Blame it on 'IZO'—the MFJ Antenna Analyzer Dilemma

By Rick Hiller – W5RH

Up on the House Top

So there we were, up on K5IZO's roof on a rainy afternoon, tearing apart the balun coupled feed point of his 80 meter loop. Directly connected to the antenna, we were getting an R (resistive value) of "0" on the MFJ 269 Antenna Analyzer. X (reactive value) read 37. Before hand, I had modeled his loop with EZNEC and found that it was so close to the ground (wavelength wise) that the radiation resistance was pretty low. So, on 160 meters, where we were trying to 'force' it to work, the modeled Radiation Resistance was even lower -- 10 ohms or less.

John (K5IZO) had put up this horizontal loop to get on 80 meters....fitting a large loop like that on the typical Meyerland/ Sharpstown house lot was an undertaking reminiscent of the art of origami....slanting, folding and zig-zagging were the name of the game. So this loop had no purposeful shape or radiation characteristic, it was, known intuitively to be, close to resonance on 80 meters, due to the fact that it had the proper amount of wire.

I had mentioned to John, a few weeks back, that a closed, 1 wavelength long, resonant loop could be used on a frequency that was half of the fundamental frequency (See Notes below). You can use a 40 meter loop on 80, like I do, or use an 80 meter loop on 160, as John wanted to. All you have to do is open it up at the proper point and the feed z obtained on the half fundamental frequency would be "reasonable". You do have to 'tune' the system (antenna and feeder), but it would work. (I do it every Wednesday evening for the Rag Chew Net). Unfortunately, so far this day, John, was questioning my theory....and I didn't blame him...I was questioning my theory too, and I had a "working" 40/80 meter loop.

So, with the MFJ-269 providing a confusing impedance reading of R = 0 and X = 37, and nothing we could do would change it – we quit. With my tail between legs and scratching my head I departed. Down, but not defeated, I trudged onward thru the fog.

Top Banders to the Rescue

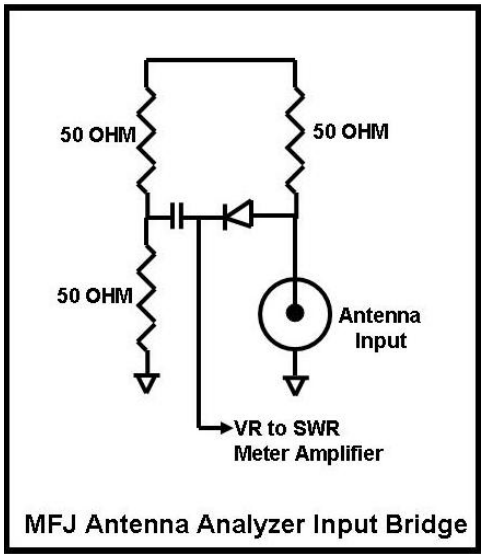
Since this was dealing with 'Top Band' 160 meters, I decided to put out the call for help on the 160 meter Top Band e-mail reflector (contest.com)....back came the answers. "High RF field strength from a nearby offending signal ...most likely an AM broadcast station....was causing the problem". 1.8 MHz is right above the AM band and this IS Houston, with at least one 50 KW AM station (KTRH). This could be causing the MFJ to mis-calculate the R and X impedance values. OK, so without a spectrum analyzer, how was I to know if there was an offending signal and why does this phenomena occur?

Serendipity was in my pocket the day I wrote that inquiry note. W8JI, Tom Rauch, one of the designers of the MFJ analyzers (and a big player on the Top Band) responded. He stated that the MFJ analyzers were not made to function in an environment of, even, medium level RF

signals. The front end detectors of the MFJ were very wideband and would gather many megahertz of RF signals and use them as a composite input into the MFJ's digital computing engine. (Note: MFJ does make a tuneable filter for the analyzer ($100) and you can essentially 'notch out' the offending station, but others warned of the 'effect' of this filter interfering with the actual Z being determined. Tom replied that the filter was designed so that the desired Top Band signals were not affected by the filter, if it was used properly.) Unfortunately, I did not have a filter, nor did I have the $100 for one.

