N.E.W.S. LETTER

The Publication of the North East Weak Signal Group

November 2008 Volume Seventeen Issue 4

Next Meeting

Presentation by Dr. Gordon H. Pettengill, W1OUN

Early Radio Amateur Moonbounce (Before WSJT)

November 15, 2008

IN THIS ISSUE

Bring Your Items For The Duct Tape Auction

Don't Forget

The North East Weak Signal Group
2 Meter VHF and Above Net
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W1COT, WZ1V or K1PXE Net Control

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Preferably via email with "Newsletter" in the subject line to donw1fkf-news@yahoo.com

The President's Corner

The second weekend of the Microwave cumulative was pretty wild! I spent Saturday on Mt Washington FN44ig with Larry, K1LPS. We had a great opening to FN03 land, working multiple VE3 stations on 10 GHz at ~ 700 km. Larry was working them with his 18" offset dish and 250 mW in sideband! I spent Sunday on Mt. Kearsarge. Activity seemed fairly good, although my 24 GHz contact count was way down from past years

K1LPS on 'The Rock' Mt Washington FN44ig

KT1J and I continue to work on 122 GHz. We still have a heat issue in one of our multipliers. Despite this, I hope to report a successful 8 km contact at our next meeting.

As I'm writing this, the ISS (International Space Station) is going overhead with Richard Garriott, W5KWQ on board. Richard is the son of Owen Garrriott who first made ham radio contacts aboard STS-9. Richard has the SSTV project running. Quite a few images have been captured such as the one I caught below. In the top of the frame is the Soyuz capsule.

AMSAT has set up a photo gallery of the images at http://ariss-sstv.ssl.berkeley.edu/SSTV/

It's so easy today to do SSTV. There's free software and you need nothing more than a soundcard. Richard was also very active on voice. I had a chat with him as he passed over Vermont.

At our last meeting we set the date for several upcoming meetings. They are:

Nov 15, 2008

Jan 10, 2009

Mar 7, 2009

Our annual Conference April 17-19, 2009

The Picnic on July 11, 2009.

We set the July date so as not to conflict with the CQVHF contest that is always held the third full weekend in July. We will want to set the remaining two meeting dates for 2009 so that we can reserve the Storrs Library.

There is a possibility that some new beacons can be located on Mt. Equinox. I'm looking for input on bands that might be useful. If you have any thoughts, we'll discuss this during our meeting.

It's never too early to start thinking about election of officers and BOD seats. With the exception of Mark, K1MAP everyone's term on the BOD is up. Also, my term will be up as well as Mark, KA1OJ Paul, W1GHZ and Tom, WA1MBA. Elections aren't until July of next year, but they're closer than you think!

Dr. Gordon Pettengill, W1OUN will be our featured speaker this month. His talk will be "Early Radio Amateur Moonbounce (Before WSJT!)" Don't miss this one!

Looking ahead to January, Tom, WA1MBA will bring us up to date on his 78 GHz amplifier project. Tom did this presentation at MUD this year so here's your chance to see it if you couldn't make it to MUD.

Finally I'd like to thank Ken for a great presentation on his 2M amplifier. For those that couldn't make it, Steve, N1JFU videotaped the presentation. Thanks Steve! I have it on DVD for anyone who'd like to see it.

73, Mike, N1JEZ

From our Secretary

NEWS Meeting 27 September 2008, Storrs Library, Longmeadow, MA
Next meeting November 15 at the Storrs Library, Longmeadow, MA
Board of Directors meeting convened 1215 at Royal Buffet, Enfield, CT
Agenda for NEWS meeting:
- meeting dates for 2009
- Constitution changes
- NEWSletter ads

Board meeting adjourned 1240

NEWS Meeting , Storrs Library, Longmeadow, MA
Called to order by President, N1JEZ, at 1318
New member KB1LKV welcomed.

