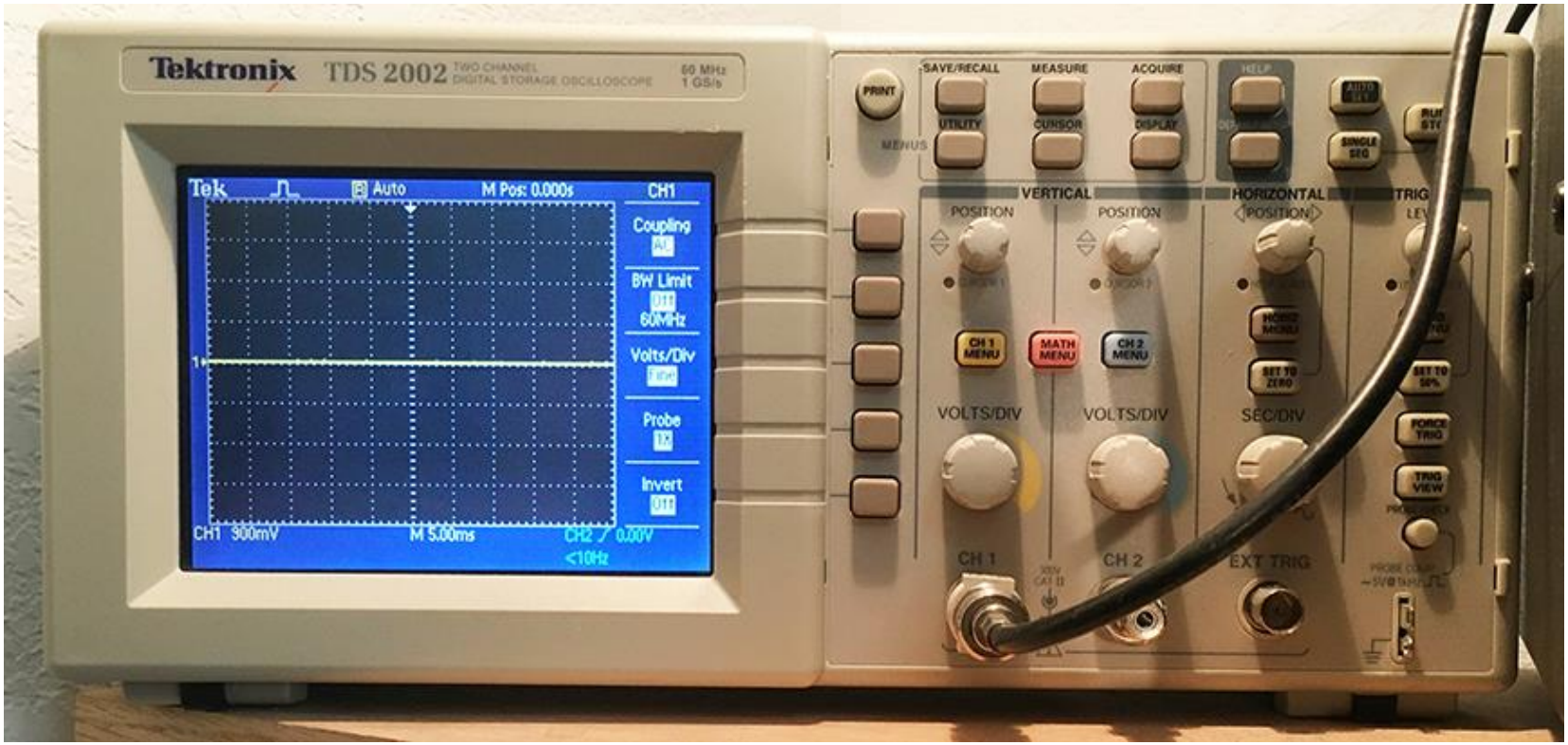
Leading edge of “dit” 3 & 10 msec





$350 eBay

USED 60 MHz Storage LCD Scope

