Packrat Microwave MDS Testing

Why MDS testing?

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What is MDS anyway……

- MDS = Minimum Discernable Signal.

Calculating the actual minimum detectable signal is simply a case of adding the required SNR to the noise floor:

MDS dBm = Noise floor dBm + SNR dB (SNR= Signal to Noise Ratio)

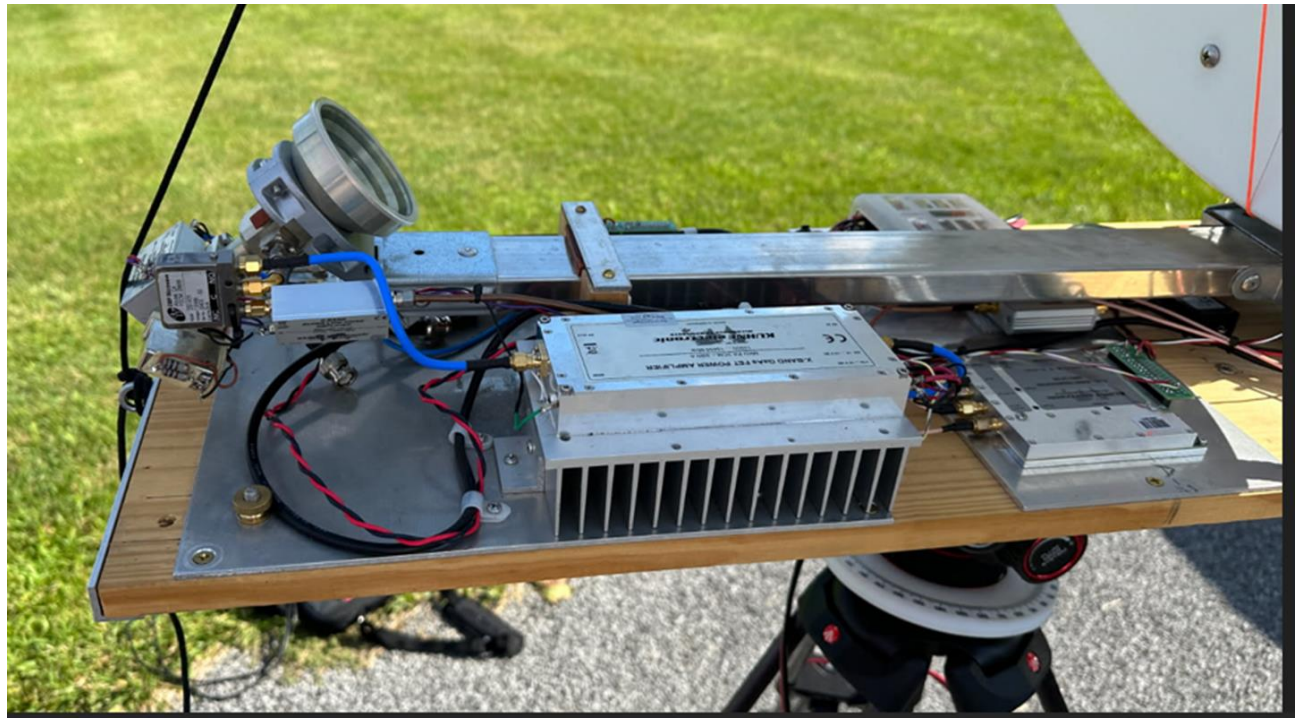
For our MDS test, we define the required SNR as the ability for the operator to copy a CW signal. A simple explanation of SNR to achieve this is 3 dB above the noise floor.

Modern radios with digital signal processing and waterfall displays can detect and display signals much lower than 3 dB above the noise. We should have a pass/fail definition for our test, in this case the ability to copy CW.

Why MDS testing? Why is this a popular activity?

Many stations still homebrew hardware or a combination of commercial equipment for bands 10 GHz and above. Operators always welcome testing to verify operation.

Equipment needs to be tested as a system, Antennas, TR switches, sequencers, cables, PS etc.