OLD BUSINESS
Constitutional Amendments - members have been notified by mail, as required:

Article 6
This constitution or the by-laws may be amended by a 75% vote of the membership present at a regular meeting. Proposals for amendments shall be submitted in writing and shall be voted on at the next following regular meeting, provided all members have been notified by mail, or email, or other suitable clear and effective means of the intent to amend the constitution and ,or by-laws at said meeting.
Motion by W1RIL, seconded by W1TDS - Approved unanimously

By-Laws: Article 7
2. Membership: Full membership is open to all licensed amateurs. Associate membership is open to all other interested persons. Full membership includes all privileges as well as rights to hold club office or board position, and to vote for said positions. Associate membership includes all club privileges except for the right to hold club office or board position, and vote for said positions. Applications for membership shall be submitted in writing, or via email, or by other clear and effective means.
Motion by W1RIL, seconded by W1TDS - Approved unanimously

Meeting dates for 2009:
1/10/09
3/7/09
Conference
Picnic 7/11?

NEW BUSINESS
- Request has been received to run a commercial ad in the NEWSletter, from WD1V for LeCroy. Consensus was that these scopes have amateur applications, so we will accept an ad, in return for Conference prizes.
- NoBARC maintains repeaters on Mt. Greylock. The state is now charging $800 per year, so contributions are requested.

MOTION by W1GHZ to make a $50 donation. Seconded by KA1OJ, unanimous.

TREASURER'S REPORT (by KA1OJ for A1MBA)
- Please pay dues
- Balance $2945

ANNOUNCEMENTS
- the KT1J grid corner operation will be featured in CQVHF
- Thunderbolt GPS units may be available thru Time-nuts group
- A Show-and-Tell session followed, featuring a video of 78 GHz operation.

Meeting adjourned.

PROGRAM
W1RIL described his new 2-meter amplifier using a Russian GI-46 tube.
This started when Ken was stationed on Ulithi Atoll during WW2, with a Loran station. He found an ARRL handbook in the hut, and starting building electronics in his spare time.
The new amplifier is modelled after the W6PO 8877 amplifier, but is smaller since the Russian tube is smaller. Since no sockets are available, Ken also had to make a socket for the tube.
Like all of Ken's work, the construction is beautiful, and the amplifier puts out a solid 400 watts.

N.E.W.S Hats will be available at the next meeting ! $12 each - cash

902 MHz Transverter for the Multiband Rover

Simple and Cheap

Paul Wade W1GHZ ©2008

w1ghz@arrl.net

The original multiband transverter scheme did not include 902 MHz because it did not fit into the common local oscillator (LO) frequency scheme based on a 720 MHz common starting point. However, for a 2-meter IF, the normal LO frequency for 902 is not that much different, near 760 MHz, so eventually it occurred to me that the same LO board might be used with a different crystal. The transverter is similar to the 1296 MHz version except that the filter frequency is changed, of course.

Local Oscillator

The difficult part was finding a standard clock oscillator that would provide a useful IF frequency for 902 and 903 MHz. After considering a couple of possibilities that ended up with an odd, upside-down, IF in the 6-meter band, I settled on 756 MHz. This yields an IF frequency of 146 MHz for 902 MHz and 147 MHz for 903 MHz – a slight inconvenience, but most modern rigs have multiple VFOs and memories. 756 MHz is a simple multiple of 108 MHz, which is a fairly common frequency.

While I had hoped to find an oscillator for 108 MHz, there were none in the Digi-Key or Mouser catalogs. However, there were oscillators available for 36 MHz, one-fourth of 108 MHz. There are two obvious choices for getting from 36 MHz to 756 MHz: either multiply x3 to 108 MHz, then x7 to 756 MHz, or x7 to 252 MHz, then triple to 756 MHz.

I chose the latter combination for two reasons: first, the oscillator square-wave output has plenty of odd-harmonic output even at x7, and second, the LO board was designed with a comb-line filter at 240 MHz – changing to 252 MHz is as simple as changing the tuning capacitors. The hairpin filter at 720 MHz on the LO board is tuned lower than 756 MHz, but some simulation showed that trimming 1/8” off both ends of each hairpin would raise the frequency enough. I hacked up a board, assembled it with a 36 MHz oscillator, and it worked. Of course, there are now spurious responses only 36 MHz each side of the desired output.

What about a combination board? I went back and fine-tuned the hairpin filter dimensions so that it covers 720 to 760 MHz with the normal range of manufacturing tolerances. The revised LO board now works at either 720 MHz or 756 MHz, simply by populating the appropriate oscillator and tuning capacitors for the comb-line filter.

