Multiband VHF/UHF and Microwave Transverters Revision C

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PREFACE:

Revision A and B of this paper were published and presented at the SVHFS conference in late April and at the CSVHFS conference in late July of this year. Rev C of this paper will be presented at the 2018 Microwave Update conference in mid October. The reasoning for the different Rev's is because changes have been made in circuit design and components that will be utilized in the final design. This paper is to report on the progress that has been made towards the final architecture and final physical design of the proposed Multiband transverters. This paper will also address the latest changes to the design that have developed though new component availability. As of this writing, the "complete" final design has not been prototyped or tested as a complete assembly but individual circuits have been built and tested to verify that a circuit board will exist in the near future for both designs. Now, a brief review is in order.

Beginning In 2009, I published and presented various papers related to the multiple uses of the N5AC A-32 and VHF ApolLO synthesizers. Some papers described how to utilize both designs to produce a standard weak signal source to aid in receiver checking for sensitivity and frequency calibration. Other papers described how to upgrade older transverters by replacing the crystal based local oscillator in the VHF/UHF region or to replace the complete 1GHz crystal based frequency source in a microwave transverter. The reason for all of this was because this synthesizer was one of the first units that had acceptable phase noise through the microwave regions after frequency multiplication. This prompted ideas with experimenters in that they could use one single frequency locked microwave source with its instant frequency changing abilities to drive multiple transverters in a multiband system. This concept was driven by pure economics when upgrading more than one older transverter.

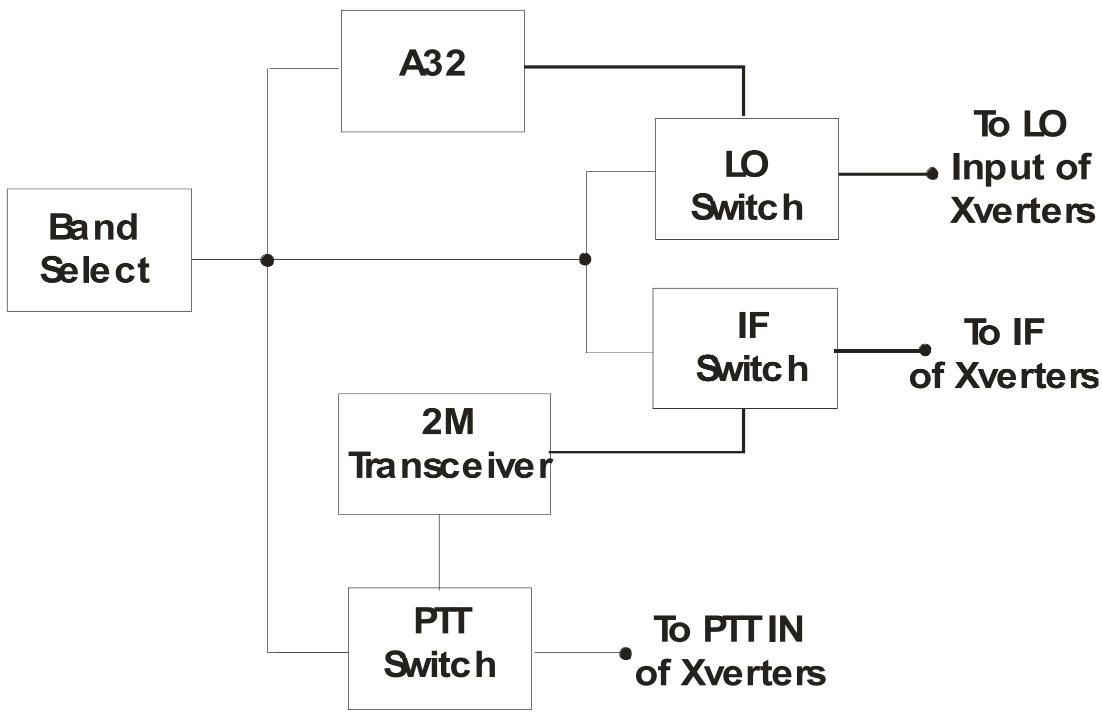
It was at this time we considered a standalone commercial multiband transverter but because of factors such as simple wideband amplifier components, small physical sized filters and the requirement of frequency multipliers to generate Local Oscillator frequencies higher than the 1 GHz range, the task became difficult to justify because of physical size, economics, and complexity within one unit.

The Rev. A paper and presentation described the breakthroughs in technology in frequency mixers, amplifiers, both power and low noise, filters, and Microwave frequency synthesis that have now become economically "Ham Friendly" allowing the production of future multiband transverters. Rev. B described the various components that were selected and discussed the reasoning for their use and demonstrated a complete feasible design on paper with preliminary testing to verify individual circuits and design concept. Rev C. further elaborates on tested circuits and introduce changes entered into the design because of past design failure, cost, or recently developed products.

RELEVANT REVIEW:

As presented in a previous paper written in 2009:

The economic implementation of an A-32 synthesizer is to incorporate one A-32 synthesizer with multiple transverters. Your system may already have a multiband IF switch to select individual transverters connected to your single 2M transceiver. This switch may also incorporate the PTT signal lines. What if this same switch chose the operation frequency of the A-32 and directed its output to the correct transverter. Using the A-32, this could be implemented with 7 microwave transverters 900 MHz. through 24 GHz. resulting in a more economic and compact physical design.