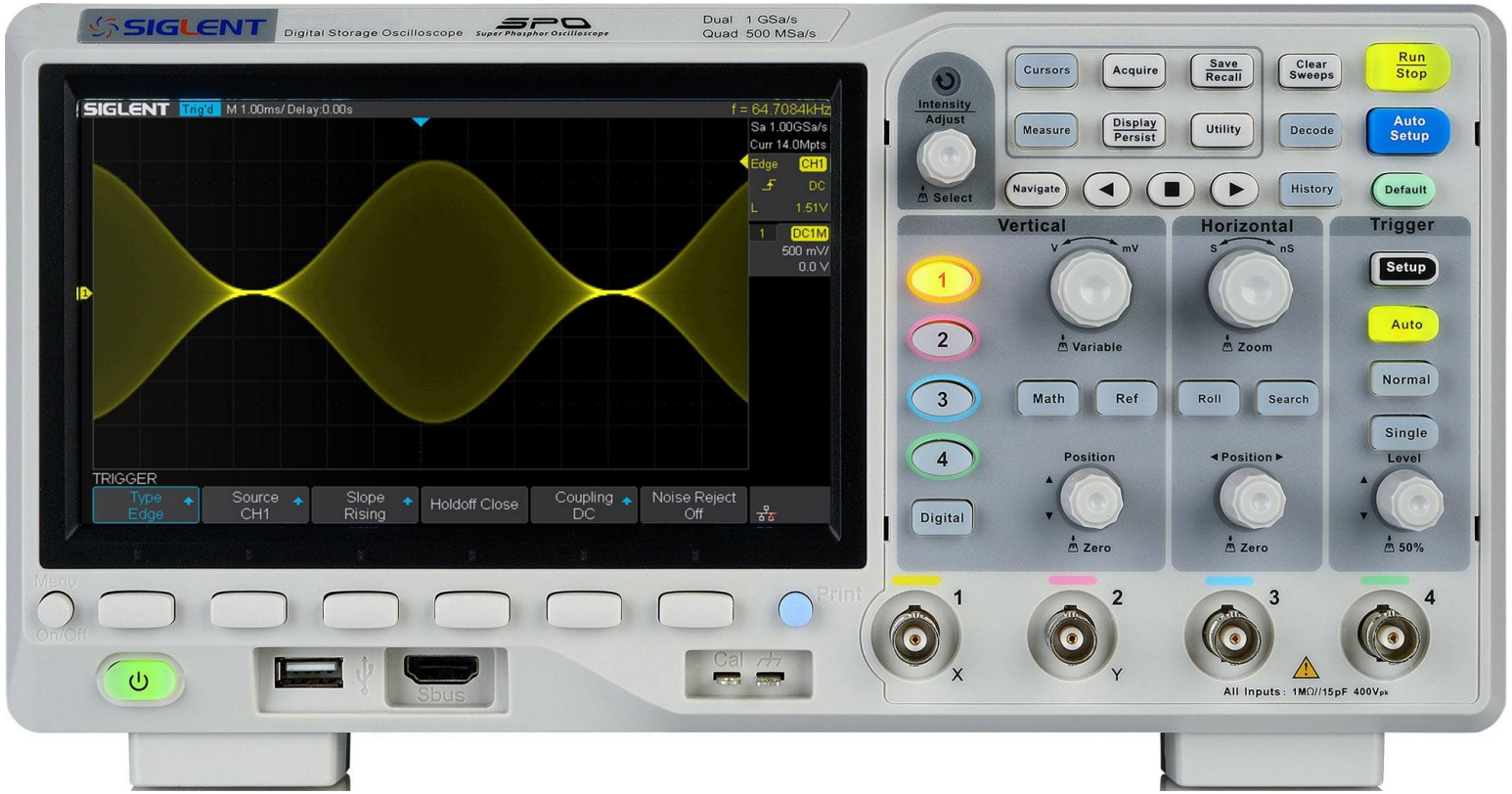


LCD scopes take up very little depth on your operating bench.