The schematic for 756 MHz is shown in Figure 1; the 720 MHz schematic is unchanged.

The revised LO board with the combination filter works very well, with a 756 MHz output of +7 dBm, perfect for driving a mixer. The spurious outputs at 36 MHz away on each side are at least 30 dB down, and all other frequencies are more than 40 dB down except for a strong second harmonic at 1512 MHz.

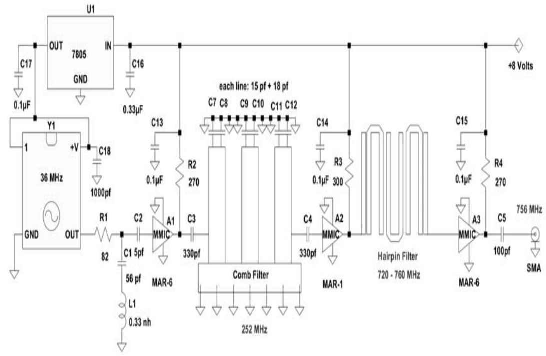


Figure 1 – Schematic of 756 MHz Local Oscillator

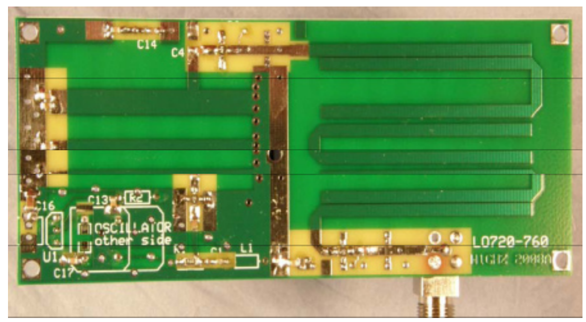
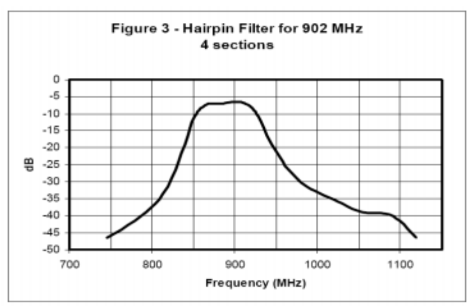


Figure 2 – Revised LO board for 756 MHz



Transverter Board

The transverter board for 902 MHz started with the 1296 design, using the same philosophy, that *gain is cheap*. Since the LO is now at the desired frequency, an LO multiplier and filter are not needed, saving some space on the board. Instead, there is a simple LO buffer MMIC in case the LO output is not sufficient to drive the mixer, which requires +5 to +7 dBm. Since my LO board had enough output power, I used a jumper wire instead of U4. The extra space was needed for the larger 902 MHz filter – there is enough space available to fit a four-section filter rather than the three-section used at 1296 MHz. This should provide more out-of-band rejection, as shown in Figure 3. The LO rejection is about 40 dB.

Figure 4 is a photo of the transverter board for 902 MHz. Construction is straightforward – solder the parts in place. Figure 5 is the schematic diagram of the transverter board. No tuning is needed – mine came right up with 15 dBm output. The output is pretty clean, with the LO around 40 dB down. The biggest spurious output was 27 dB down at 1656 MHz.

I haven't measured the noise figure yet, but I did listen to our local beacon on 903 MHz.

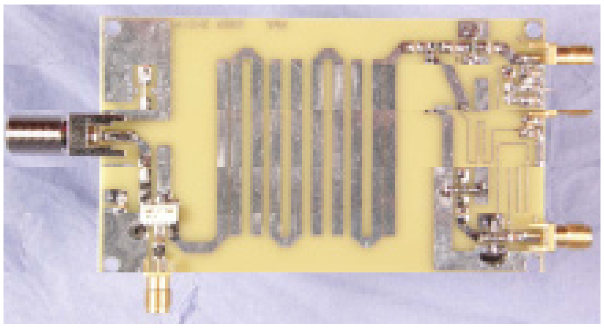


Figure 4 – Transverter Board for 902 MHz

Since the LO input is not tuned, this transverter may be used with other LO frequencies and sources, perhaps a synthesizer if you choose.