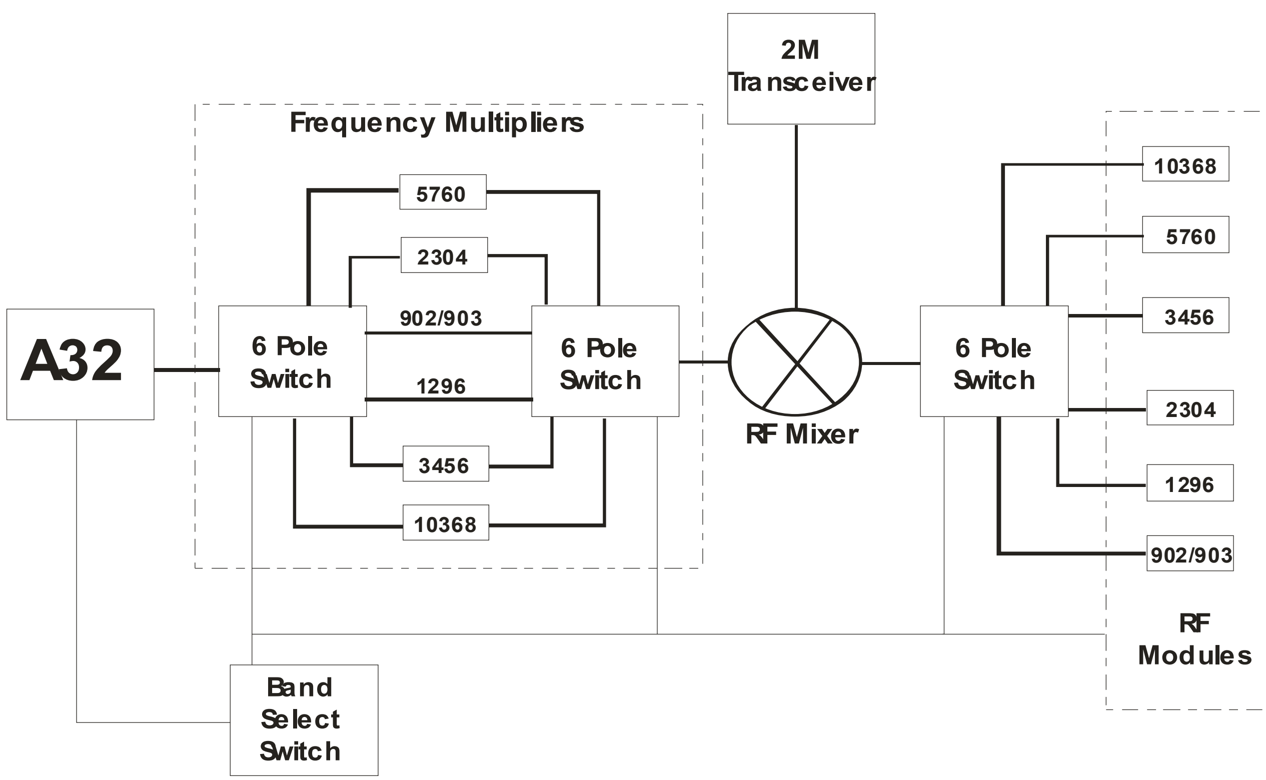


A multi-poled wafer switch or computer interface could control the actual band switching. The only other item added to your system would be a multiple position 1 GHz RF switch and a single A-32 synthesizer replacing six/seven crystal based oscillators. Since the RF output level of the A-32 is around +5dBm, you could build a single pole multiple throw PIN diode switch to switch the A-32 signals to the LO inputs of the transverters. In any case, you would eliminate all oscillators in the existing transverters. This would eliminate warm up times and stability problems. It will also allow you to shut down the transverters not in use to save battery power during portable operation. In fact, installing an extra pole of switching to power the transverter "ON" when that band is activated could be utilized to further save battery power. There is no need to keep the transverter warm when using an A-32 synthesizer.

The block diagram of 2009 assumes all transverters (commercial or home brew) being utilized can be modified in a way to accept a 1 GHz input frequency range. In theory, most commercial microwave transverters can and therefore the assumption is, no matter what transverter(s) you have, with some thought and some work, the idea could be accomplished simply by paying attention to details.

However, if you were to be so motivated to “Home Brew” a microwave transverter system utilizing a single frequency selectable Local Oscillator, it would be more economical and space saving if you were to base the design on a single frequency Mixer eliminating the converted frequency (the IF frequency of choice) switch but would need to include a switch for the separate frequency multipliers per band to input to the mixer. Then, a switch to separate the RF frequencies (the separate bands) would be required. This RF switch would normally be handled by the separate transverters, but now, if all is incorporated into one unit, it would be done on the RF side of a single mixer. Again, as presented in a previous paper:

The future implementation of the A-32 synthesizer or a future project with the A-32 may be something like shown in the next block diagram. A single A-32 synthesizer and a single mixer that operates from 900 MHz through 10 GHz. are the main features of this future transverter. Between the A-32 and mixer is a pair of single pole, 6-position PIN diode switches that select the correct frequency multiplier stages (not required for 900 and 1296 bands) as the frequency selection of the A-32 is made. The “IF” port configuration of the mixer, once set, would never change as the bands change unless it is desired.