New price $500

Siglent SDS 1104X-E

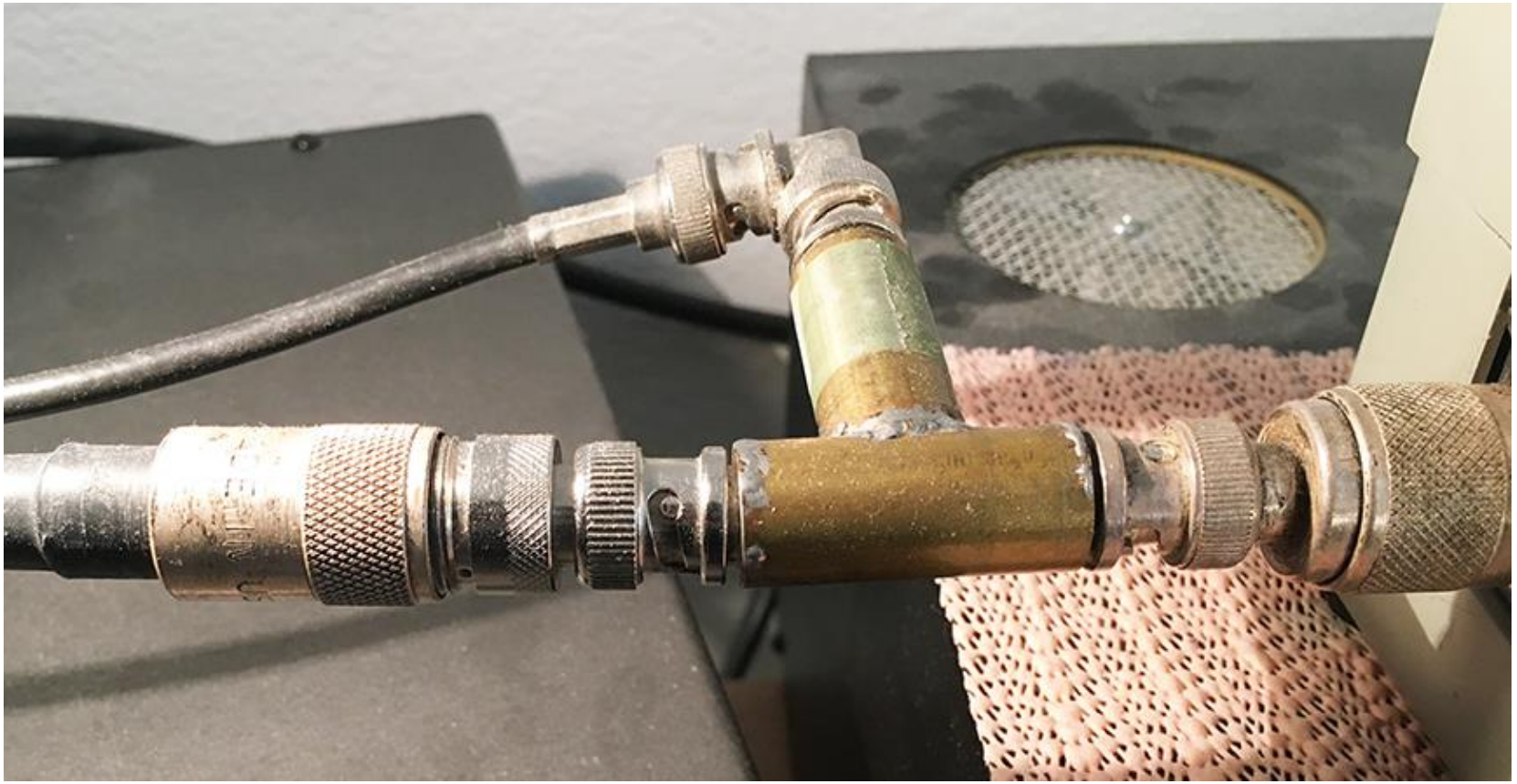
100 MHz, Digital Storage, 4 channels, other models available



One of my operating positions

Sampler 2022 Handbook page 25.58

How do you monitor your signal?



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

$200 eBay, HF slugs $100+

Classic Bird 43 wattmeter

- 450 kHz to 2.3 GHz, Watts to Kilowatt slugs

Tyler KA0KA CleanRF Sampler

500 kHz to 60 MHz

Legal limit rated

Output attenuation
-26 to -50 dB

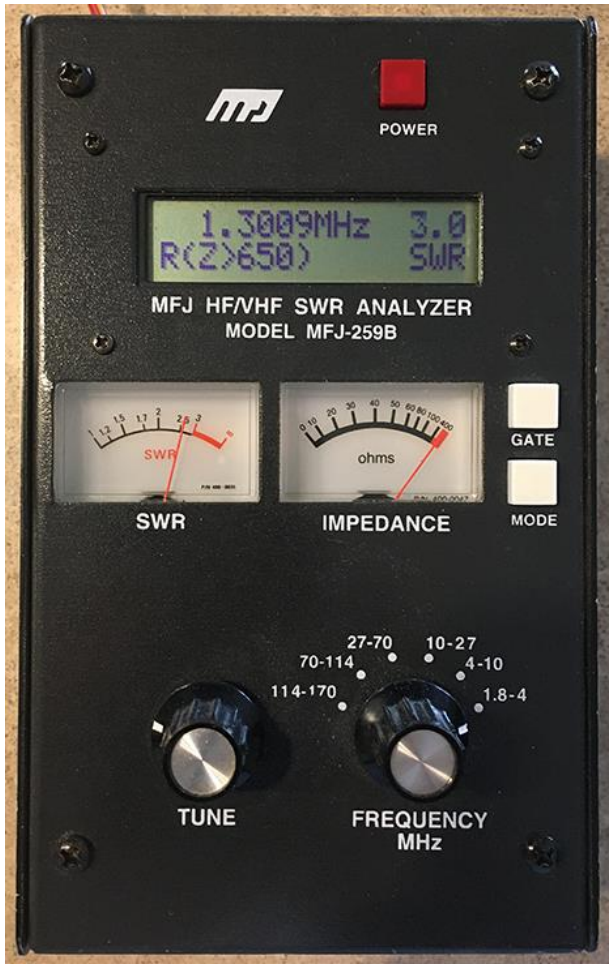
$105

Options for checking your antenna

- SWR bridge all sorts of brands
- 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. $100
- Array Solutions VNAs, several models
- $1000 range

Be careful testing 160 & 80m verticals.
AM broadcast signals can blow the unit.