Tom also pointed out another possible problem. The Radiation Resistance we were trying to measure was very low (10 ohms in the EZNEC model) and that this value was at the edge of the analyzer's A to D converter resolution, generating, at that value, only a one bit difference in the A to D output for a fairly wide range of values. MFJ analyzers do better with impedances closer to the 50 ohm value, more commonly seen in RF transmission lines and HF antennas. There are more bits of A to D conversion resolution available at the 50 ohm or higher impedance values, so the calculations will be more accurate.

Back to the high RF signal strength problem, I further asked about indications, if any, on the MFJ, that there was an offending signal. This was easily determined, I was told, by placing the Analyzer in "Frequency Counter" mode (which turns off all internal oscillators) and watching the SWR meter, as the antenna was plugged into the input jack. If the SWR meter needle moved off of 1, then there was an offending signal, with the meter indicating the input's relative field strength by the amount that it deflected up the scale. The SWR meter is driven off of a detector that is directly connected to the input bridge. (see the schematic of a typical MFJ Analyzer input bridge in Figure 1).



MFJ Antenna Analyzer Input Bridge

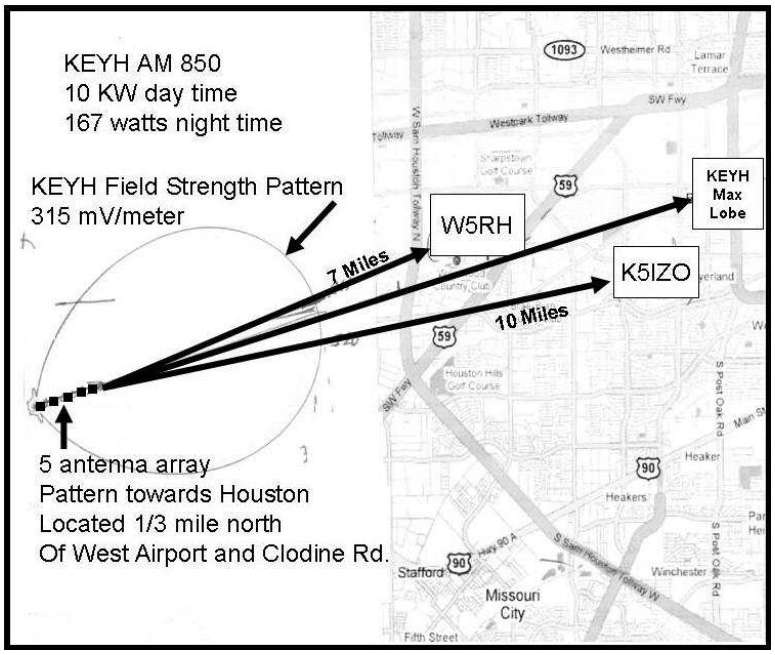
If there is a strong signal on the antenna it will drive the bridge into an erroneous condition and that will be detected and passed onto the SWR meter. Normally the bridge is driven by a low power internal oscillator, which then allows controlled measurement of the bridges condition. (For further measurement theory, read the Radio Amateur Handbook about Wheatstone bridges and how they work).

OK, so a strong AM station screwed up our measurements at IZO's house and you can "see" this offending signal on the SWR meter. I figured if John is under the influence, then I would be too, as he is just 3 miles east of my QTH. I plugged in my 40 meter delta loop, which has a known 90 ohm input impedance at resonance, and BINGO!....the SWR meter went to the half way point...crap! OK, so what or who is the offending signals?

