Racal-Dana 9009 AM/FM Modulation Meter

Recently I was at a local Ham flea market and obtained this modulation meter. I wasn't looking for a modulation meter but I like collecting test equipment. Also, the price was right. It was free but I did give a small donation to the club that was disposing of it. It also came with the original maintenance manual.

The basic operating frequencies were from 30 to 1500 MHz. This range could be extended somewhat by providing an external local oscillator signal. FM deviation measurements are up to 100 kHz. On the back of the unit there are 3 BNC connectors, they are Audio Out, DC Out that is a DC level proportional to the front panel meter reading and a 500 KHz IF Out. Both the audio output and the IF output are useful as described later.

I was interested in determining the accuracy of the instrument and I performed some tests. These tests were not extensive. For the FM deviation accuracy I used the Bessel zero method along with an HP 8640B signal generator. A calculator for this is available on this website. Here is the link. Bessel zero relies on the fact that at certain modulating frequency and at a certain deviation the carrier disappears and only the sidebands are left. For doing the Amplitude Modulation tests I used the method described by W2AEW on his YouTube channel. Here is his link.

After doing the tests it was determined that no calibration of the instrument was necessary.

FM Performance Tests

To do the FM deviation tests an RF signal generator is required and a variable frequency audio source to modulate the generator. To view the carrier nulls for the Bessel zero detection I used an SDR receiver, a SDRPLAY RSP-1A along with SDRUNO software.

If you want to produce say 3 kHz deviation you need to modulate the generator with a 1247 Hz tone. Starting with no output from the audio source you need to slow increase the audio level until the carrier disappears on the spectrum display. This should be the first carrier null and this is the one you want. Increasing the audio level more will produce other carrier nulls. See the calculator link above for testing other frequencies and deviation of interest.

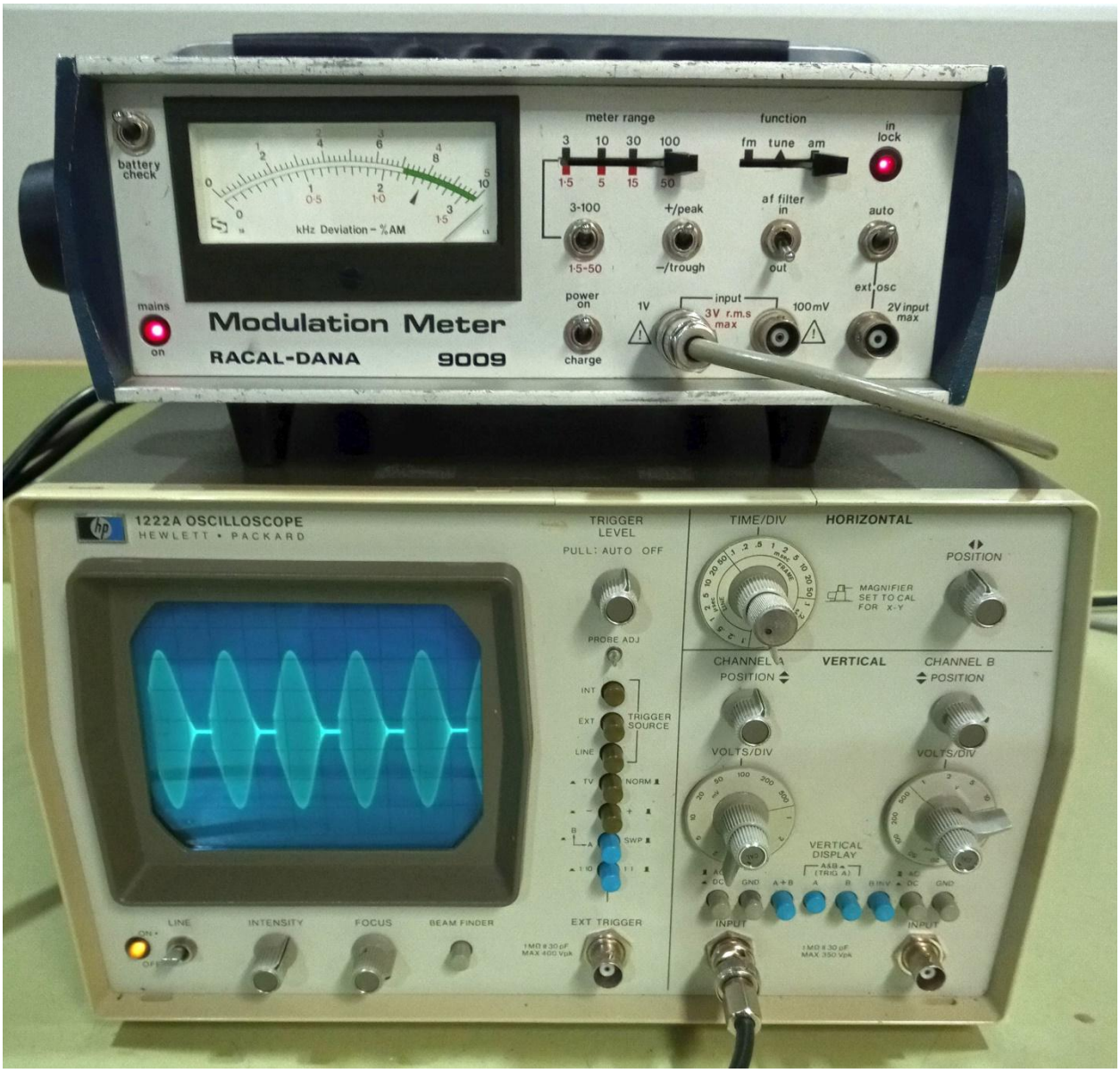
This screen shot shows a carrier null. Modulating tone was 1247 Hz indicating 3 kHz deviation. The RF frequency shown was the one that just happened to be dialed up on the RF generator at the time.