- Encourages new activity, operators have added the band after seeing equipment at these events. You don’t have to live on Ridge Road to enjoy 10 GHz!

Social activity for the club, attendance at our summertime events was starting to decrease, increased attendance last year for testing and picnic. Talk to other operators of microwaves, “what are you using?”

Popular activity, North East Weak Signal group has been doing this for a long time, always well attended. Rochester VHF Society has also started this activity. They are having fun!!

NEWS Group test

Rochester VHF test

Well, we (The Packrats) can have fun too!

More than enough activity in Packrat territory and Mid Atlantic States to support this activity.

Test method

- Last year, we used a constant CW carrier. This year, considering using our beacon message, CW and W3CCX in I minute interval.

- For equipment setup, a strong beacon signal will be on from our source. This will be our 1 minute W3CCX beacon message. (W3CCX CW then carrier for remainder of 1 minute cycle.)
- Start of test, the signal level will drop to an approximation of 20 to 30 dB above a typical minimum level. Verify all stations copy a sold signal.
- Then- Signal will drop in 1 dB steps at start of each minute.
- Operator rases hand when signal is no longer copyable.

We need a RF source for MDS testing.

- Attempting to attenuate RF sources at microwave frequencies to a level below a sensitive receiver MDS is expensive, and difficult.

Typical older microwave synthesizers are available but limited low end RF attenuation, and difficult to add external attenuation.

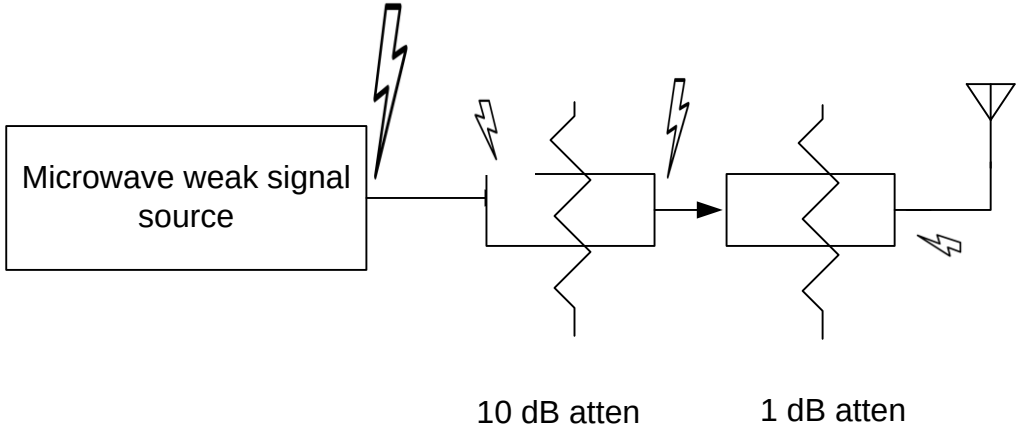
Table 1-1. Specifications (cont'd)

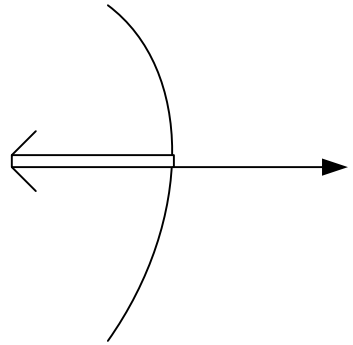
Electrical Characteristics	Performance Limits	Conditions
RF OUTPUT		
Output Level (8673C):		
Standard Calibrated Output	+11 dBm to −100 dBm	0.05 to <2.0 GHz
Normal Mode	+5 dBm to −100 dBm +2 dBm to −100 dBm	2.0 to <16.0 GHz 16.0 to 18.6 GHz
Bypass Mode	+8 dBm to −100 dBm +5 dBm to −100 dBm	2.0 to <16.0 GHz 16.0 to 18.6 GHz
Option 001 (Delete Attenuator)		
Leveled Output	+12 dBm to −10 dBm	0.05 to <2.0 GHz
Normal Mode	+7 dBm to −10 dBm +4 dBm to −10 dBm	2.0 to <16.0 GHz 16.0 to 18.6 GHz
Bypass Mode	+10 dBm to −10 dBm +7 dBm to −10 dBm	2.0 to <16.0 GHz 16.0 to 18.6 GHz
Option 004 (Rear Panel Output)		
Leveled Output	+10 dBm to −100 dBm	0.05 to <2.0 GHz
Normal Mode	+4 dBm to −100 dBm +1 dBm to −100 dBm	2.0 to <16.0 GHz 16.0 to 18.6 GHz
Bypass Mode	+7 dBm to −100 dBm +4 dBm to −100 dBm	2.0 to <16.0 GHz 16.0 to 18.6 GHz