A third 6-position PIN diode switch is utilized on the RF port of the mixer to switch the low-level band dependant TX/RX RF Amplifier/Filter sections. A simple 6-band low-level transverter of 10 mW and respectable noise figure could be designed to fit into a small single enclosure. This would then make it possible for the operator to add higher-powered (1-10 watts) /lower noise figure TX/RX/Filtered modules one at a time or design and build their own as the operator saw fit to increase their operating fun and as economics allowed them. Higher-level single band modules could be provided as stand-alone or "plug-in" RF units if an enclosure was properly designed.

For now, there a few items preventing this from happening. An economical wide band mixer covering 900 MHz. – 10 GHz. is not yet available. ***(April, 2009)*** *It may be possible to stretch the frequency limits of some mixers on the market now but I have not had a chance to try any as of yet. Designing the frequency multiplier/filter circuits for 4 bands (remember two bands are bypassed) on one circuit board should be a simple task. Each circuit would only be powered up when that band is switched on. This also assumes that the A-32 will operate in a wider range (750 – 1152 MHz) than now specified. Testing has been done to provide the A-32 for 33 cm operation and it will not be a problem in the near future.* ***Bottom line is simplifying the frequency source will change the future of transverter design. (July 2009)***

Since 2009, many changes in technology have occurred and most for the betterment of the Amateur Radio Hobby. It is now possible to obtain wide band frequency mixers, wide band MMIC transmit power greater than a couple of miliwatts and wide band MMIC Low Noise Amplifiers, economically. These three items alone potentially improve the economics, size and performance of a low level multiband transverter design. What has been stopping the development was the requirement of the frequency multipliers and switches to complete the correct frequency mixing scheme. This would require a direct frequency output of a Local Oscillator circuit or Synthesizer that could switch frequencies as the bands were changed. This coupled with narrow band pass filtering on the RF frequencies would complete the list of components required to consolidate the previous block diagrams.

THE MULTI-BAND TRANSVERTE DESIGN CONCEPT:

To design an efficient multiband transverter, band sensitive components need to be limited to filters only. Band switching is then accomplished with simple PIN diode switching by placing the correct filter in line with the common Mixer and Transmit-Receive gain stages. This switching can be manual or set up to follow a band decoder input from a Transceiver or computer system of choice. This switch would also select an auxiliary output signal to control switching functions of any external equipment such as additional power amplifiers, receive preamplifiers and relays, DC or RF. The PIN diode switch has now become the latest most significant change in the REV C design.

A single mixer design is very important eliminating LO power dividers or switches and to conserve board space. All gain stages need to produce near equal gains on all desired bands within the transverter or external equipment and adjustments will be required. The transverter would also have all transceiver interfacing included such as abilities to separate TX and RX IF lines, provide attenuation of the input transmit signal from a standard transceiver and have certain safety features to protect the transverter and auxiliary equipment connected to it. Remember we are converting a common 10M or 2M transceiver in to a multiband Microwave transverter.

Then, because of the possibility of damage to LNA's or Power amplifiers, any RF stage comprised of new era machine soldered components will need to be modular. This process has been tested in past DEMI products and has satisfied customer needs. Simply un-plug the bad and plug in the new! This also allows for easy change of obsolete components or upgrading to a better product in the future.

Rev B determined that two separate multiband transverter designs should be produced. A microwave version will start at 900 MHz. Because of available inexpensive "MUX" chips that could be replaced by hand soldering if damaged, 6 bands would be the easiest to implement. Then because of the additional use of the 13 and 9 cm bands for satellite and EME operation and international band plans, a seven band microwave transverter starting at 900 MHz would include 1268 ,1296, 2300, 2400, 3400 and 3456 with each frequency segment requiring its own narrow band filtering. The 6CM band could be enabled but the available filters have band widths too wide for transverter operation. If AUX filter positions are designed into the transverter, it could become a complete microwave transverter through 10 GHz as components became available. One Rev C update was that an auxiliary RF port will be included to send a "Pre-Mixed" signal to a separate 5, 10 and 24 GHz add on transverter that will also be a multiband device. The will require a 8 separate bands of switching for complete operation and will be discussed in detail in the presentation

A VHF/UHF product covering the bands between 2M and 23 cm could be very simple and economical to do if the helical type filters could be eliminated. SAW type filters below 70 cm with low insertion loss are difficult to find but inroads are being made with ceramic type chip filters on 144 and 222 MHz. Then adding 902/3 and 1268/1296 MHz in this design would create an overlap in designs with the microwave transverter. The filtering could be a hybrid design of SAW and L-C type filters if kept as a low level transverter (100 mw) It may also be possible to include 50 MHz for a 6-7 band set or include a break out to send a signal such as 144 MHz to a multiband microwave transverter or a premixed higher frequency signal such as 1296 to a 10 or 24 GHz transverter. This transverter design is completed and waiting for the PCB board layout. The reasoning for the wait is that since the major expense of a project like this is the mechanical enclosure, we desire to produce one enclosure to fit both boards. The VHF/UHF circuit board will be smaller in size but we intend to include a 1 watt power amplifier in that design that will require some additional heat sinking. Also included will be a provision for an external output port of the desired band such as 2m, 70cm or 23 cm to be utilized as an IF for higher band microwave transverters. The final theory being a short stack of transverters that operates from 6M through 24 GHz from a 28 MHz IF transceiver if desired.

