

Setting up a Laboratory for Ham Radio

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Background

- For most of us, our lab equipment is a growing pile of test equipment that often is the result of haphazard or opportunity acquisitions. This talk may give you some guidance in developing a good lab in stages. What I am presenting for choices are based on my prejudices and experiences. I have tried to be conservative and choose well proven instruments.
- Here are some general statements:
- As far as possible get gear that is whole and works. Eg. Waiting 10 years to get a probe won't do.
- You may get a great deal on half of a piece of gear but have to pay good money for the other.
- Getting a deal on an HP 432 power meter and paying good money for a calibrated probe is a good idea.

Contents and Levels

- I'll talk about beginner, intermediate and advanced lab levels.
- For each level, I'll talk about
 - General equipment
 - Frequency Measurement
 - Power Measurement
 - Spectrum Analysis
 - Signal Sources

Long Term Plans

- Decide on what your goal is-
 - Do you only want new equipment?
 - Will you only need HF and below equipment?
 - Are you going to need to go up to 1Ghz? 10Ghz?
 - What are the most essential parameters you want to measure?
 - Do you have some favorites you used to work with or have wished you had along the way?
 - In my opinion it is better to get the right piece of gear and pay a little more . “No green bananas” theory.

So what should you get?

For Starters-

- A good DV M like a **Fluke 73** DVM because it has autorange and is hard to hurt.
- For a DMM one with an oscilloscope I recommend the **UT-81**.
- An MFJ 269 Antenna Analyzer
- Begin collecting a set of attenuators in N and SMA connectors.
- Collect various **coaxial adaptors**.
- Buy about a 10 amp **lab power** supply. Clearly mark where the 12volt settings are.

Fluke 73

Simple, sturdy accurate and quick.



UT81B



MFJ 269 Antenna Analyzer





Beginner's Level- Two Approaches

How about getting your whole lab in one unit? The HP8924C

It could be the only piece of test gear you will need.



Hp 8924C

- The 8924 and its cousins do everything well, unlike other service monitors. They are cheap and measure everything, generate and analyze from 400KHz to 1GHz. All in one big, heavy box. Extremely well made and reasonable to work on.
- They all generate AM, FM and have a calibrated output signal generator, have 2 separate audio tone generators, have 2 μ V sensitive "off the air receivers" with antenna input, encode/decode standard tone (PL) (CTCSS), have sinad, distortion, S/N meters, receive AM, FM and SSB, have modulation / deviation meter, frequency error meters.
- The problem is, everything is in one box, and the range may not suit you.

Web Page

Comparison of Service Monitors

Beginner's Lab one Piece at a Time

- Generator- Get an **HP8642A**. It is a time proven generator that is excellent and has great harmonics.
- A **Systron Donner 6245** counter is a good bet.
- An **HP 141** spectrum analyzer.
- For power measurement look at the QST reviews and buy one that will fit your needs used. A Comet CN 101L is has a wide range and pretty good accuracy.
- For all of the above you will probably spend \$1,500, but you will have an excellent lab that will last you many years.

HP 8642A or B

- Extremely stable
- Has BITE
- Good harmonics
- Resolution to 1Hz
- Sweeps entire range
- Audio generator from DC to 100KHz
- Frequency from 10KHz to 1.05Ghz

Systron Donner 6245A

- Strong and portable
- Excellent time base
- Few repairs
- Reads to 20GHz
- Repairable and documentation available

Counters Systron Donner 6245A

DC to 20GHz Very stable with option 013.



HP141 Series

- Several RF plug ins available from DC to 40Ghz
- Good amplitude resolution
- Easy to fix and sturdy
- Do not get any add ons like a preamplifier or tracking generator unless you also get the matching cables!
- There are many other analyzers in this price range from HP, Systron Donner and AIL. All can be good. Just see if it meets your needs. Stay away from narrow sweep units like Tek491, Singer, and Polarad 84W
- Sleeper deals are the newer Polarad, Systron Donner and a working, cheap HP8551.