MFJ 259B antenna analyzer



259B used $150 and up

259D new $350

259D covers 100 kHz to 230 MHz

Compare to General Radio 916A

I use this on my vertical antennas.

NanoVNA

Vector network analyzer

Can be run from your PC via USB

Under $100 new

New price $260 QRP to Legal Limit

Peak Reading Watt / SWR Meter

Covers 2200 meters and 630 meters (136 kHz & 472 kHz)

$75 eBay a great bargain

Economical Wattmeter

Drake W-4

Used market only

No direct SWR reading

100 W forward and 4 watts reflected, SWR = 1.5:1

Very reliable

200 and 2000 watt scales

Accuracy +/- 10% typical

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

- It is handy to have an analog meter with a dB scale for antenna noise gain measurements.

$100 and up eBay

Fluke Handhelds – Great products

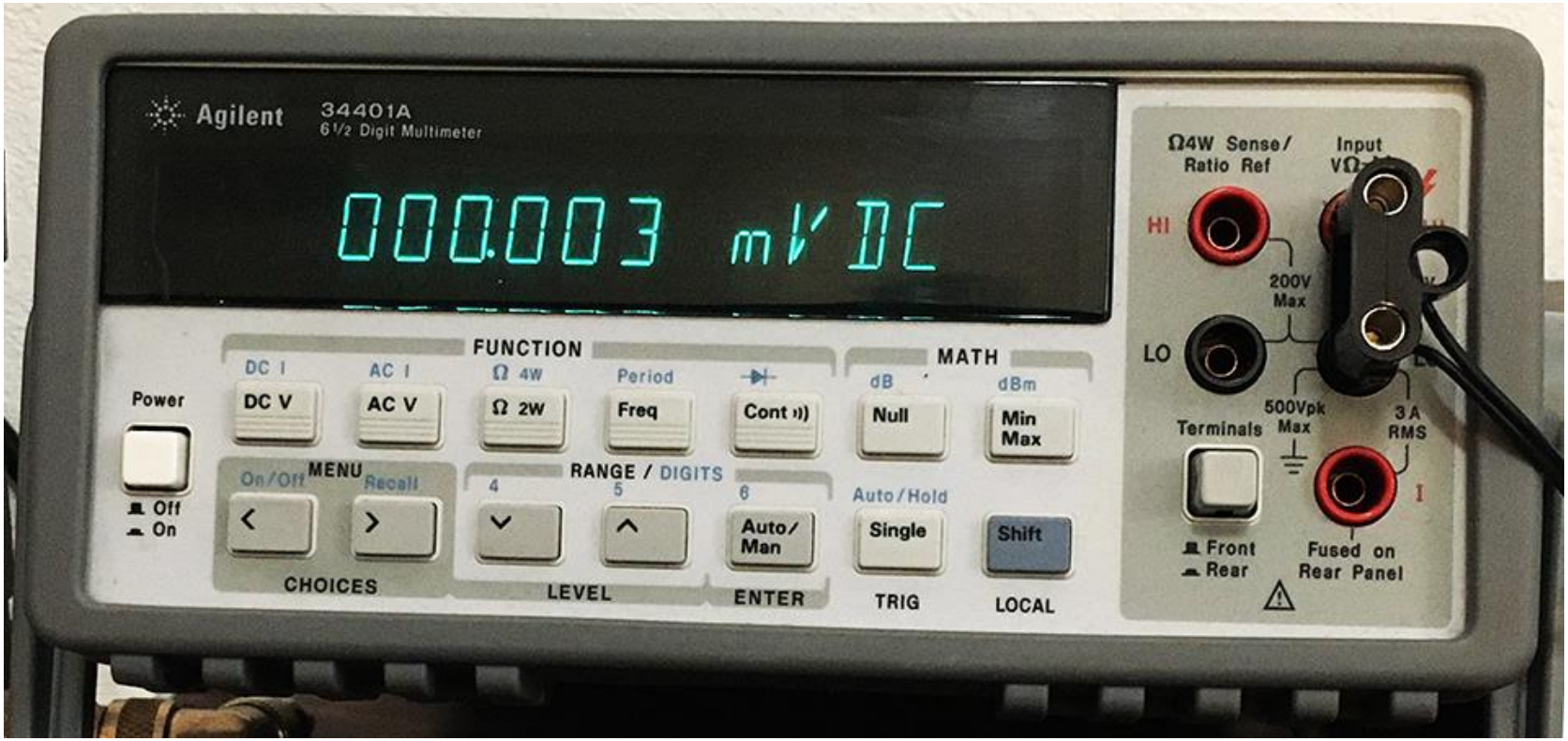
Purchased used on QTH.com

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

$500 and up eBay

Agilent Bench DVM

- Purchased used on eBay, likely overkill



Adjustable temperature and various size tips

Soldering Stations

I have several Metcals

$200 range used ebay

Used Metcal under $100 ebay

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

$120 and up eBay

Narda 150 watt 30 dB 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

Important there is an IN and an OUT !