THE DESIGN:

Listed next are the five key items that have been addressed to complete the designs. We will discuss them individually explaining the factors that either promote or prohibit their utilization with the multiband transverters.

NARROW BAND FILTERING

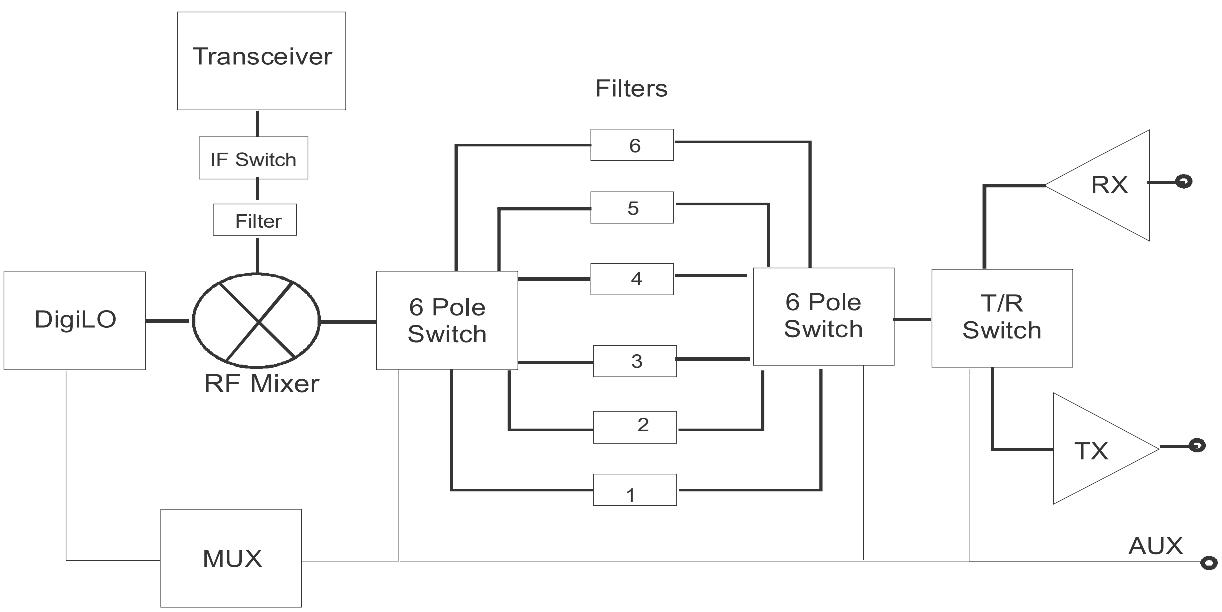
WIDE RANGE FREQUENCY SYNTHESIZERS

WIDE BAND FREQUENCY MIXERS

WIDE BAND MMIC TRANSMIT AMPLIFIERS

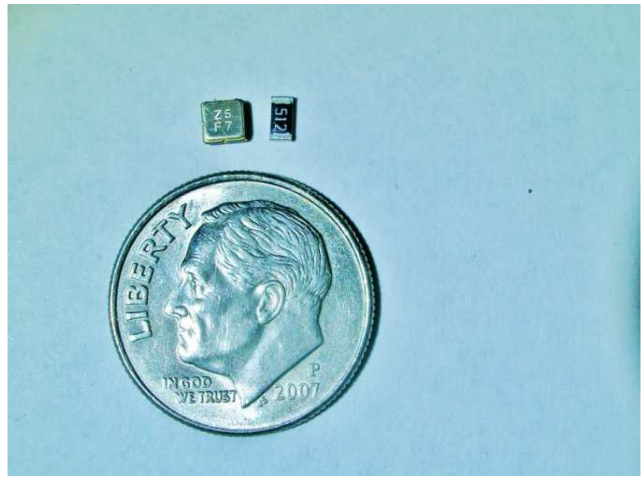
WIDE BAND MMIC LOW NOISE AMPLIFIERS

Examine the block Diagram below. This is the latest purposed basic multiband transverter design we are working with. As far as operation frequency, you can plug in anything you want in the LO and filter positions 1-6.



Understand the 6 positions shown above is a random number. The Rev C transverters will utilize 8 pole switches adding an AUX positions to allow the end user some flexibility and provide a RF port for other higher band transverters. Also understand that the design would be catered to the weak signal enthusiasts of the bands dictating the frequency of operation and range of the transverter's operation. Satellite and EME bands along with options for some international bands will be included in the designs since the filtering will be narrow as desired with a weak signal transverter.

