N.E.W.S. LETTER

The Publication of the North East Weak Signal Group

January 2010 | Volume 19 | Issue 1

Next Meeting January 9, 2010

1 PM Storrs Library
Longmeadow MA

January Contest "rap-session"

+

Duct Tape Auction

Reminder

ARRL January VHF Sweepstakes 23th - 25th

Don't Forget

The North East Weak Signal Group
2 Meter VHF and Above Net

MEMBERSHIP in the N.E.W.S Group is $15 per year. Apply to Tom Williams, WA1MBA.

Email mw(at)wa1mba.org You may download an application from our web page http://www.newsvhf.com/

The President's Corner

Hopefully, the weather will be with us for the next meeting. January in New England is always "iffy" . Start digging around your shacks and grab your duct tape folks as we will have the celebrated Duct Tape Auction at our next meeting at the Storrs Library. Please keep the size below several hundred pounds, and no forklifts allowed. We don't want to be thrown out of our fantastic meeting place at this point when they see what junk gets dragged in..

You all know how it works. You duct tape a fine piece of gear along with a possibly not so fine specimen together and the pair are put up for auction together. I know I have a stash of 5Y3 and 5U4GB rectifier tubes that I have hoarded over the years for that special project that never materialized. Now I can tape it to my retired 1296 cavity amp and have it auctioned off by a skilled auctioneer. You should never underestimate the entertainment value of some of your prized possessions from years ago. It is amazing how times change making our hoarded stash obsolete.. Acorn tubes are out….HEMTs are in.

With the cold weather setting in and the road up the hill to my "shack" closed, I have been working on some projects for next year here at home. I have my K3/ panadaptor running for 10 GHz now and can see 190 kHz. Of bandwidth. I spent some time adjusting gain distribution so as to get good sensitivity on the panadaptor and waterfall displays. It should be great next year for finding wayward dash senders who are not where they think they are.

The January ARRL Sweepstakes s fast approaching. It is time to check out the gear and have everything set for operating that weekend. We will spend some time discussing the contest effort from a club perspective. Feel free to present your plans to the group, so we all are aware of them. The goal is a higher level of club participation., and more fun too.

Thanks to Ed Parsons, K1TR for a very interesting talk last meeting. He really put a fine talk together for our benefit. Being competitive on a mountaintop is not at all simple as we all found out. Thanks again, Ed! If anyone has any ideas for future presentations, please contact one of our club officers.

73 Dave K1WHS

From our Secretary

Minutes of NEWS meeting 14 November 2009
Storrs Library, Longmeadow, MA

Directors meeting: 1240Z

- VHF Conference Apr 16-18
- MUD October 2011
- 900 MHz band plane
- Mt. Mansfield upgrade

President K1WHS called meeting to order 1316Z

Next meeting January 6, 2010, Storrs Library, Longmeadow, MA

Introductions:

Treasurers Report: 82 paid members, 13 permanent, 19 have not renewed yet

- Eastern VHF/UHF Conference Apr 16-17
- 2011 Conference & MUD Oct 2011
- Meeting dates for 2010 were approved

No Old Business:

New Business :
- K1MAP - new transatlantic reflector on qsl.net

A Show & Tell session featured:
N1DPM - BLF578 NXP LDMOS KW amplifier ($400 device)
N1JEZ - Mt. Mansfield TV TX upgrade
WA2AAU - 2.3G amp conversion
W1GHZ - directional coupler
N1EKV - Toyota Prius inverter 25kw
K1AE - GPS distribution amplifier, SMA relay
WW1M - 4 band radio controller www.K1XM.org

PROGRAM:

K1TR - Tale of Two Mountains
VHF Contesting - Mt. Wachusett and Mt. Washington

From our Treasurer

Not much news from the treasurer. A few membership dues and one new member came in since the last meeting. I'm sure there are a few more out there who intend to pay their dues but have not yet. As far as I know I have contacted every overdue member and warned them that if I don't receive dues in time for this NEWS Letter, they will be removed from the database. On a more positive note, and as you will hear at the next meeting, the club funds are in good shape. See you in January.

Tom WA1MBA

Waveguide Slot Antenna – Update 2009

Paul Wade W1GHZ w1ghz@arrl.net

Dan Welch W6DFW

The waveguide slot antenna spreadsheet in the *W1GHZ Microwave Antenna Book – Online* has been used to successfully calculate dimensions by a number of hams. Some of them have reported having to trim, but few of them were made with enough precision to be sure.