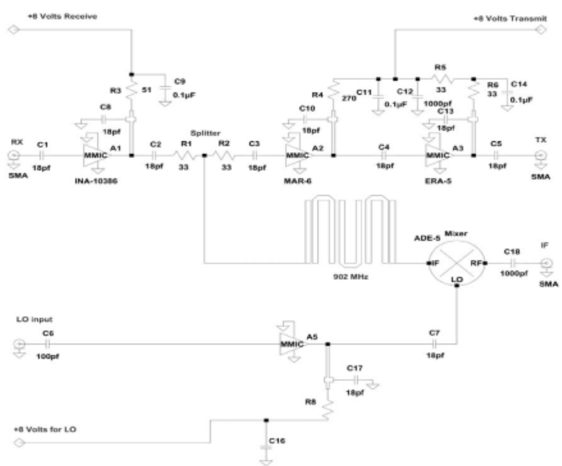
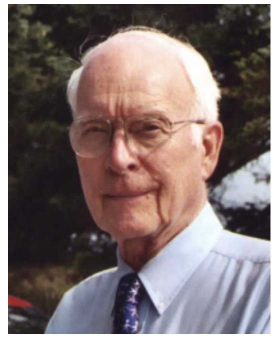


Figure 5 – Schematic Diagram of 902 MHz Transverter Board

Summary

This transverter is intended as a simple, cheap rover rig, and I think it will fill the bill. One advantage it offers is covering both 902 and 903 MHz within the 2-meter IF. For operation with power amplifiers, or near a cell site if you hope to hear anything, real metal filters are recommended. However, while testing this, I compared it to my current 903 transverter, based on an early Down East Microwave board, which I built when I had limited test equipment. I'd say that the simple one is not bad compared to what I and probably lots of others have been using.



Presentation by Dr. Gordon H. Pettengill, W1OUN
Early Radio Amateur Moonbounce
(Before WSJT)

His radio amateur QSL card was sent to confirm amateur radio contacts he made from Arecibo, 1963-1965

Still another version of the Multiband Microwave Transverters boards - a 1296 MHz transverter with low-side LO injection, so it comes out right side up. Also an 1152 MHz LO board, or you could use it with a synthesizer like the apolLO details at: www.w1ghz.org/MBT/multiband.htm

Boards for these and the 902 MHz transverter, as well as the previous ones, are now available.

73,

Paul W1GHZ

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classified ad

Signal Generators:

HP 614A 0.9 to 2.1 GHz $15
HP 616B 1.9 to 4.1 GHz $15
HP 618B 3.8 to 7.6 GHz $15

Sweep Generators:

Wavetek 1801B 0 to 500 MHz $50
has 450 to 950 range, but no output

Systron-Donner 5000A with
plugin 5014 4 to 8 GHz $50

can deliver to NEWS meeting.
W1GHZ w1ghz@arrl.net

73
paul

A x4 Subharmonic Mixer for 24 GHz
Part II

Paul Drexler, W2PED

The first installment of this article gave some background on subharmonic mixers and gave a brief discussion on the mixer theory of operation. This installment will continue by presenting the design of the various circuit networks used in the mixer design.

For clarity, the mixer block diagram is again shown here for reference.

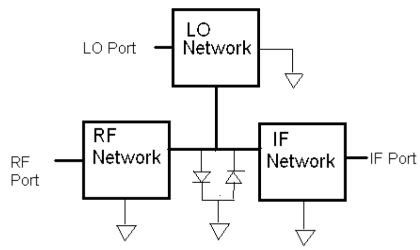


Figure 3 – Subharmonic Mixer Block Diagram

RF FILTER SECTION

The RF bandpass filter is a simple arrangement of two short-circuited l/4 lines forming resonators at 24 GHz. The resonators are directly coupled through another transmission line, which is approximately l/4 in length. All lines are nominally 70 ohms as a 70 ohm transmission line tends to give the best Q for filters. The resulting filter response is a broad bandwidth bandpass response centered at 24 GHz.