Adequate for testing 500 watt amps
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.

A Bird dummy load and a sampler are also options for some measurements.

$50 or less typical

Termination / Dummy Load 1 GHz

You should have one of these.

100 watts

Lots of brands available

Need N to UHF adapter

Hamfests, eBay or QTH.com

Signal Generator

- This is a difficult choice at low cost.
- Used to check receiver sensitivity
- Check S meter linearity
- Needs wide range output attenuator
- Low leakage for MDS measurement
- Output as low as -138 dBm

- Function generators generally not adequate

$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 accuracy at low levels is very poor.

uHz frequency resolution
Similar model multiple sources

No specs for phase noise

UNI-T brand UTG962D $200

As with previous example, not accurate for RX testing.

$350 on eBay plus shipping

Classic HP 8640B, Avionics opt 004

I used two of these for many years, but age and reliability is an issue.

HP produced these for decades.

Be sure it works and has a return policy !

$500 eBay

HP 8657B from eBay

100 kHz to 2.06 GHz, +13 dBm to -143.5 dBm
General purpose signal generator
Good choice for RX testing if you can justify the price.

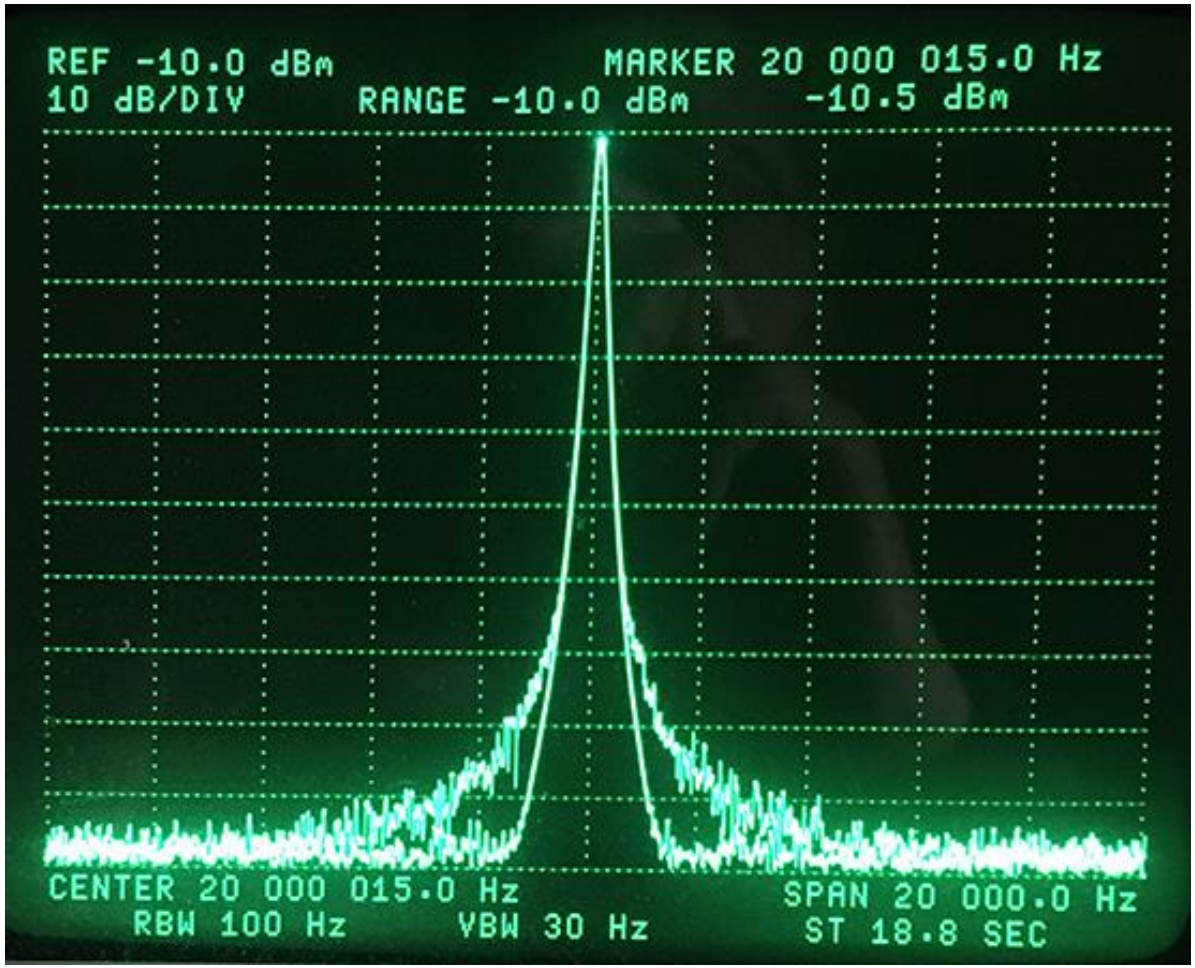
Not a typical ham choice

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



8657B is fine for general purpose testing.