Sometime in 2005, Petr Kauler (kauler@volny.cz) suggested that I had made an error in the spreadsheet calculations, in the slot offset in cell G36. The formula used is

=(WG_a/PI())*SQRT(ASIN(New_Y))

While the correct form based on the equation should be:

=(WG_a/PI())*ASIN(SQRT(New_Y))

The difference in results is pretty small, and furthermore, previous versions of slot antenna spreadsheets by others had used the same form, so I figured it was close enough.

Remember that some of the other numbers in the spreadsheet were found by eyeballing graphs in old papers, so they aren't accurate to six decimal places.

Earlier this year, Dan Welch, W6DFW, reported that he had built some 24-slot versions for 10 GHz using a precision CNC machine. These accurately machined antennas, calculated for 10.368 GHz, were centered at about 10.220 GHz.

I changed the formula in the spreadsheet, and Dan made an antenna with the new, slightly different, dimensions.

Dan measured this one as centered at 10.331 GHz, with about 20 dB return loss and about 200 MHz bandwidth, so it is good with no tuning.

He sent another copy to me. It is a thing of beauty, and I have confirmed the results.

The corrected spreadsheet is now at www.w1ghz.org/antbook/slotantenna.xls and http://www.qsl.net/w/w1ghz/antbook/slotantenna.xls

The small difference in dimensions should not affect the antenna performance, only the return loss, so you don't have to throw away your old slot antenna. For those who made them with a drill and a file, there shouldn't be any difference – and I respect your ham spirit for getting the job done with what you have.

36th EASTERN VHF/UHF CONFERENCE:
APRIL 15-17, 2010
CROWNE PLAZA HOTEL (860)-741-2211
1 BRIGHT MEADOW BLVD. (OFF RT.5)
ENFIELD, CT 06082

For Sale:

Vacation & Ham Radio Real Estate in Plainfield, MA FN32mn. Waterfront property on Crooked Pond, 2+ acres, cabin. This is on a pond located in a very slight depression between the high hills in the Berkshires. It is one of the headwaters of the Westfield River and everything flows downhill from here. The 1745 amsl elevation at lake level makes this 1/2 mile long body of water one of the highest elevation ponds in the Berkshires. If you want to satisfy your Ham location (HF&VHF) craving and make the whole family happy with water, trail, skiing, snowmobile, hunting & fishing activities from your doorstep, this is the place. It's at least 10 degrees cooler than Hartford, Boston, or New York City on a hot summer day. Borders KMD State Forest. Windsor and Savoy State Forests are within 1 mile. 11 miles nearly LOS to Mt. Greylock, and easily worked on 10GHz.

Mark Casey, K1MAP

A 6 GHz Synthesized Local Oscillator For the W2PED 24 GHz Subharmonic Mixer

Paul Drexler, W2PED

Microwave Update 2009

INTRODUCTION

The author has presented a subharmonic mixer design for 24 GHz. A Subharmonic mixer uses a lower frequency LO that is a sub-multiple of the normal LO input frequency. The unique feature of the mentioned mixer design is that it is based on a **x4** LO scheme, or requires an LO that's ¼ of that required for a standard type mixer, giving the advantage of simpler LO hardware. This is especially helpful in getting on a higher frequency band like 24 GHz. A synthesized 6 GHz LO is described here as a companion to the 24 GHz subharmonic mixer. The LO is locked to a 10 MHz reference; it uses the N5AC ApoLO-32 synthesizer followed by a frequency multiplier designed by the author

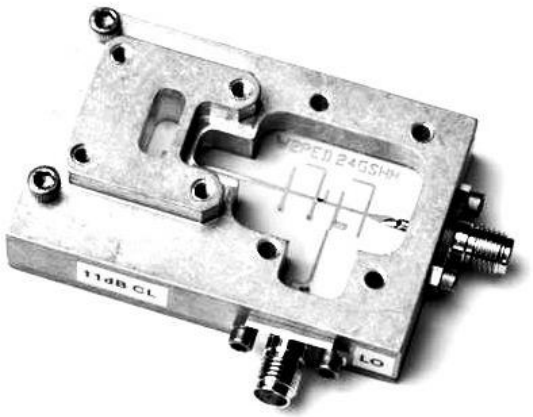


Figure 1 – W2PED 24 GHz Subharmonic Mixer

apolLO-32 SYNTHESIZER

Steve Hicks, N5AC has done a wonderful job designing a versatile and user-friendly high frequency synthesizer that operates in the 750-1300 MHz frequency range. The synthesizer is an outgrowth of his USB controllable ApolLO-1 design and is intended as a replacement for the Down East Microwave MICRO-LO board. The board has over 50 preprogrammed frequencies that are user-selectable by choosing the appropriate several solder bridges. Among the internally programmed frequencies are several LO frequencies useful for the 24 GHz application for both 24048 MHz as well as 24192 MHz. The apolLO-32 board is shown below; the user-selectable pads may be seen at the right side of the board.