NARROW BAND FILTERING:

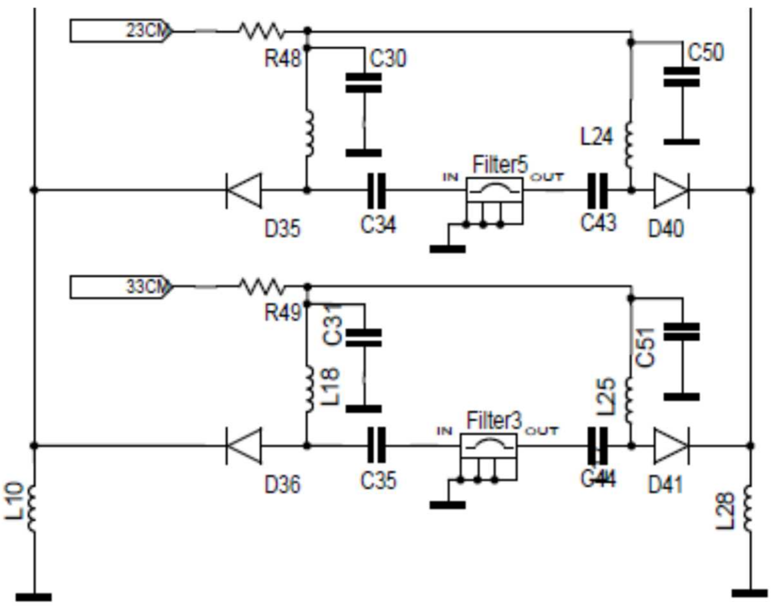


The introduction of SAW filters many years ago brought us designs centered on the “IF” bands of commercial receiving equipment. They were designed to pass very narrow band widths and exhibited large amounts of insertion loss making them unacceptable for amateur radio usage. Recently SAW, BAW and Ceramic filters technology has evolved enough in order to produce narrow band low loss filters through the microwave frequency regions as high as 6 GHz. The newer SAW technology has reduced attenuation in the pass band while improving the bandwidth and selectivity. They are also becoming almost economical to custom order specific frequencies. The only drawback of SAW filters is their physical size. The large ones measure 3 mm square. One is pictured above referenced to a 1206 chip resistor and a dime. The filters have six pads that solder on the bottom and require wave soldiering for best performance. Fortunately, their low cost of standard filters allows for mass assembly. We have been utilizing SAW filters for the 23 and 33 CM bands in LNA’s and separate band transverters. They work Great as the data shows. Our testing shows that SAW’s may be utilized economically and performance wise for frequencies between 70 and 12 CM, and we are still pursuing their use above and below.

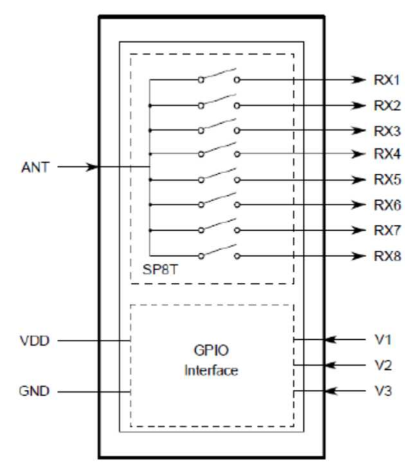
At VHF regions, a good helical is hard to beat but the latest in ceramic chip technology has engineers looking at the cost advantage vs. the expensive and size of helical designs.

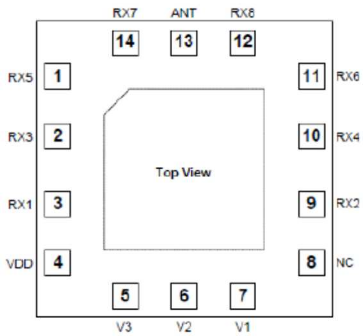
A VHF/UHF multiband transverter would provide 144, 222, 432, 902 and the 1296 Bands all converting to the 10 Meter IF region. The options or AUX positions that could be added are the 50 MHz band and the 24 CM Satellite uplink band at 1268 MHz. Because of the narrow bandwidth of the SAW filters, the 23/24 CM band will require a separate filter for 1268 and 1296 MHz that would provide 5-6 MHz of usable bandwidth. Filtering can be accomplished to cover the whole 2M and 1.25M bands with lump or helical type but on 70cm, a 4 -5 MHz bandwidth SAW would cover both the Weak Signal and the Satellite band. The entire 33 CM band can be utilized with standard ISM band filters that are available. This would enable a 6 band transverter. Then individual bands can be switched in and out of the RF path utilizing simple PIN diodes and circuitry as shown in a section of the general Rev B schematic below.

A Microwave transverter design utilizing a 2 Meter IF, starting at 902 MHz, is logical and provides overlap with the VHF/UHF design. It would include the two filters for the 23/24CM band and include filters for both the 12/13 CM bands for 2300-2320 and 2400 MHz. On 9CM both 3400 and 3456 would be provided with Ceramic filters. The concept of implementing the 5 cm band in this design has been dropped for the idea of including it in a future multiband 5, 10, and 24 GHz design mostly because of a drop in quality of filter required for the 5 CM band. The newer ISM band filters are too wide for Amateur use offering less performance than a single pipe cap filter. An AUX position will be added to the multiband design to enable an RF port to exit the transverter to be utilized by a different transverter. This will be discussed in the presentation of this paper.



What is new in the REV C design is that recently, various chip manufactures are producing economical multi-pole RF switches that will replace many components on the circuit board and minimize the amount of board space required. If the Rev B design (only two switched filter circuits shown above) was to be manufactured as a 6 band design, it would require 12 pin diodes, 14 chip inductors, 24 chip capacitors and 6 resistors just to switch the filters in and out of the circuit, This is approximately $9-10 worth of components and board space with routing to provide signal to switch the circuits.