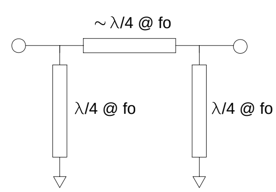


Figure 5 – Basic RF Filter

Next, resonant stubs were added to the filter at the input and output to provide a short circuit response at the LO and 2xLO frequencies. Each of the open circuited microstrip stubs are ~l/4 in length at their respective frequencies, so these essentially look like trap filters at the LO and 2xLO frequencies.

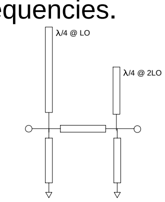


Figure 6 –RF Filter with Stubs Added

The filter section was designed using rough hand calculations and then the first iteration of the design was optimized using the student version of the Ansoft Designer circuit design software[1]. Line lengths were adjusted for best match and insertion loss at 24 Ghz, and best resonance of each trap. The predicted RF filter response is shown in Figure 7. Low insertion loss is predicted at 24 GHz (blue trace), with the LO and 2LO frequencies being highly attenuated (reflected). The second trace (red) shows the return loss at each frequency. The RF filter is designed to have a very good return loss at 24 GHz, and a reflective impedance at the LO and 2LO frequencies.

Note that three discrete attenuation nulls are seen on the plot below, with an unaccounted-for transmission zero at the 3LO frequency (roughly 18 GHz). There is no stub present for this frequency, so where did this come from? The answer is that the longer stub at the LO frequency is an odd multiple of a quarter wavelength at the 3LO frequency as well!

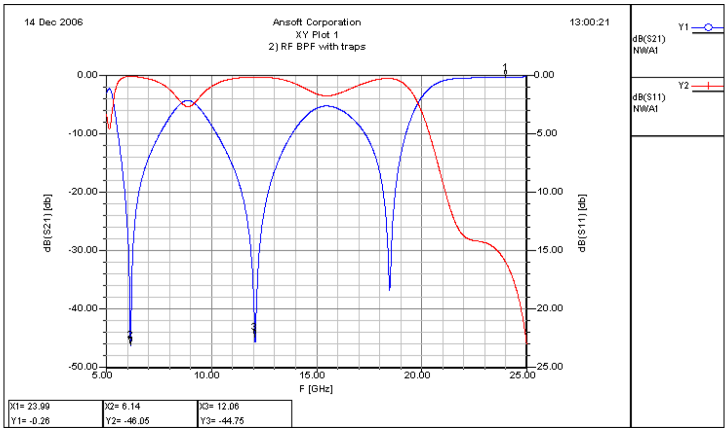


Figure 7 – Predicted Response of RF Filter with Stubs

LO FILTER SECTION

The LO bandpass filter is a simple edge-coupled design made from two $\lambda/4$ lines at the LO frequency. A more complex filter is unnecessary as the LO filter simply has to pass the LO and look reflective at the RF, 2LO, 3LO, and 4LO frequencies. The center frequency was designed for 6 GHz and the bandwidth was made wide enough to cover other possible desirable LO frequencies; in fact the bandwidth is considerably wider than necessary but this helps to ensure that reasonable etching process variations don't spoil the performance. In order to present a 50-ohm impedance match at the filter input/output, the coupled transmission lines need to be higher in impedance and consequently end up being *very* narrow lines. The lines are ideally around 4 mils in width with 4 mil spacing, when made on 10 mil Rogers 5880 material. For illustrative purposes, 4 mils is about the thickness of a sheet of standard copy paper! These line widths and spacing get to be a bit tricky to reliably etch by the board vendor. The author chose to compromise the design somewhat and make the coupled section lines just a little wider and slightly farther apart in order to come up with a more manufacturable design. Of course, this degrades the impedance match, so in order to improve the match; the final filter has two low impedance stubs added at the input/output. As a point of reference, the coupled line section of the filter is approximately 0.4 inches in length.

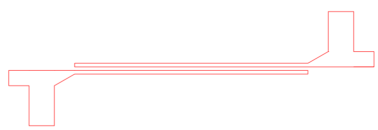


Figure 8 – Layout of Edge Coupled LO Filter

The design of edge coupled filters can be especially troublesome unless the design includes all of the coupling effects, and the best way to do this is to make use of an electromagnetic (EM) simulator. An EM simulation showed that the basic design was shifted in frequency and would have given about a 3 dB insertion loss. With the aid of the EM simulation, the design was adjusted in length to give the desired center frequency.