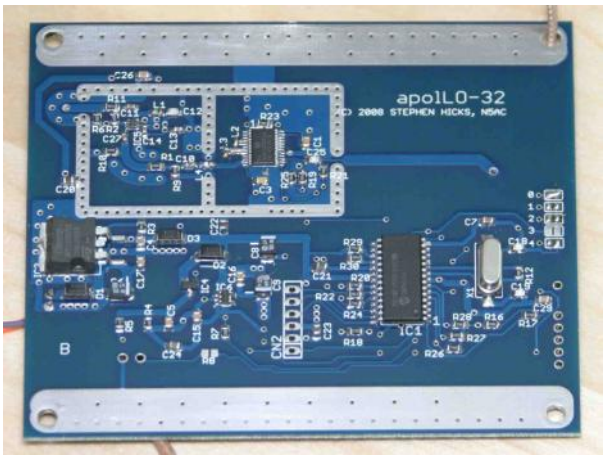


Figure 2 – N5AC apolLO-32 Synthesizer Board

More information regarding the apolLO-32 synthesizer may be found on the N5AC web site. Boards may be purchased from the N5AC web site as well as through Down East Microwave.

PI attenuator changes for N5AC board:
Change R11 (series R) to 22 ohms
Change R2, R6 (shunt) to 180 ohms.

LO BLOCK DIAGRAM

The overall block diagram of the local oscillator is quite simple. The apolLO-32 is locked to an external 10 MHz input. It's output is then multiplied x6 using a frequency multiplier board (described later). The LO output frequency is in the range of ~ 6 GHz as determined by the operating frequency and the chosen IF frequency. For clarity only round numbers are shown .

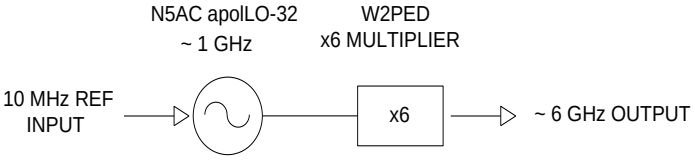


Figure 3 – 6 GHz Synthesizer Block Diagram

AVAILABLE FREQUENCY SCHEMES

A number of 24 GHz frequency schemes are available using the apolLO-32 internally programmed frequencies. The math is best illustrated by example; the case of a transverter using the subharmonic mixer operating at 24192 MHz with a 144 IF is illustrated below.

Subharmonic Mixer LO = (24192 –144) / 4 = 6012 MHz

Multiplier Input Frequency = 6012 / 6 = 1002 MHz

In this case, the mixer requires an LO of 6012 MHz. Since a x6 multiplier precedes the mixer LO input, the apolLO-32 needs to generate a frequency that's 1/6 of 6012 MHz, or 1002 MHz.

The currently available frequency schemes for operation at 24048 and 24192 MHz (low side injection) are shown below.

RF Freq	IF	LO Input
24048	144	996.000
24048	147	995.875
24048	432	984.000
24048	435	983.875

RF Freq	IF	LO Input
24192	144	1002.000
24192	147	1001.875
24192	432	990.000
24192	435	989.875

X6 FREQUENCY MULTIPLIER

Others have described MMIC frequency multipliers extensively in the amateur literature and Down East Microwave has effectively used them in a number of designs for the "No Tune" transverters. Anyone who would like to learn more about the use of MMIC amplifiers for frequency multipliers should get a copy of Jim Davey, WA8NLC's article published in the late 80's. I just recently read (re-read) Jim's article and I probably could have saved myself a little time and effort had I done so sooner!

In this application with an output at 6 GHz, I considered using a MMIC as a x6 multiplier. Although the efficiency is poor with the higher order multiplication, in this application the filtering is fairly easy. Since the multiplier input frequency is at ~1 GHz, the nearest undesired multiples of 1 GHz will be at 5 GHz and 7 GHz (a bit easier than trying to filter out something 540 MHz away!). A 5-section microstrip edge-coupled bandpass filter looked to be a good choice to provide adequate filtering. A Mini-Circuits ERA-2 MMIC was chosen for the multiplier stage based on the fact that its gain response is fairly good past 6 GHz. The block diagram for the x6 multiplier chain is shown below.