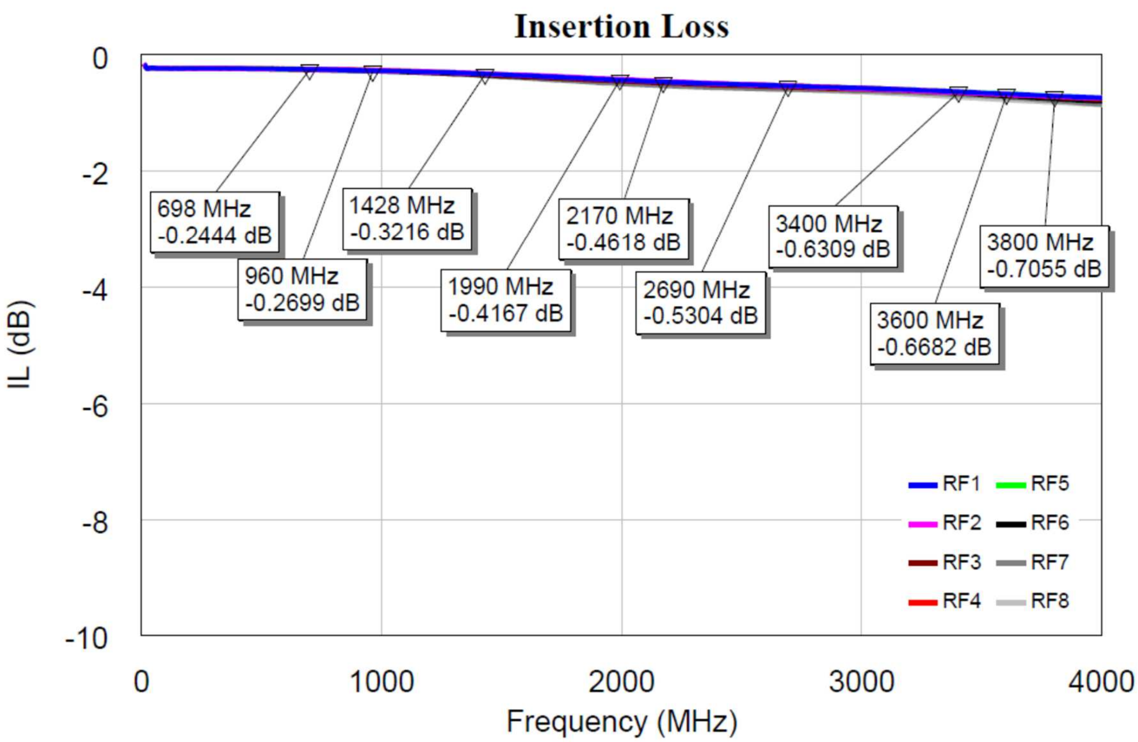




With Rev C's design, it is all replaced with two 50 cent IC's that measure between 2 and 3 mm Square or almost ½ the size of a single 1206 chip capacitor! This is a Win-Win!

These RF switch chips are available as antenna diversity switches and can be ordered in many different configurations and poles. The one shown here (schematic and chip pin out) is an 8 pole unit and would most likely be utilized in the multiband microwave transverter. But 10 and 12 poles are available!

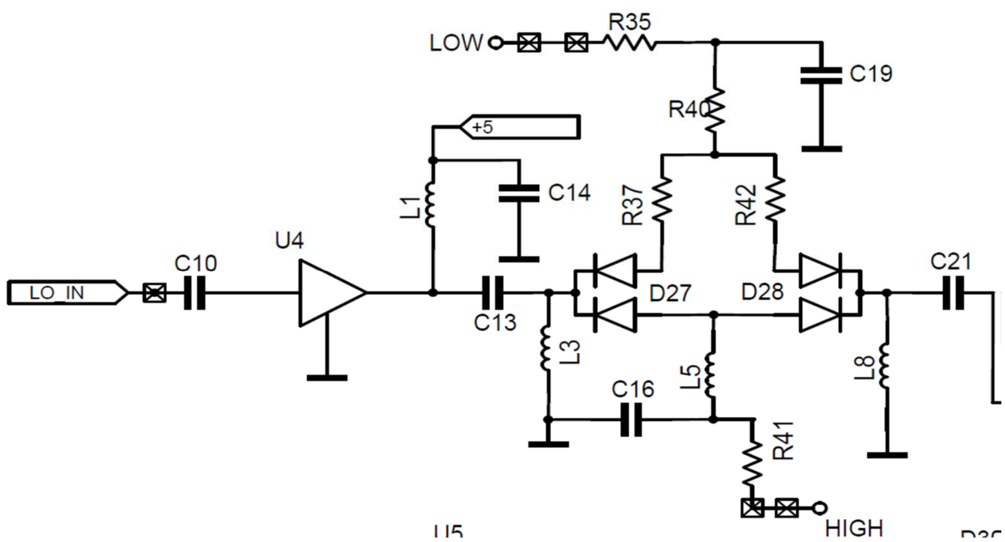
Below is a graph showing the insertion loss of all ports to the common connection. Many designs also incorporate high isolation techniques but 20 dB would be plenty for a filter switch. Then a simple SPDT switch will be employed to combine the TX and RX amplifiers to the filter section of the transverter.