After the 3 kHz deviation was determined as shown above, the rf cable from the generator was transferred to the modulation monitor to verify that the meter reading was correct. The meter was on the 5 kHz scale. The meter accuracy was also checked at 5 kHz deviation and 1 kHz deviation on this scale. Some readings were also taken on the 10 kHz scale.

AM Performance Tests

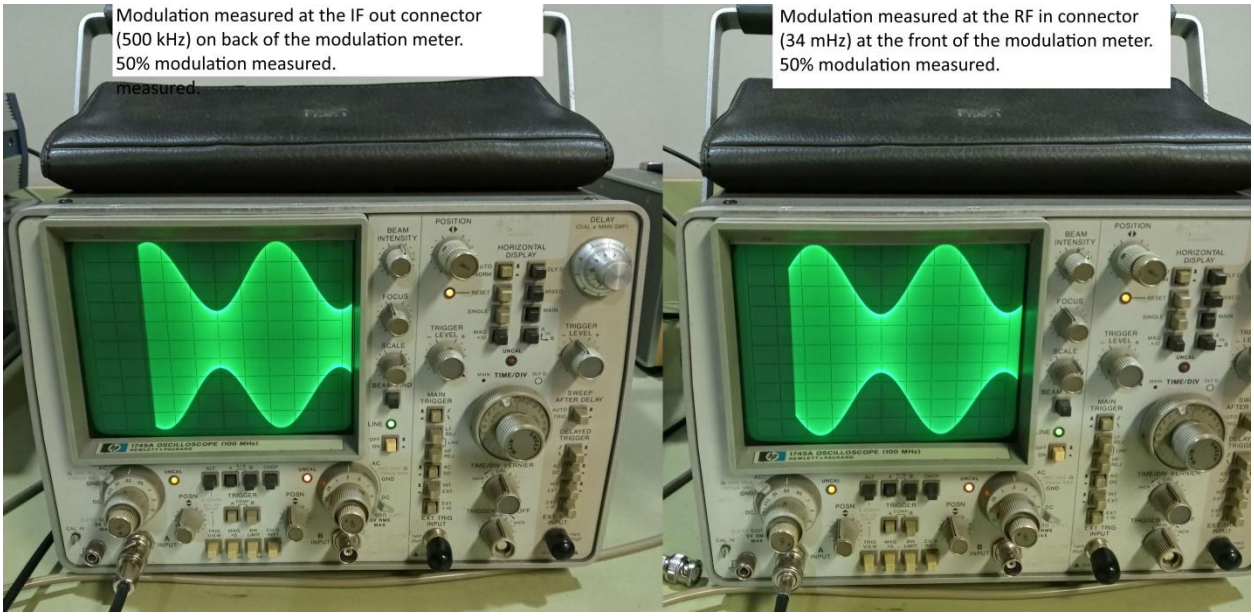
Refer to the W2AEW link above to determine how to do these tests. There are simple calculations involved to determine the percent modulation. I found it easier to put them on a spreadsheet if you are making a lot of measurements.

I wanted to see how the meter would handle an over modulated signal. With an oscilloscope connected to the IF output the results are below. The meter shows over 100% modulation and a visual representative of the modulation is shown on the scope.



Using the IF Output

The IF output duplicates the signal at the RF input BNC connector but at a frequency around 500 kHz. This is useful if you want to see what the signal you are measuring looks like and you don't have a high speed oscilloscope. The oscilloscope shown below is a 100 mHz scope but I also have a 15 mHz scope shown above that can easily be used on the IF output. The test signal shown below was at about 34 mHz.



The above is a comparison between a 34 mHz signal at the input of the meter and the signal at the IF output.

<u>Using the AF output</u>

The AF output is the recovered audio from the applied RF signal. I was interested in seeing if I could measure a low frequency FM tone at low deviation. Shown below is the set-up. The generator was modulated with a 100 Hz tone and the deviation was set to about 800 Hz. As can be seen the frequency counter on the AF output shows 100 Hz.

Conclusion

I tested the FM deviation accuracy of the meter up to 10 kHz using the Bessel zero method. Above 10 kHz I used the HP 8640B signal generator and checked the meter up to 100 kHz deviation. Between the two instruments, the reading agreed very closely. For a practical test I connected a whip antenna to the RF input of the meter and checked a UHF handheld radio for maximum deviation, DTMF deviation and CTCSS deviation. I did not want to get to close to the meter while doing this but it worked fine.

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