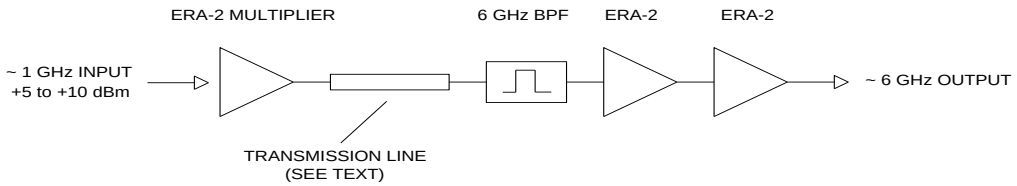


Figure 6 – x6 Multiplier Block Diagram

The board material I chose for this design is 30 mil thick Rogers 4350; I like this material as it's a good low loss high frequency board material but much lower cost than the teflon type boards.

This board is considered a laminate substrate and looks and feels very similar to standard FR-4 / G-10 type board material except that it has an off-white appearance. Since this is essentially a "hard board," the PC board houses have an easier time processing this material, which also helps to keep the finished board costs more reasonable.

A 5-section edge coupled band pass filter was designed for the multiplier board. The measured filter response is shown below. Insertion loss is less than 3 dB and the return loss (not shown) is 15 dB. The filter needs to work over the 5900 to 6012 MHz bandwidth in order to cover all of the possible 24 GHz LO schemes. The measured response is centered at 6 GHz and has sufficient bandwidth to cover our needs for the multiplier application. The bandwidth was designed to be a little wider than necessary so that any etching tolerances at the board house wouldn't ruin our filter response. Note the undesired signals at 3, 4, 5, 7, and 8 GHz should be attenuated by many dB!

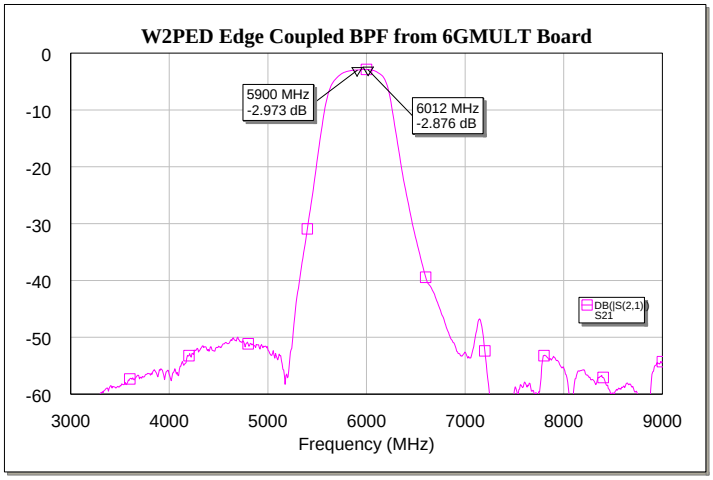


Figure 7 – Measured Response of Edge Coupled BPF

It was found that the multiplier stage works best with an input signal of ~ +5 to +10 dBm. Increasing the RF input level past +10 dBm results in greatly increased spurious signals and no increase in output energy at 6 GHz. In fact, if the RF input is continued to increase, the output level actually *decreases*. The multiplier chain (like most multipliers) is drive level sensitive.

INITIAL PERFORMANCE

Several prototype multipliers were built using the above filter design and the ERA-2 MMICs. Initial results were pretty good – with +5 to +10 dBm input, the high frequency output was +8 to +10 dBm. The MMICs were biased at their recommended bias point of 40 mA; no attempt was made to further optimize the circuit performance with DC biasing. The spectrum analyzer however, showed that there were undesired spurs present at ~250 MHz away from each side of the desired output signal. The spurs were in the neighborhood of -35 dBc. I tried a number of things to improve the spur levels including input drive level, additional tuning (shunt C at various points) and various external filters at the multiplier input. I was able to tune a number of boards to have spurs on the order of -40 dBc. While this was probably "good enough for amateur work" I really wasn't happy with the spurious performance and the amount of tuning time required on each board.