WIDE RANGE FREQUENCY SYNTHESIZERS: Without frequency agile synthesizers in accuracy, range, and constant output power level, a commercial multiband transverter would not be feasible because of simple economics. If a Local Oscillator source for a microwave transverter requires frequency multiplication to obtain the correct mixer injection frequency, it adds cost to the final product and increases the size of the circuit board. If Separate frequency multipliers per band were required, it would make the final design cumbersome in size and costly with many components with only a single use. Band switching schemes become complicated and tune up and

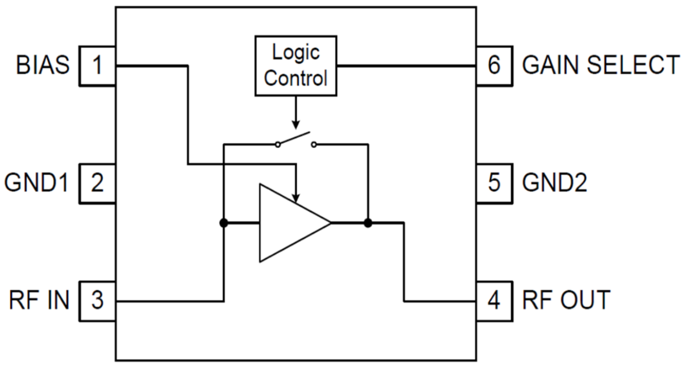
adjustment would be time consuming driving the final cost up further. Then factor in the "More components, less reliable" issue and you now have a product that may be past the economical amateur radio enthusiast's price point for an extra complicated product.

With a frequency synthesizer such as the Q5 Signal DigiLO pictured on the left, direct frequencies can be generated to support transverters from the 6M band through the 5 cm band without frequency multiplication. This eliminates many costly components, saves boards space, eliminates test and alignment time and will simplify a multiband transverter design. This type of design will provide higher reliability while lowering final cost vs. multiple single band transverters that would produce the same results. Plus, it can be accomplished in a package much like the size of a single mono-band transverter. The availability of the new DigiLO is the single driving force of the multiband transverter design and this ongoing work has been a proving ground for the DigiLO providing important data for improvements such as phase noise and spur reduction that's has been implemented with every revision.



The one issue the DigiLO has is the output power rolls off at higher frequencies. To eliminate this problem and to deliver a consistent LO drive level to the Mixer, an Amplifier that acts as a buffer/amplifier would be inserted between the two. This will then have an additional switchable attenuation circuit that would ensure the correct drive level per band of operation. This circuit is show above. When the LOW is biased, the PIN diodes switches in the "T" pad attenuator. When the HIGH is biased, no attenuation is in line.

The above was a fun circuit to design to prove out but its complexity will be replaced with a simple MMIC (depicted to the left) that is an amplifier with a built in By-pass switch. So, U4, C10 and C13 in the above schematic would remain in the circuit



and the extra 3mm square MMIC would operate in the bypass mode on all bands except for 9 CM to provide a correct LO level for the Mixer. This was another aspect of the Rev C update. This MMIC is a LNA by design but has a P1dB of +27 dBm or so. With this performance, one can assume there may be other uses for this same component and will be discussed in the presentation of this paper.

WIDE BAND FREQUENCY MIXERS:

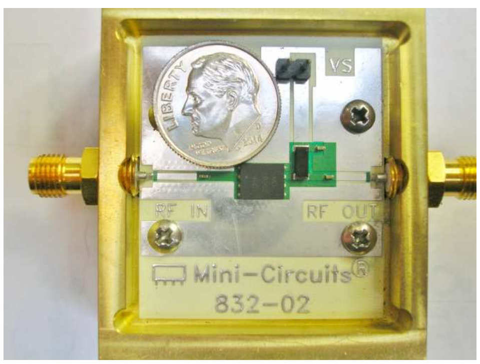
Many component manufactures now offer Frequency Mixers with octaves of bandwidth on both LO and RF ports, great port to port isolation, low insertion loss and produced in many different packages at different LO drive levels. That was mouthful but it describes what is now available and very economically by many different manufactures! The most complicated part of picking a mixer that operates between 1 and 10 GHz is deciding what size of package is desired in the final product and how it is to be soldered on to the board. Most are hand solder-able and a unit of that type will be chosen. The only major specification that is important is LO-RF port isolation. This spec in combination with a good RF filter will keep the LO leakage through the mixer from being amplified and transmitted. This is an easier task compared to past transverter designs because of the more selective filtering.

The VHF/UHF transverter would employ same type of High level mixer of standard issue that has been utilized in many transverters produced in the past. And again, because of the simplicity of the RF filter design, LO-RF isolation is very important if a one watt transverter is selected to be manufactured. The addition of a filter or two to eliminate the problem is possible but additional RF switching would be required and would complicate the design. This issue cannot be stressed or tested enough before the actual production of a product starts.