100 dB enough?

Using a microwave weak signal source is difficult to attenuate to levels below high sensitivity receivers .

Making a RF tight enclosure is difficult at microwave frequencies.
Finding quality RF cables and connectors for high isolation at microwave frequencies is expensive.





So, how do we do it?

The same way all of our equipment works,

- We mix a microwave LO signal with a IF to produce a desired signal.
- Lower frequency synthesized signal generators are available and affordable with highly accurate attenuation much lower in amplitude.

HP 8648 is an example. Very accurate attenuation down to – 136 dBm.

HP 8648 specification

Output

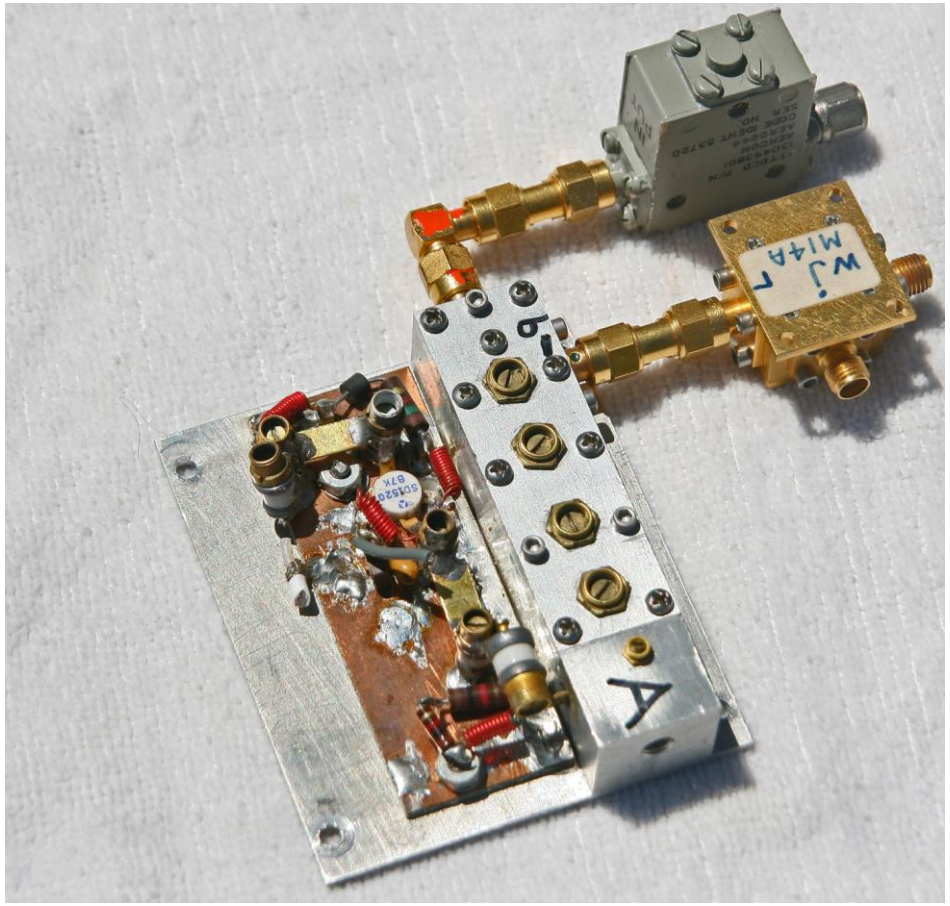
Range		
8648A	+10 to −136 dBm	
8648B/C/D		
≤ 2500 MHz	+13 to −136 dBm	
≤ 4000 MHz	+10 to −136 dBm	
Maximum Leveled*	**Option 1EA**	**Option 1EA and 1E6**
< 100 kHz	*+17 dBm*	*+13 dBm*
< 100 MHz	+20 dBm	+13 dBm *(typically +16 dBm)***
≤ 1000 MHz	+20 dBm	+18 dBm
≤ 1500 MHz	+19 dBm	+17 dBm
≤ 2100 MHz	+17 dBm	+15 dBm
≤ 2500 MHz	+15 dBm	+13 dBm
≤ 4000 MHz	+13 dBm	+11 dBm