IMPROVEMENTS FOR SPURIOUS

During a conversation with Steve Kostro, Steve reminded me that the 1989 article by Jim Davey indicated that the multipliers "work best" with a transmission line added between the multiplier circuit and the band pass filter. I couldn't find my copy of the mentioned article, but started to think about this a bit. Around the same time I also saw an old HP App note that included a transmission line after a Step Recovery Diode multiplier, but made no mention as to why. After mulling over the situation, I realized that the fundamental energy at the MMIC multiplier output was likely the culprit to the undesired spurious levels; the fundamental level at the output of the device is probably *at least* 10 dB above the x2 and x3 energy and many more dB above the desired x6 energy. The BPF is reflective out of band and looks like a short or open circuit anywhere outside of the 6 GHz pass band; all of the fundamental energy was being reflected back to the device output and causing who-knows-what additional distortion inside the multiplier device. The mathematical possibilities of these products were almost mind-boggling!

I next built up a prototype MMIC multiplier by itself, along with a separate BPF, both with SMA connectors. When various cable lengths were inserted ahead of the BPF, it looked like a quarter wavelength transmission line at the fundamental frequency greatly improved the spurious output. It seems that the fundamental energy is undergoing a 90˚ phase shift, reflecting off the BPF, undergoing a second 90˚ phase shift, and arriving back at the device output 180˚ out of phase.

This is illustrated . Since the amplitude and phase relationships are likely not 100% perfect, the cancellation is limited but the net effect is that the close-in spurious signals are all but eliminated and the next closest spurious energy at 5 GHz is now down 50-55 dB from the desired. The experiment showed a 15-20 dB improvement over the original lineup.

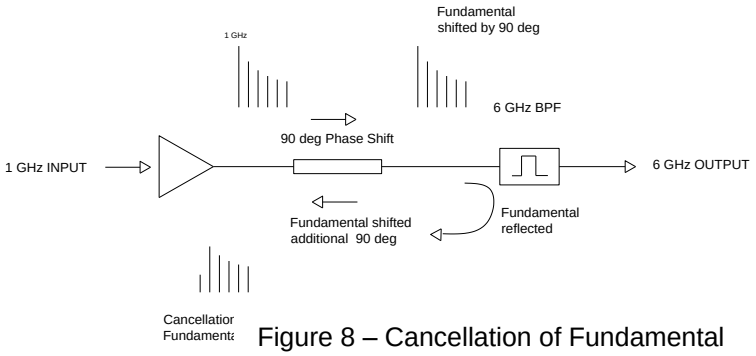


Figure 8 – Cancellation of Fundamental Energy

Once I proved out the relationship with coaxial lines, I repeated the experiment using a microstrip line. The final board layout incorporated this length and also allowed provisions to shorten the line length by a small amount. In practice, I found that a small capacitor (2-3 pF) placed to ground along this line provided a helpful phase adjustment. In addition to improving the spurious signals, the desired signal actually *increased* by several dB over the case where no additional transmission line was used. This is apparently due to the reflected energy improving the efficiency of the multiplier circuit. Jim's article and an HP App note discuss this phenomenon. Perhaps the greatest benefit from all this is that the revised multiplier boards are now *much* easier to test and tune and are very repeatable.

A spectrum analyzer plot of the final multiplier circuit is shown The RF input was at 1002 MHz at +10 dBm. The 6012 MHz output measures -12 dBm. The worst-case spurious signal at 4 GHz is now -45 dBc. All others are improved to better than -50 dBc… more than sufficient for our mixer local oscillator!

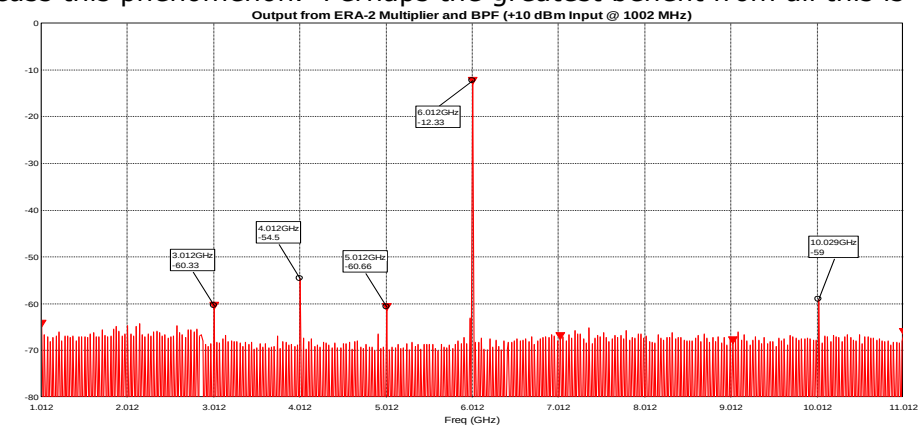


Figure 9 – Output of MMIC Multiplier with Transmission Line and BPF

The assembled multiplier is shown. The input is at the lower left, and the output at the upper right. The MMIC multiplier stage can be seen at the lower left adjacent to the SMA input connector. A serpentine microstrip line forms the quarter wavelength line prior to the band pass filter input. Additional gain stages are seen following the BPF.