Good for noise floor or sensitivity measurements.

Can’t test state of the art transceivers.

Too much noise.

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 !
- Measures distance from the shack to an open, shorted or damaged feedline.

$150 to $300 eBay

Tektronix 1503B TDR

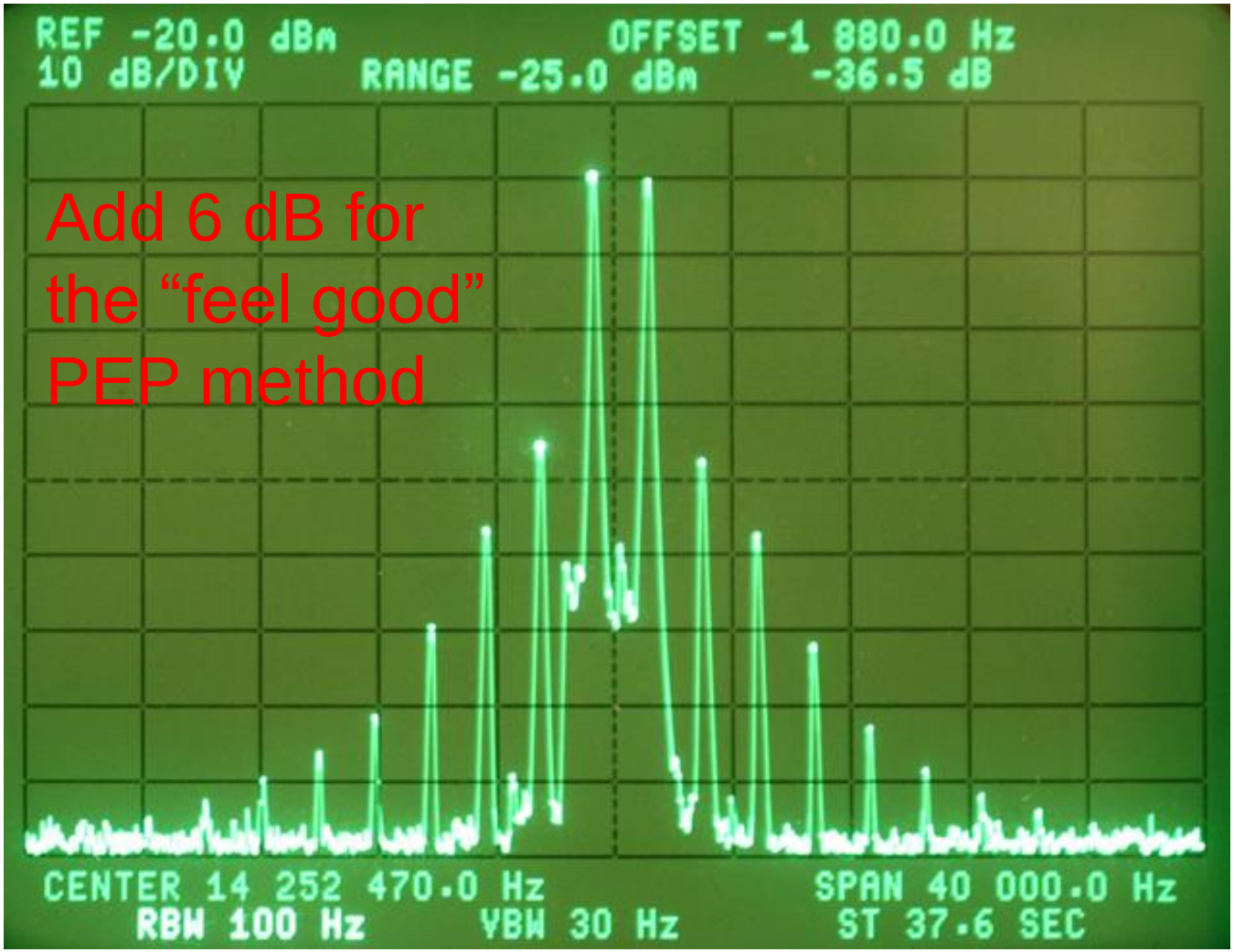
Spectrum Analyzer Options

- A regular scope is a time domain device.
- A spectrum analyzer = frequency domain
- Used to measure transmit IMD
- Swept analyzers and FFT analyzers
- FFT to measure transmit composite noise
- Can measure signal generator noise
- An SDR radio can work very well, such as a Perseus, Apache or Flex.
- 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