The predicted LO filter response is shown in Figure 9 below. Insertion loss is under 0.5 dB and the return loss is better than 20 dB according to the simulation. The out of band response is not shown, but the filter is reflective at all the required frequencies.

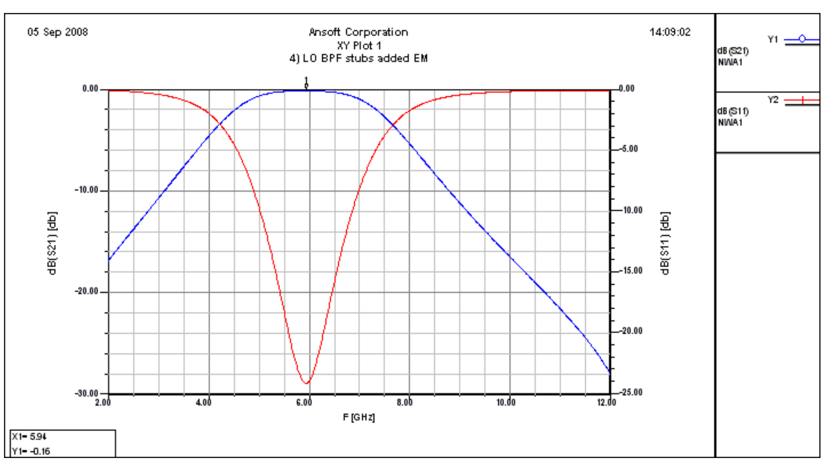


Figure 9 – Predicted Response of LO BPF

IF NETWORK

As mentioned earlier, the IF portion of the mixer is just as complex as the other portions of the design. This network is responsible for injecting the LO energy into the mixer diodes, passing the mixer's desired IF energy, and reflecting the RF, LO, and 3LO energy back toward the diodes. The IF section reflects the RF energy and all LO products back toward the diodes for two reasons:

- To prevent undesired energy appearing at the IF output (i.e. to attenuate the RF, LO, and LO harmonics)
- To reflect all energy other than the desired IF back toward the diodes in order to achieve low conversion loss.

Each of the open circuited microstrip stubs are ~1/4 wavelength at their respective frequencies and can also be thought of as high-Q *idler circuits.* This is not unlike the resonant stubs used in the 432 to 1296 tripler circuits of the past. All of the stub lengths are very sensitive in order to attain best mixer performance. Should a given stub be off by more than a couple of mils in length, the mixer performance will quickly degrade.

It should also be noted that it is no mistake that the high frequency stubs (i.e the RF and 3 LO stubs) are closest to the diodes. This keeps the reflected transmission path of the RF and 3 LO energy to be as short as possible for lowest loss. All of the interconnecting line lengths were optimized for best performance. Perhaps the most sensitive line length is the short line at the left side of the network - the line between the diodes and the RF stub. This line serves as an impedance match between the diodes and the rest of the circuit.

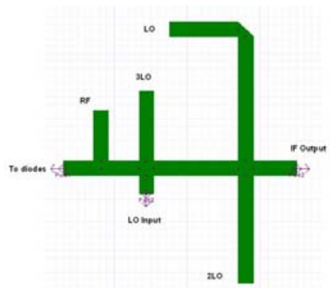


Figure 10 – IF / LO Injection Network

CONNECTING IT ALL TOGETHER

The initial mixer was designed for 10 mil thick Rogers 5880 high frequency circuit board material. The Rogers material was chosen as it has very good high frequency circuit properties including low dielectric losses (loss tangent ~0.0009 at 10 GHz). A 10 mil thick material was chosen in order to keep the transmission line widths a reasonable width considering the frequency of operation. At one point I considered using a 5 mil thick material, but I found that the thinner material would result in *extremely* narrow line widths in the LO bandpass filter, making it un-manufacturable on the thinner 5 mil material.