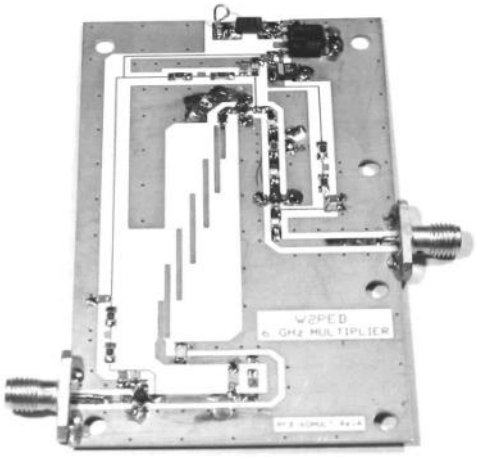


Figure 10 – Assembled 6GMULT Board

The last plot shows the complete multiplier chain as seen on a spectrum analyzer. The center signal is at 6012 MHz; power output is +9 dBm with +10 dBm input at 1002 MHz. Some low level spurs can be seen at 4, 5, 7, and 8 GHz; the worst offender is at 4 GHz and is ~55 dB down from the desired. The spurious response has been improved even further due to the shunt C "phase tweek" capacitor. Note that the close-in spurs seen on the plot are from the signal generator being used. While the plot below illustrates performance at an output frequency of 6012 MHz, similar results are obtained with the other frequency schemes. The assembled 6 GHz LO using the apolLO-32 synthesizer gives nearly identical results to those shown.

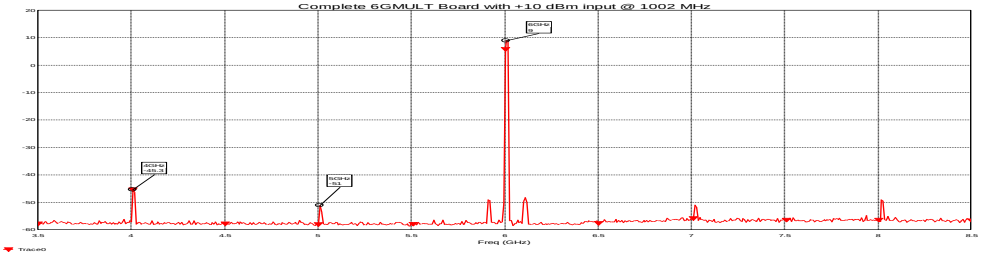


Figure 11 – Spectrum Analyzer Plot of Assembled 6GMULT Board

The assembled 6 GHz LO is shown below. The boards are packaged in one of the housings available from DEMI. A connector for the 10 MHz reference input is on the rear panel, and RF Output and lock indication is provided on the front panel.