$500 to $1000 eBay

HP 3585A/B Audio to 40 MHz

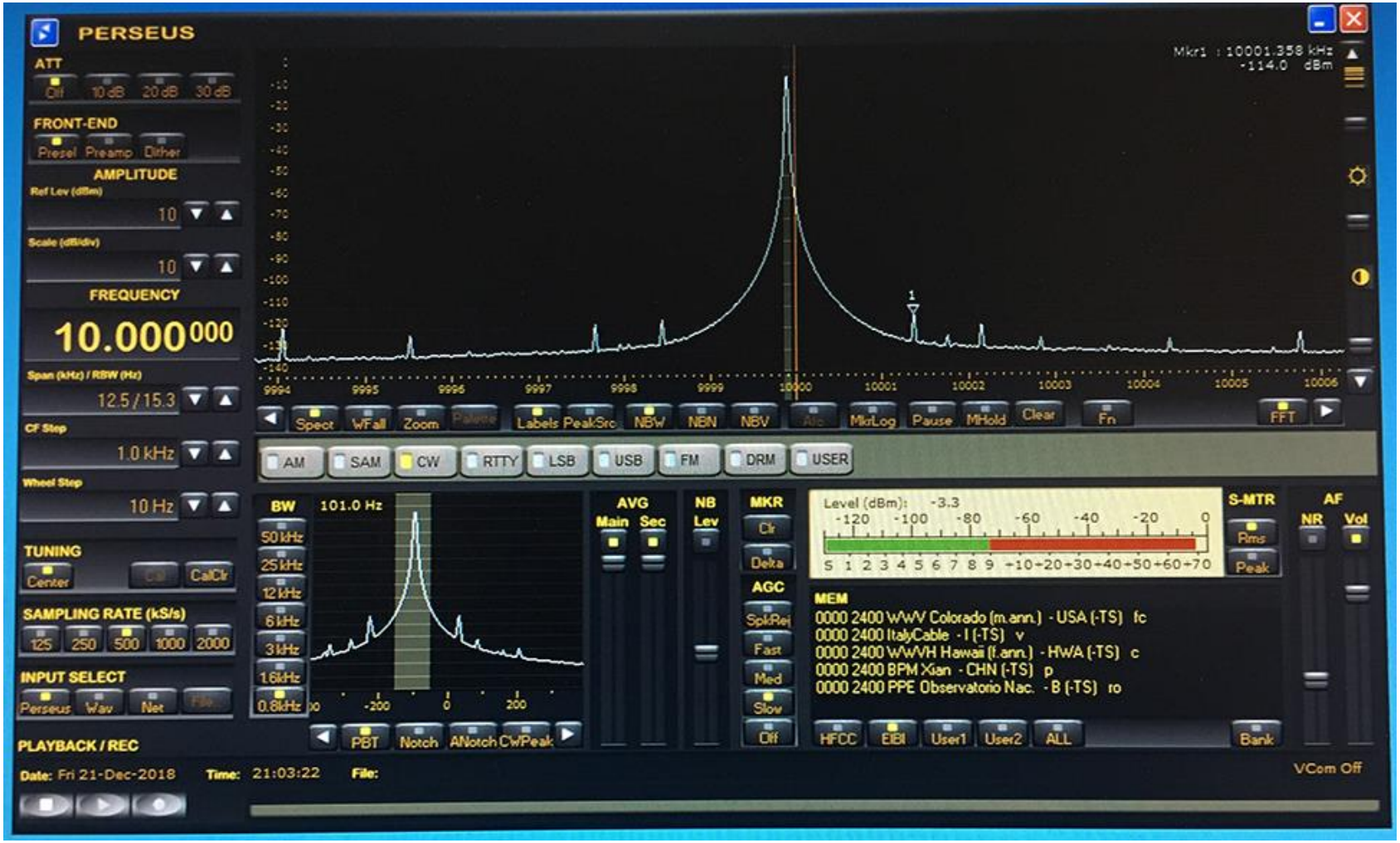
$770 new HRO

Perseus SDR FFT receiver analyzer

Runs under Windows. Version 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