HP 141 Analyzer with 8555A and 8552B



Watt Meter Diamond SX 600

The problem with watt meters is that anything better than 5% of full scale accuracy is expensive. Better to take an inexpensive meter and compare it against someone else's better meter. This is only one choice among many. It is 5W,20,200W and 1.6-500MHz. Good wide range.





Intermediate level

Intermediate lab

- Add a GPS frequency source like a **Thunderbolt**
- Upgrade to a Spectrum analyzer that will read gain and frequency like the **Tek 492a** with options 1,2,and 3. I avoid HP analyzers as they have a tendency to have weak switches.
- Upgrade to a **Bird 4410** watt meter for power measurement.
- Invest in an inexpensive oscilloscope.
- Buy an **HP 432** power meter, cable and head.

Tek 492A

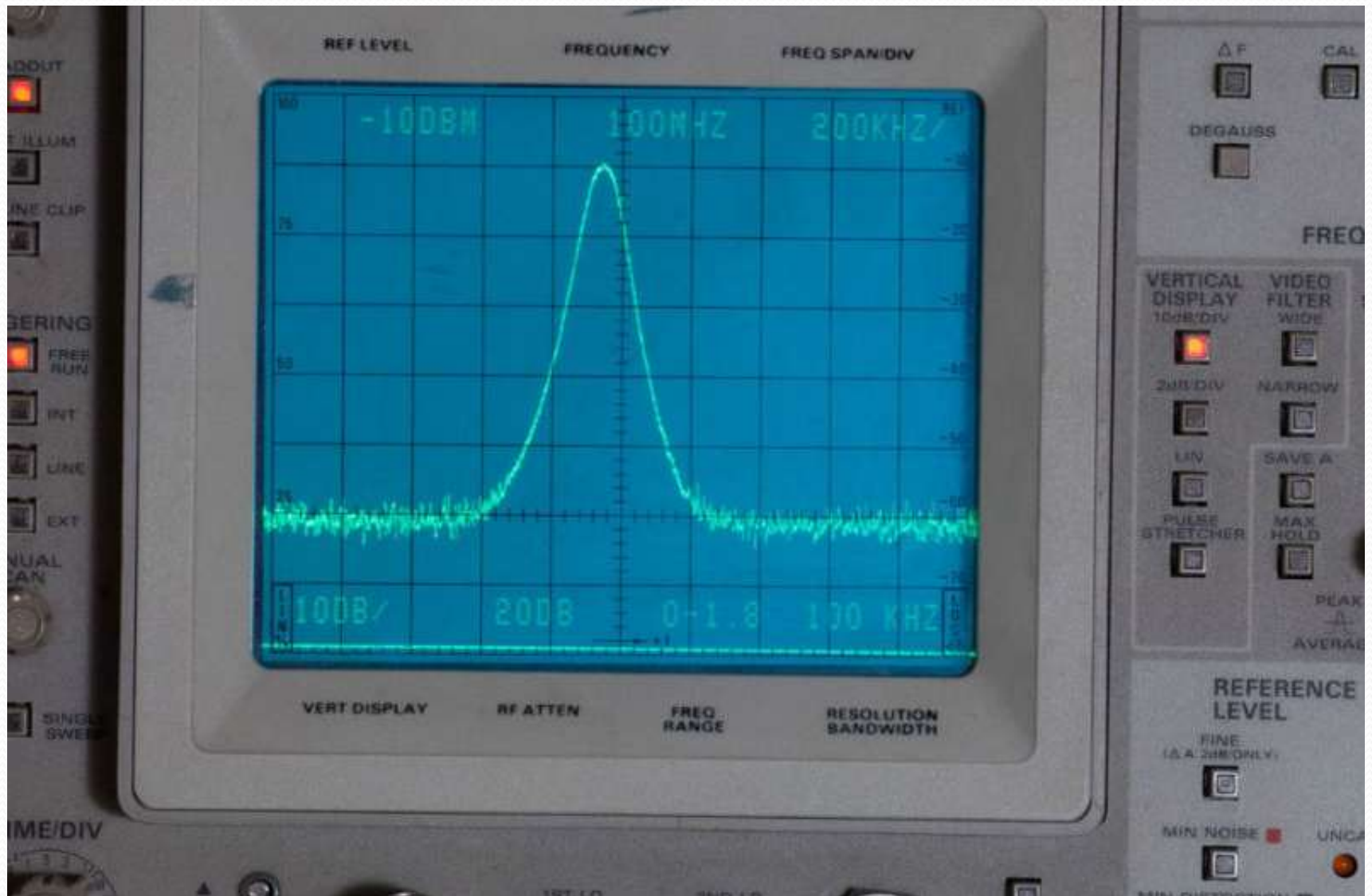
with options 1,2,3

- It reads frequency and gain 10KHz to 21Ghz
- It takes a 10MHz source
- It also takes mixers up to 300GHz
- On screen display
- Lots of parts available and well known

Spectrum Analyzer 492A



Screen Shot



Bird 4410

They are very accurate and each element covers four or five power ranges.



Power Meter

- At the minimum a 432 meter and sensor. Use attenuators to get to higher power levels. There are other meters made by Gigatronics and Pacific Microwave. But information is limited