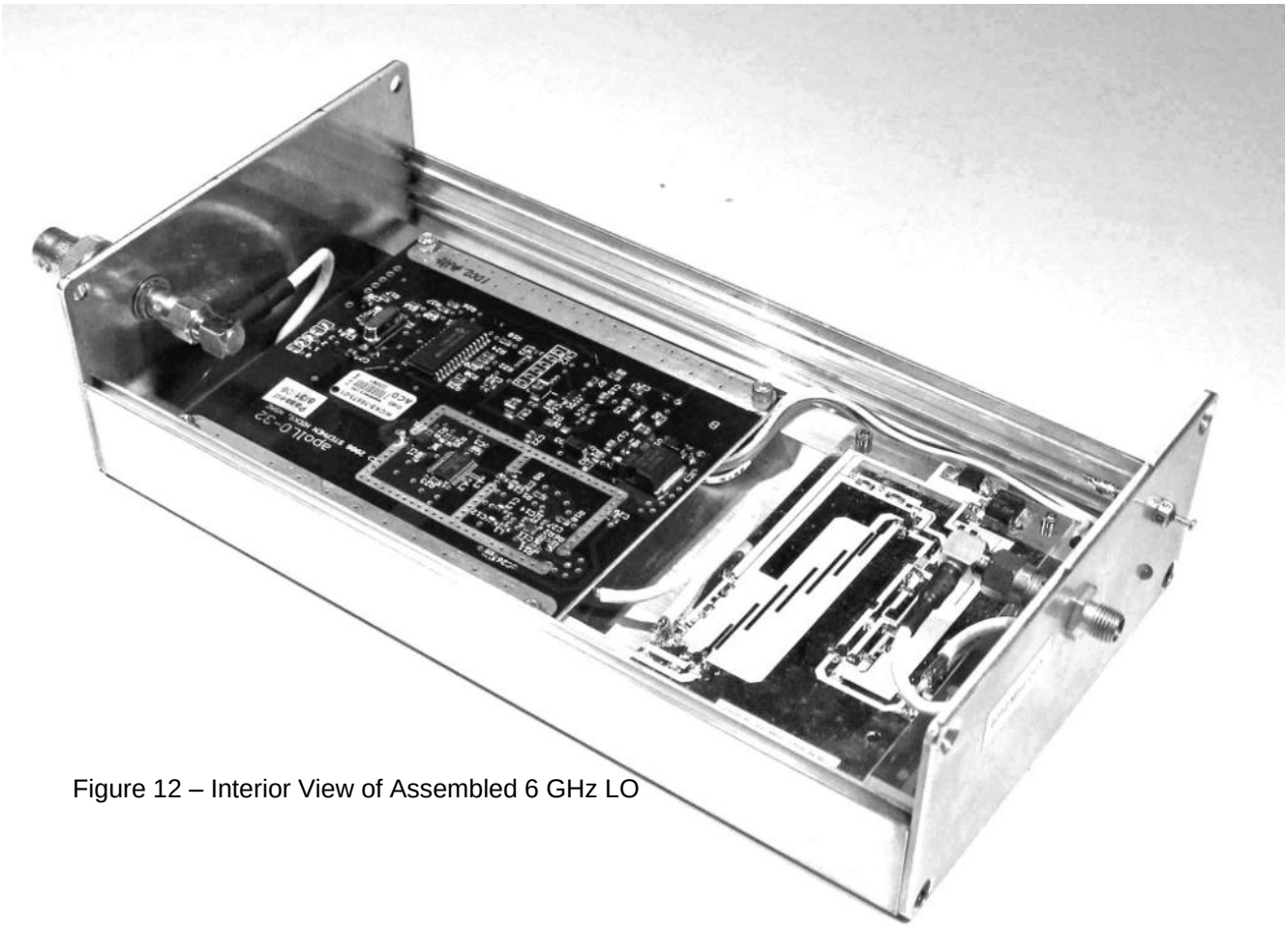


Figure 12 – Interior View of Assembled 6 GHz LO

CONCLUSION

A synthesized 6 GHz LO has been designed as a companion to the W2PED 24 GHz subharmonic mixer. The author is providing complete LO assemblies as well as multiplier boards for those who may be interested.

73, Paul Drexler w2ped paul@w2ped.com

P. Drexler, W2PED, "A x4 Subharmonic Mixer for 24 GHz," Proceedings of Microwave Update 2008
S. Hicks, N5AC, "A USB Programmable High Stability LO for Microwave Transverters," Proceedings of the 2008 Southeastern VHF Conference.
www.n5ac.com
www.downeastmicrowave.com
Jim Davey, WA8NLC, "Frequency Multipliers using Silicon MMICs," Proceedings of Microwave Update 1989
"Step Recovery Diode Multipliers," HP App Note AN920
"Comb Generator Simplifies Multiplier Design," HP App Note AN983