Perseus screen capture

Noise measurements to -125 dBc



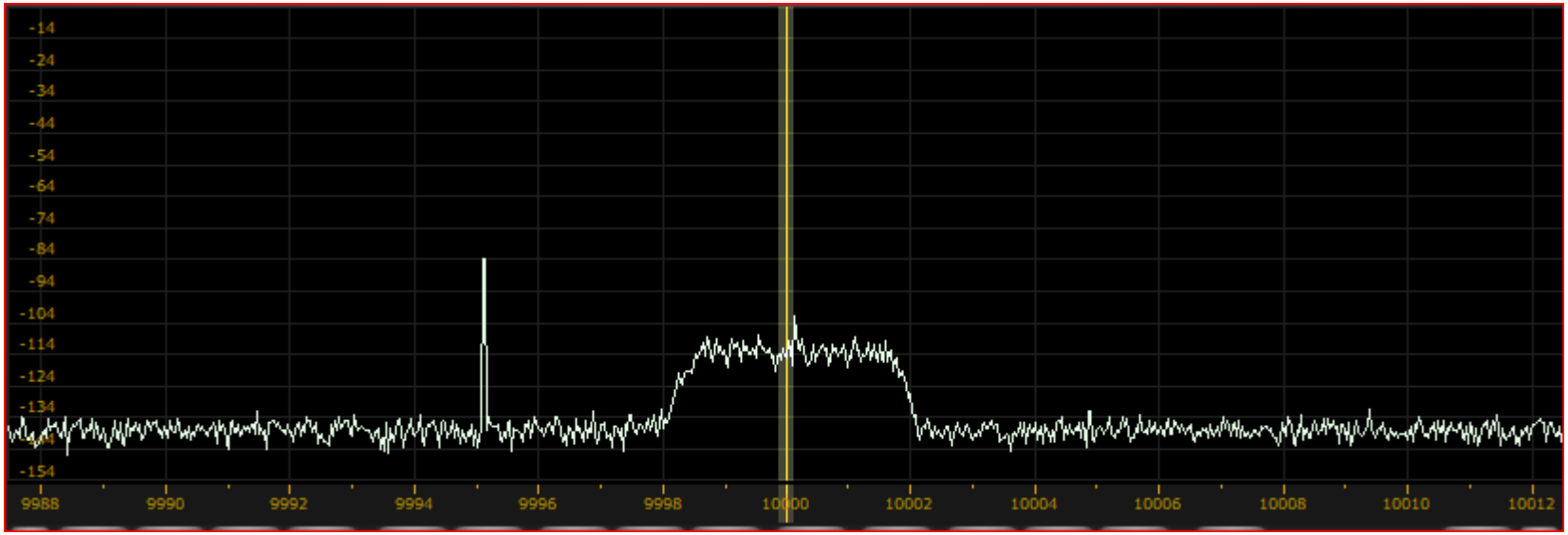
New Perseus SDR FFT RX & Analyzer

10 kHz to 225 MHz.

Price & availability unknown

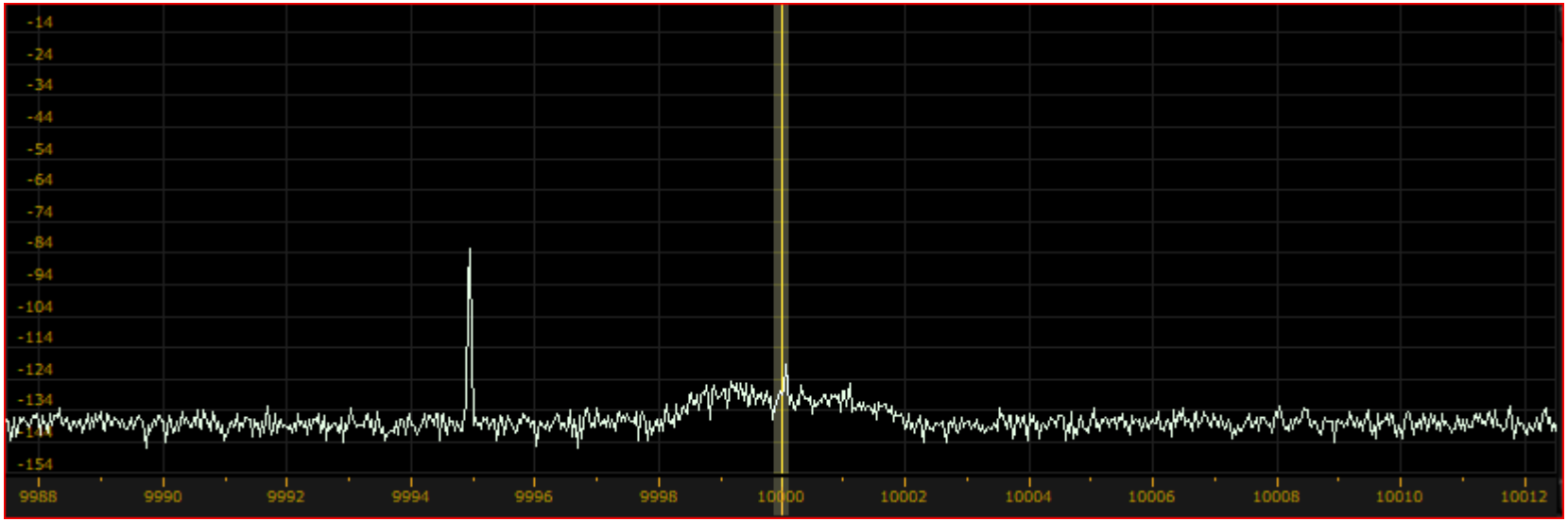
First new product from Microtelecom in years.

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

Sherwood Engineering

Emails welcome for questions or PDF of presentation

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