- Get a 435 meter to be able to use the cal output. The 432 doesn't have a calibrated output and this will help you a great deal.
- Spend the extra money and get a meter, cable and head. Covers a wide frequency and power range with different heads.
- Getting a 436 meter is much more expensive.

HP 432 Power Meter and Head



Signal Source

- You are still good with the HP8642 A unless you want to upgrade to a B model that goes to 2Ghz.
- Getting generators that go much higher for microwave work means getting older synthesized generators that break down more easily and/or are expensive.
- Instead use the harmonics of the 8642a or make a signal source from a Qualcomm board.



Advanced Lab

Advanced Lab

- Add a **Tek 494ap** analyzer or HP equivalent
- Noise figure meter and head like the **HP8970a**
- Higher frequency signal generators like the **HP 8672a**
- Bench DVM like a **Fluke 8840A**
- Rubidium frequency source like an **LPRO**
- Network analyzer
- The sky can be the limit.

Spectrum Analyzer

- Advanced Tek 494ap
 - It reads to 1Hz at 100GHz and will accurately read level.
 - It has memory for traces and set up.
 - Self calibrates after each sweep.
 - Reads signal gain anywhere on the screen
- Some of the considerations in more advanced labs is how to calibrate your equipment and how to fix it if it breaks. Buy equipment with the latter in mind.