AM Broadcast Information from the FCC

A quick note to the BVARC and HQRP reflectors about AM stations and patterns and power brought numerous responses on AM stations and where to find their location, antenna patterns and transmitter strengths – all on the FCC site. (Pretty cool stuff just to see what AM stations are doing)

It looked like KEYH 850 AM, 7 miles away, was the most likely candidate. See pattern in Figure 2 (a composite of the FCC field strength pattern and a Google map). Note that the main beam of the pattern goes directly across my QTH and is very near John's too. One definite fact was that KEYH 850 AM was 10KW in the day and was 185 watts at night (also found on the FCC web site), so if I timed it right, I could watch (hopefully) the SWR meter reading change when the station went from 10 KW to 185 watts. change Sho'nuff.....the meter does low power when they go to night time, enough to mode, but still is powerful readings on distort the antenna Z my loop.



Solutions

Now, there are a few ways to solve this problem....1) kill the offending signal -- desirable, but not realistic—hi, or 2) use one of the new (and more expensive) Vector Network Analyzers that are available for hams. These are a "driven" type analyzer – meaning that you pump some higher power into the antenna system through the analyzer and it then calculates the feed Z. Some of these VNA's are not affected by out of band or 'off frequency' received signal levels, (See Rudy Severn's reference -- under Notes), or 3) as I showed at the December Home Brew night in 2007, measuring the Z with an active/passive, two step system of using an HF transmitter and antenna tuner to 'get a match' to 50 ohms, then, once matched, pull out the 'tuner', properly terminating it's input with 50 ohms and measure the tuners output Z with the MFJ. This provides the antenna system feed Z 'complement' (on the reactance), but since the numerical value is equivalent, the reading is relevant, just invert the sign on the reactance value. (See QST Technical Correspondence reference under Notes)

Summary

So, the lesson learned is—before you measure anything with your MFJ analyzer, be sure to check the Field Strength of local signals with the simple SWR meter check. (I found that in my garage when I am measuring coax or components that it is not a problem) If you do get an indication, be wary of any impedance readings. You can estimate the feed z of an antenna by modeling or taking an educated guess, so if the impedance R and X values are "significantly" different than what you figure theoretically, then you should use an alternative method of impedance measurement.

One thing I do, even more so now, is to 'dip' the antenna only (not the antenna / transmission line system) with a GDO (Grid Dip Oscillator) to see where the antenna is resonant, then I know that I should get an indication of R plus a low reactance X value at that frequency. I

have done this for years when using a Noise Bridge to measure antennas, just to get me in the ball park, instead of starting in the middle of no where.

Technical Conclusion

I have explained, 2 things were against us...10 ohms was at the low end of the range for the meter itself and the presence of high strength RF inside of the wide band pass of the meter front end. So, when using the MFJ or any other analyzer, these are things to notice in your model, test for when making actual measurements and, hence, definitely avoid.

Personal Conclusion (tongue firmly in cheek here)

The complete exercise of having to find out more about the MFJ Antenna Analyzers and local AM stations patterns was quite painful and is completely the fault of John, K5IZO. If he would not have invited me to model his loop, and then not invited me to bring my analyzer and measure the loop in situ ...none of this would have happened. It means that when using the MFJ 249/259/269 Antenna Analyzer and a strong interfering RF field is present, I will have to go about measuring things another way....causing me more work, frustration and headaches. It just isn't as easy, as it says in the adverts. Arrrrrg! **Blame it on IZO!**

Now, next time K5IZO asks for help, I could say 'no', but knowing the interesting history of "opportunities" presented and outlined above, I will probably say an emphatic "YES". I am always interested in learning new things about this magical RF world we play in. Thanks, John.

73….Rick – W5RH

Notes:

1. This "open loop, dual band loop performance was outlined at the 2008 May meeting in the mini-antenna seminar—"The 5 'Tennas".
2. "Vector Network Analyzer Comparisons" – Rudy Severns N6LF -- http://www.antennasbyn6lf.com/files/vna_comparisons.pdf
3. QST September 2006, Technical Correspondence – "On Tuning, Matching and Measuring Antenna System Impedance using a Hand Held SWR Analyzer" – Dr. John Belrose – VE2CV tuning
4. Should you wish further information on any part of this article, please contact me at rhiller@sdicgm.com . I have a binder full of antenna analyzer articles, mods and hints etc.