* Typical for f_c < 250 kHz.
** Combining Option 1E6 with 1EA reduces output levels by 2 dB, below 100 MHz only +13 dBm (typically +16 dBm) is specified.

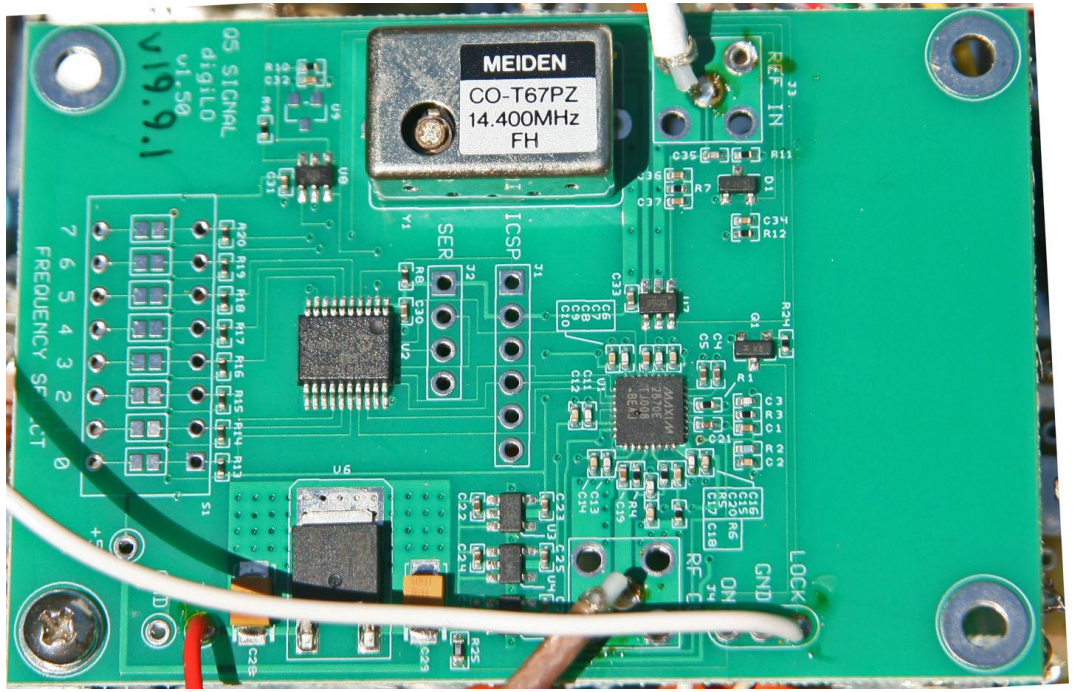
With mixer conversion loss, we can be lower than – 146 dBm.