With the basic design of each of the mixer sections in hand, the next step was to connect it all together and analyze the circuit with the aid of Ansoft Designer, a nonlinear circuit simulator. An LO level of +10 dBm was assumed to start. The initial results were not all that encouraging… the first pass at the mixer design showed an insertion loss of over 20 dB! This isn't all that surprising for several reasons: 1) when connected together, there are interactions between the various networks 2) each of the filter networks were designed to work into a perfect 50 ohm load, and the diodes do not present an ideal 50-ohm impedance and 3) since each of the reflective stubs are high-Q, it was assumed that some optimization would be required.

The next step in the design process was to go back and painstakingly optimize each stub and transmission line length in order to obtain the best performance. This included minimizing the mixer conversion loss and suppressing the output level of each of the undesired signals. Fortunately, the two are more or less related; as each of the undesired outputs is minimized, the mixer efficiency tends to improve. Several key changes gave a much improved mixer conversion loss, and suppression of the undesired signals, while further optimization yielded smaller improvements.

Once I was satisfied with the overall mixer performance as described above, a more accurate EM analysis approach could be implemented. As mentioned earlier, the use of electromagnetic analysis (EM analysis) gives much more accurate analysis results as it takes electromagnetic effects into account including mutual coupling between transmission lines. The downside is that this is a 'computationally demanding' exercise for the PC and it tends to be time consuming. Another issue is that during EM analysis, it is not possible to easily change the design to evaluate the effects of a change, so this makes it an iterative, somewhat labor intensive process. This author had decided that it would be worth the effort to go the extra step and to 'fine tune' the design using the more accurate EM analysis; this would give the best chance of a first-pass success. Additionally, two mixers were designed – one for a 144 IF, and another for a 432 IF.

Figure 11 illustrates the artwork layout of the mixer. The RF input is on the left, LO input at the bottom trace, and the IF is in the right. The mixer length is just over 0.75 inches. The LO filter appears as one solid line unless the view is greatly magnified.

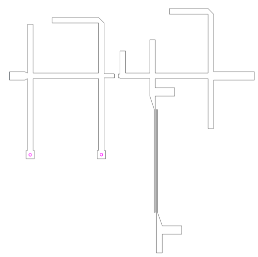


Figure 11 – Prototype Mixer Layout

The analysis plot in Figure 12 shows a predicted spectral plot of the mixer (432 IF version) when analyzed as a downconverter.

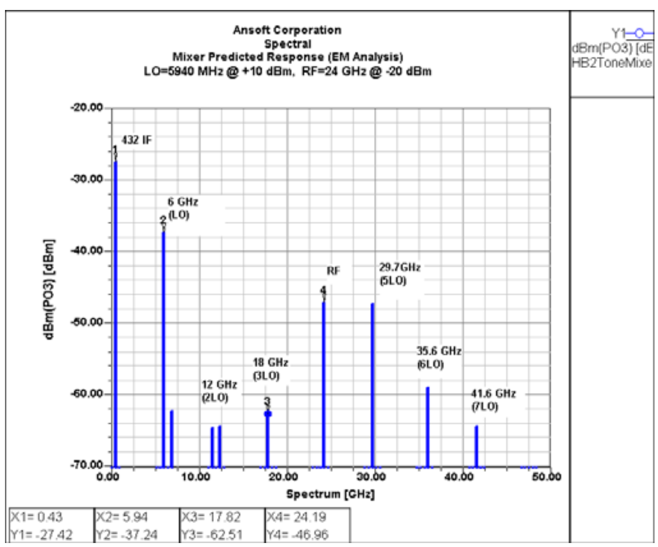


Figure 12 – Predicted Spectral Plot of 432 IF Mixer

For the mixer analysis the 24 GHz input level is at -20 dBm, and the 5940 MHz LO is at +10 dBm. The conversion loss is predicted at ~8 dB and the 6 GHz LO feed through is 10 dB below the desired IF signal level. Since the 6 GHz input is at +10 dBm and a level of –37 dBm is predicted at the mixer's IF connector, this represents some 47 dB of rejection of the LO as measured at the mixer IF. Note that the 2LO, 3LO, and RF signals are also very well attenuated. The 5LO, 6LO, and 7LO responses can also be seen but are not of much concern as they are well attenuated from the desired IF signal.

Although not shown here, the simulated results of the 144 MHz IF version of the mixer is practically identical to that shown above.