2010 North East Weak Signal Group VHF CALENDAR:

Tentative 2010 dates:
January 9, 1PM - 4PM - N.E.W.S. Group Meeting
January 23-25, 1900Z-0359Z - ARRL January VHF SweepStakes
March 6, 1PM - 4PM - N.E.W.S. Group Meeting
April 5?, 1900-2300 Local - 144 MHz Spring Sprint
April 13?, 1900-2300 Local - 222 MHz Spring Sprint
April 16-18 - Eastern VHF-UHF Conference
April 21?, 1900-2300 Local - 432 MHz Spring Sprint
April 22, ????Z - Lyrids meteor shower
April 23-24 - Southeastern VHF Society Conference
April 30-May 1 - New England Amateur Radio Festival - Deerfield, NH
May 1?, 0600-1300 Local - Microwave Spring Sprint
May 8?, 2300Z-0300Z - 50 MHz Spring Sprint
May 14-16 - Dayton Hamfest
June 5 - Rochester NY RARA Hamfest
June 12-14, 1800Z-0300Z - ARRL June VHF QSO Party
July 10, 11AM - 4PM - N.E.W.S. Group Picnic
July 17-18, 1800Z - 2100Z - CQ Worldwide VHF Contest
August 7-8, 1800Z - 1800Z - ARRL UHF Contest
August 12, ????Z - Perseids meteor shower
August 21-22, 6AM - 11:59:59PM - ARRL 10-GHz & up Cumulative Contest
September 11-13, 1800Z-0300Z - ARRL September VHF QSO Party
September 18-19, 6AM - 11:59:59PM - ARRL 10-GHz & up Cumulative Contest
September 20?, 1900-2300 Local - 144 MHz Fall Sprint
September 25-26? - Mt. Airy VHF PackRats Conference and Hamarama
September 28?, 1900-2300 Local - 222 MHz Fall Sprint
October 2, 1PM - 4PM - N.E.W.S. Group Meeting
October 6?, 1900-2300 Local - 432 MHz Fall Sprint
October 15-16? - New England Amateur Radio Festival - Deerfield, NH
October 16?, 0600-1200 Local - Microwave Fall Sprint
October 21-24? - Microwave Update
October 23?, 2300-0300 UTC - 50 MHz Fall Sprint
November 13, 1PM - 4PM - N.E.W.S. Group Meeting
November 18, ????Z - Leonids meteor shower
December 14, ????Z - Geminids meteor shower

HamCation[sm] 2010

Thought I'd list this, as it is at a convenient time for many of us that visit Florida during the winter. It's a large flea market, usually at least half the size of Dayton. Saturday is the day to come. The Florida Weak Signal Society (FLWSS) has a meeting. And, there is a large group of VHF-UHF-Microwave ops that all set up near each other in the outdoor tailgate area. Usually at least a couple of NEWS members join in. So, if you have plans to be in Florida in Feb, please join us.
February 12, 13, 14 Thanks, Mark K1MAP

http://flwss.net/http://www.hamcation.com/
http://www.hamcation.com/

N.E.W.S. Group Membership Application

Name: _____ Call sign: _____ 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 camaraderie 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, W 1FKF 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.

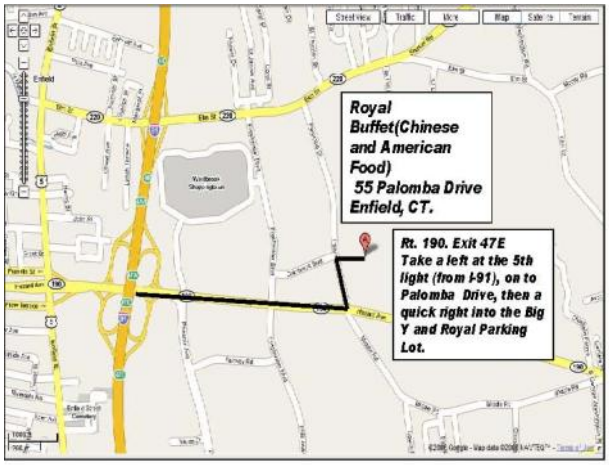
Mail to:

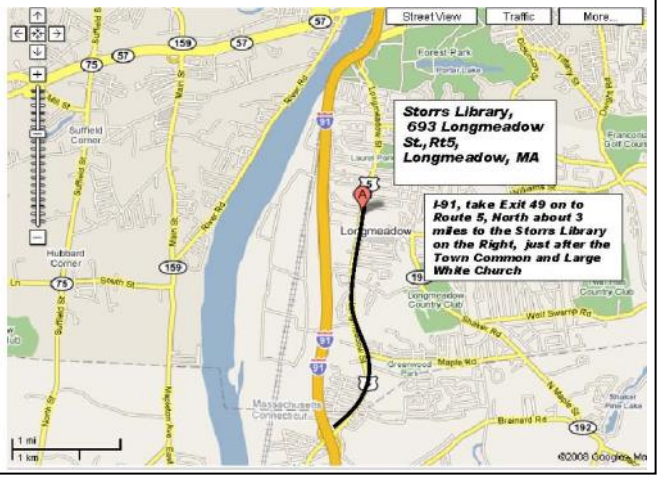
North East Weak Signal Group

c/o WA1MBA Tom Williams PO Box 28

Shutesbury, MA 01072

Email: tomw (at) wa1mba (dot) org **ARRL Affiliated**





Duct Tape Auction

1 PM at the Storrs Library
693 Longmeadow Street, RT 5
Longmeadow, MA

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!