Digi-LO Board significant Technology Advancement

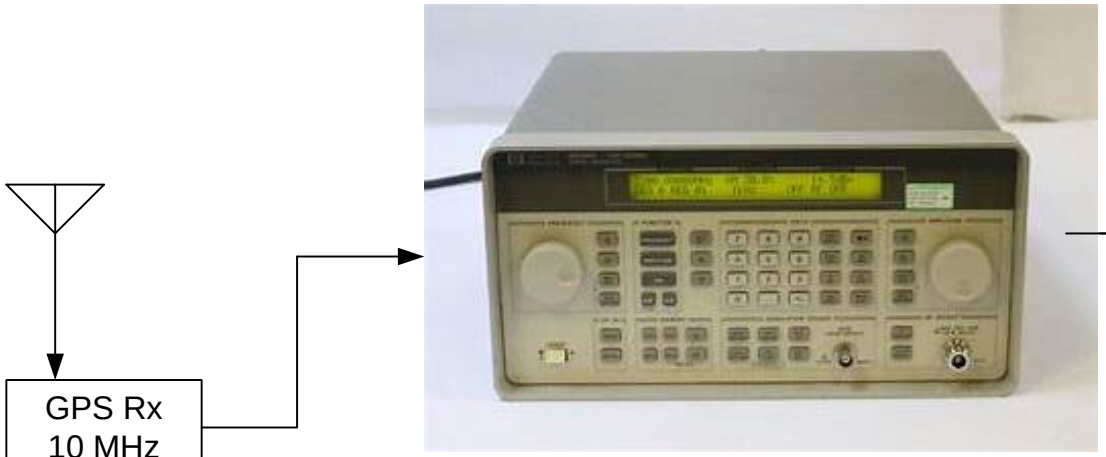
Homebrew microwave multiplier
Additional oscillator required.

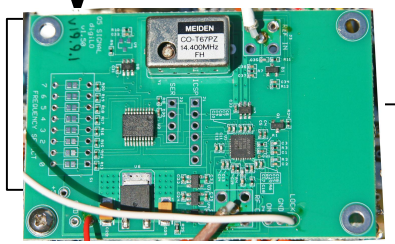


Digi-LO board, replaces multipliers, +8v, phase locked microwave source out!



Packrat 10 GHz test box.