[1] Ansoft Designer Student version may be downloaded from: www.ansoft.com

N.E.W.S. Group Membership Application

Name: ________________________________ Callsign: ______________ Grid: _______

Street: ____

City: ____________________________ State: ____________________ Zip: ___________

Phone (home) _____ - _____-_______ Optional (work) _____ - _____-________

Email ____

ARRL member? Y N Electronic Newsletter Delivery? Y N

Operational Bands (circle) 50 MHz 144 MHz 222 MHz 432 MHz 903 MHz

1.2 GHz 2.3 GHz 3.4 GHz 5.6 GHz 10 GHz 24 GHz 47 GHz

76 GHz Light Other (list)

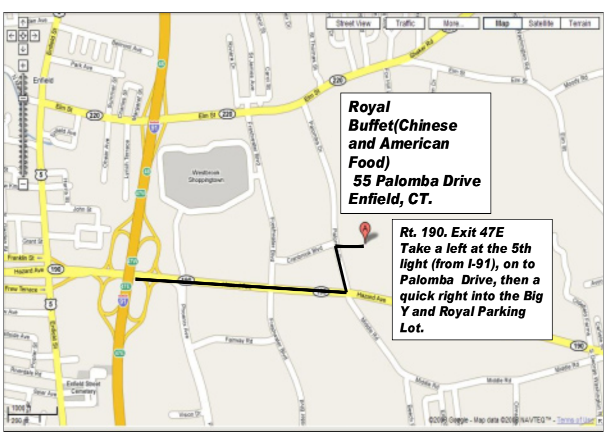
The North East Weak Signal [N.E.W.S.] Group is being established to form a comradery among fellow VHF-UHF-SHF enthusiasts, and support a convenient means to exchange technical information. We currently have 6 meetings per year, held at a centrally located facility, and provide a "NEWSLETTER" that is distributed 2 weeks prior to each meeting. Any contributions to this publication are appreciated and can be sent to: Don Twombly, W1FKF 23 Maura Dr. Woburn, MA 01801 Email: donw1fkf-news (at) yahoo (dot) com. Dues are $15/year. Remember, this group is formed by VHF'ers for VHF'ers.

Mail to:

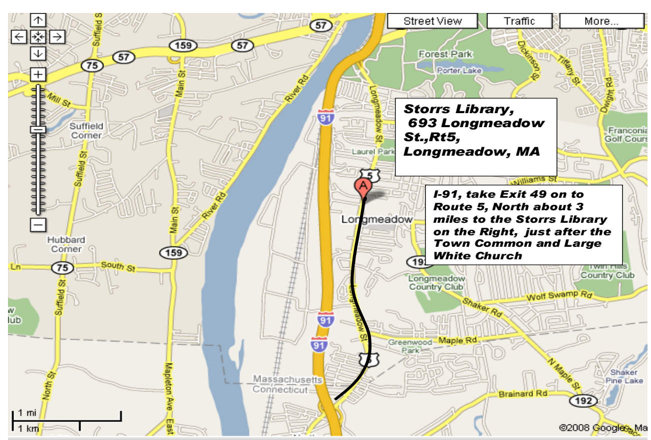
North East Weak Signal Group
c/o WA1MBA
Tom Williams
PO Box 28
Shutesbury, MA 01072

Email: tomw (at) wa1mba (dot) org

ARRL Affiliated Club



Board Meeting and Lunch



Meeting Location

Next Meeting

November 15, 2008

Presentation by Dr. Gordon H. Pettengill, W1OUN

Early Radio Amateur Moonbounce (Before WSJT)

1 PM at the Storrs Library

693 Longmeadow Street, RT 5

Longmeadow, MA

Bring Your Items For The Duct Tape Auction

N.E.W.S Hats will be available at the next meeting!
$12 each - cash (bring some singles please) or check. See Mark, KA1OJ

Don't Forget
The North East Weak Signal Group
2 Meter VHF and Above Net
Every Thursday at 8:30 PM Local 144.250
W1COT, WZ1V or K1PXE Net Control

North East Weak Signal Group
c/o WA1MBA
Tom Williams
PO Box 28
Shutesbury, MA 01072

Check your membership expiration
date on your mailing label!