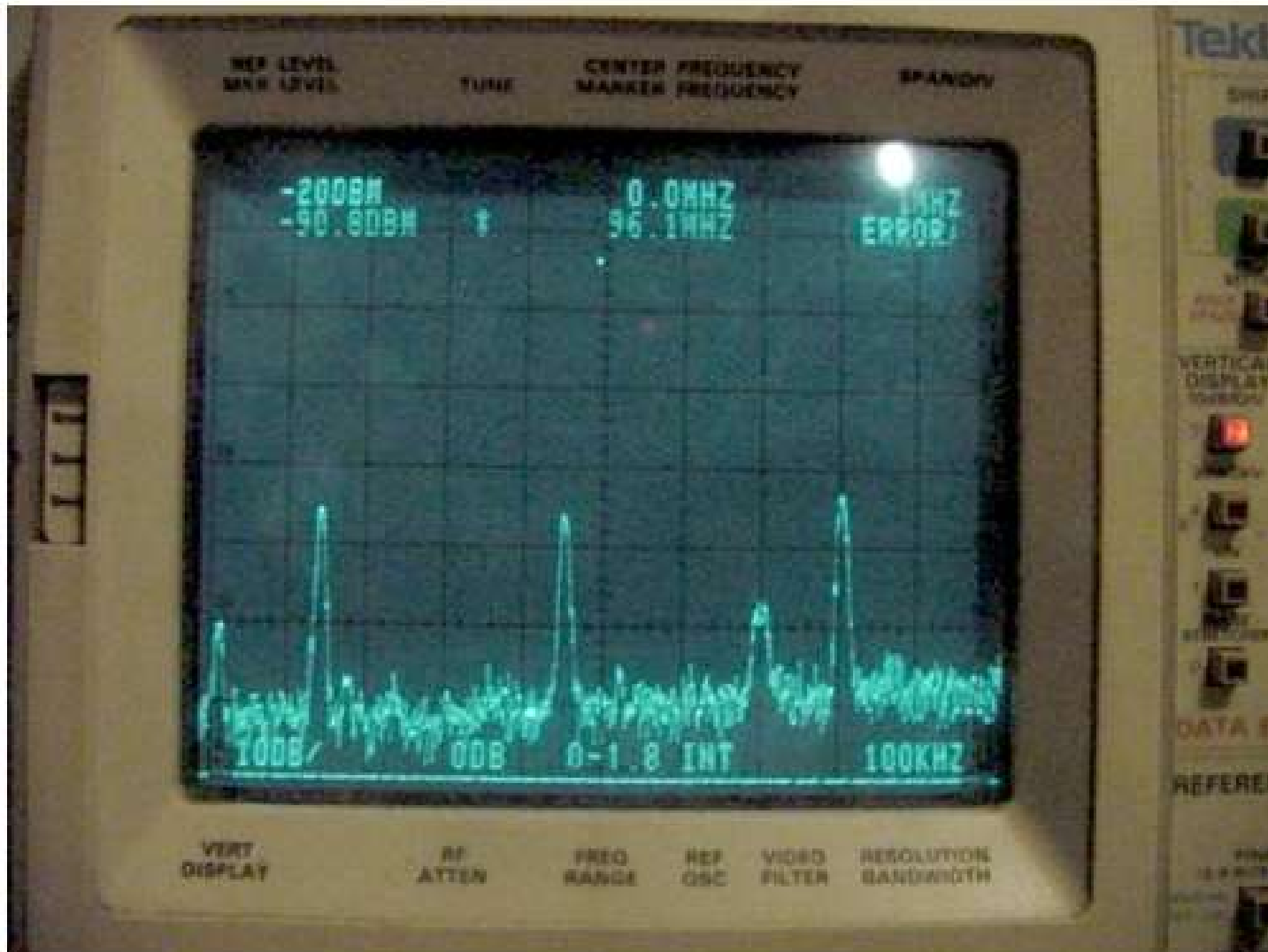
TEK494AP



TEK494AP

9KHz to 325GHz

Screen Shot- 1MHz wide



Noise Figure Meter HP 8970B

Important because it measures noise figure and gain/loss



Noise Source

- You can make your own and calibrate it against known standards
- You can buy an Ailtech and they work fine.
- You can also get an HP 346A



Signal Generator 8672A

10MHz to 18GHz



Fluke 8840A DVM 5 ½ Digits



Lab Frequency Counter-HP5372A

counts to 2Ghz plus and resolves 13 digits. Also does math.



Hand Held Spectrum Analyzer

Willtek 9102 (an SDR receiver with a computer attached.)



Rohde and Schwartz FSH 6



WWVB Frequency Reference

- WWVB is the only traceable radio frequency source that is available. GPS is not certified traceable.
- It is basically a 60KHz direct conversion receiver that has a phase comparator to an internal or an external standard. It usually requires a narrow band loop antenna.

Symmetricom 8164

WWVB Time comparator



Calibration and Repair

- Dave, WA6CGR and I have lab standards that can be used to calibrate about anything you can come up with for at least frequency and power voltage and resistance. We don't have the expertise to completely calibrate most instruments.
- There are several sources for equipment repair. One is Wei Tan, a very good local technician.

Equipment Sources

- For repair and a source of equipment a local supplier-
- RandS Surplus in Irwindale is ham friendly.
15858 Business Center Dr
Irwindale, CA 91706-2052
(626) 472-7500
- Of course there is Ebay and local swap meets.
- You can usually get good deals from other hams who are upgrading their labs and buy their old gear. Like my old HP8642A.

Resources

- A web page about the 8924c and cousins:
- <http://www.amtronix.com/diff.htm>
- Contact info:
 - Doug Millar K6JEY
 - drzarkof56@yahoo.com
 - Web page: K6JEY.com