Arduino CW message,
GPS control

368.1 MHz

RF switch CW keying

GPS Rx
10 MHz

Amplifier

Frequency
doubler

Amplifier

IF port

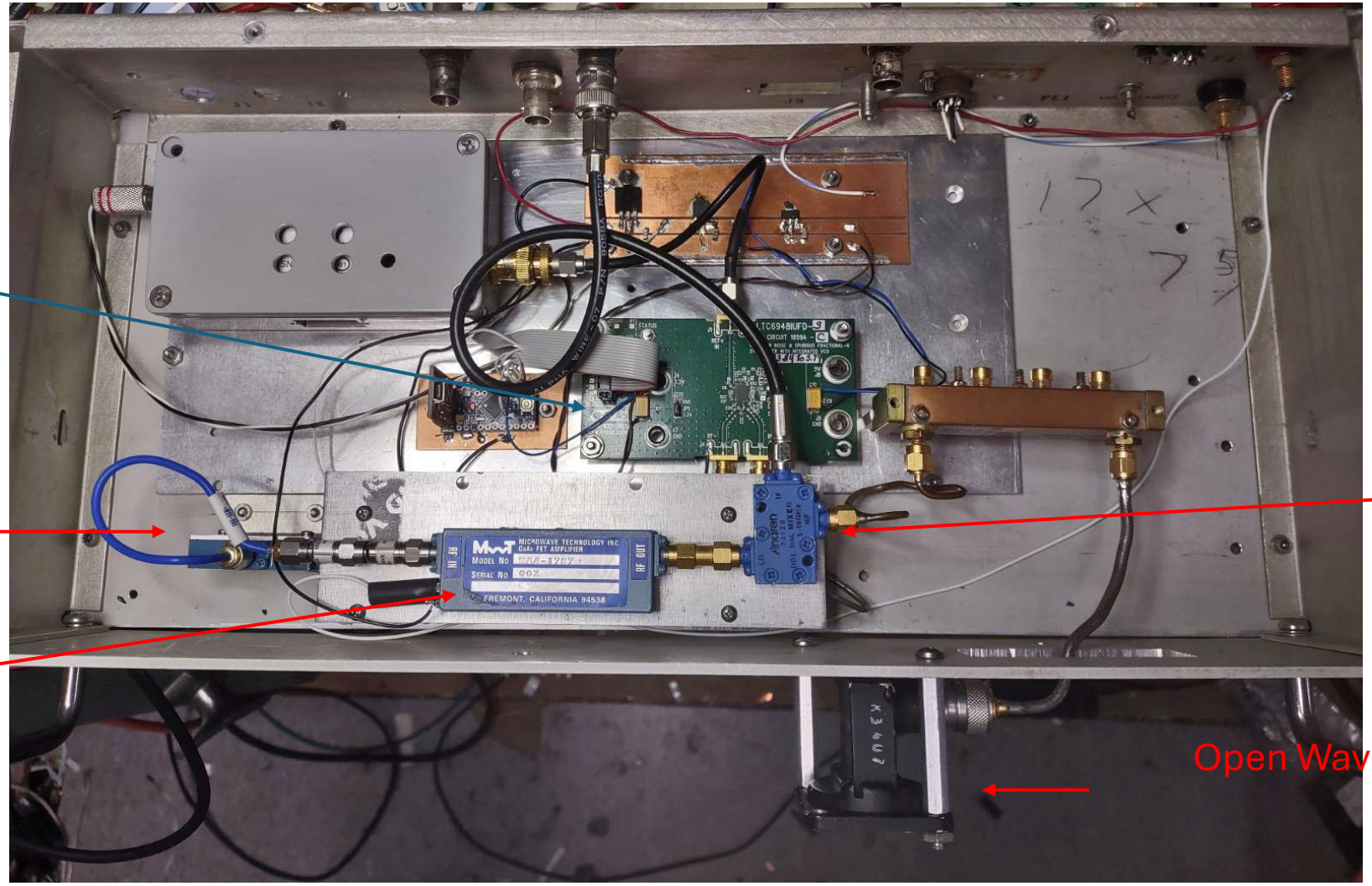
LO port

Mixer

Open WR-75 transistion
antenna

10368 filter

Packrat 10 GHz test box

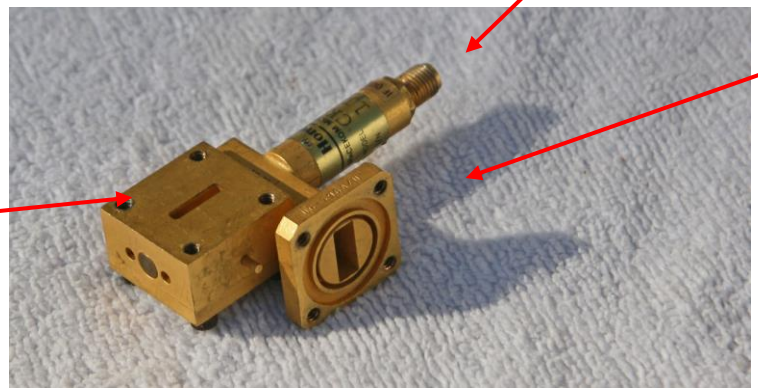


24 GHz hardware

- 24 GHz more limited availability of surplus and commercial parts.
- Same basic design used as 10 GHz, use a IF frequency, and microwave LO and mixer.

1)- Use a surplus HP harmonic mixer.
Somewhat easier, LO can be lower frequency, uses 6th harmonic.
N.E.W.S.group uses these mixers for test signal generation through 78 GHz.

2), Use available surplus components



Tom Williams, WA1MBA has published a test hardware solution used by the N.E.W.S. group, further reading here:

https://www.newsvhf.com/conf2023/2023papers/PresPapers/WA1MBA-Minimum_Discernable_Signal_Comparison_Signal_Generator.pdf

(Go to N.E.W.S. group website, look at 2023 papers.)

This years Microwave test, club picnic, White Elephant Sale and auction is July 26th

Excellent picnic, auction, and a chance to see and hear microwave equipment in operation.

- At Ben Wilson Senior Center,
- See you there!!