WIDE BAND MMIC TRANSMIT AMPLIFIERS:

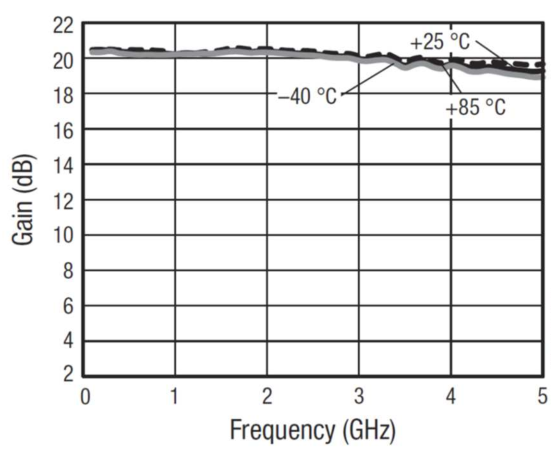
MMIC's **(**monolithic microwave integrated circuits) were first introduced to Amateurs in the mid to late 1980's. (Yes, over 30 years ago!) The 90's brought us higher frequency (DC to 6GHz) amplifiers with greater than +10dBm outputs and a minimum of 13 dB of gain with the result of improved packaging. MMIC manufactures today have mastered small surface mount designs that can only be attached to circuit boards with pick and place machines. Then with chips and die bonding, the Terahertz bands are now the limits. But that is not within the scope of this project.

Recently, MMIC's designers have taken a step back and produced simple SOT-89 packaged MMIC's (yes, you can hand solder them!) that operate up to 2 watts of output power through 6 GHz with very simple L-C surface mount matching components. But these components make the "designed MMIC" frequency specific. However, bandwidths have been extended at lower power levels that easily cover 50 MHz through 4 GHz so, 100 mw with flat gain from 900 MHz through 3.5 GHz is available and yes, still a hand solder able component.



RF circuit board designers that now rely on machine assembled circuit boards can select economical linear 1+ Watt broadband MMIC's that will operate with a very flat gain response. A sample of one is shown to the left in an evaluation circuit. This Power Amplifier MMIC can be utilized in a multiband transverter covering all bands from 6M through 23 cm producing 1 watt of linear output with a flat gain not exceeding 15dB if the filtering is maintained. This component will be utilized in the VHF/UHF transverter either as a an option or as standard product.

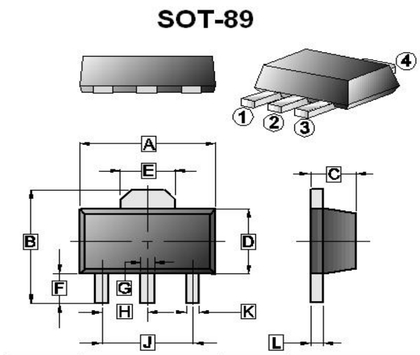
Other MMICs are available for higher frequency ranges and with minimal matching elements, they will maintain gain flatness from 900 to 3500 MHz. Gain flatness takes a drop off above 4 GHz for the hand solderable types. To achieve gain flatness through 6 GHz. requires machine solderable packages but include the latest developments of efficiencies with PHEMT technology. Up to 1 watt of output power is now accomplished with 2mm square sized chips! And more developments in output power, frequency range and gain flatness are on the horizon. But these 1.5 - 2mm physical sized amplifiers with 8 exposed pads to solder and one pallet on the underside would offer the greatest challenge to the casual kit builder or to repair. If this type of amplifier was chosen,



it would need to be preassembled and offered as a modular assembly for ease of replacement or upgrade. Higher frequency MMIC’s at 1 watt power levels are available that operate at wide bandwidths between 6 and 24 GHz and are economical in price for what they do. They will be found in a high microwave transverter of the future.

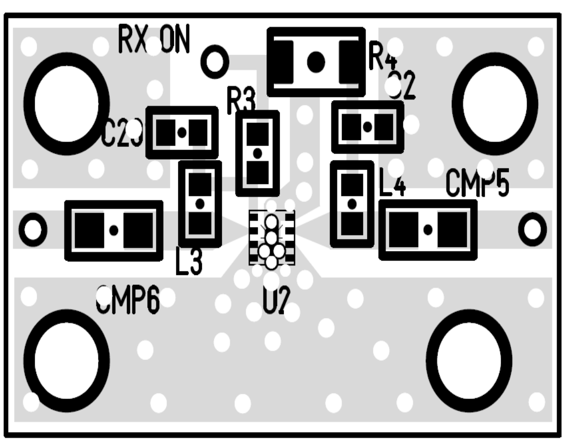
WIDE BAND MMIC LOW NOISE AMPLIFIERS:

Now is the time that you can purchase a hand solder-able MMIC (SOT- 89 as shown on the right) that will produce less than 1 dB noise figure 30 MHz through 500 MHz. Gone are the days where you will see tuning elements in front end LNA sections of VHF/UHF transverter designs. These MMICs are now basically the same as high IP3 level PHEMTs that are now broad band match within the package. A simple bias resistor or choke if on a regulated supply and low frequency bypass capacitor is all that is required. At microwave frequencies, the Noise figures increase only because of the packaging. 1.5 dB NF through 2.3 GHz is available.



REF.	Millimeter Min.	Millimeter Max.	REF.	Millimeter Min.	Millimeter Max.
A	4.40	4.60	G	0.40	0.58
B	3.94	4.25	H	1.50	TYP
C	1.40	1.60	J	3.00	TYP
D	2.25	2.60	K	0.32	0.52
E	1.50	1.85	L	0.35	0.44
F	0.89	1.20			

Machine solder-able components are available that produce sub ½ dB noise figures through 1.3 GHz and well under 1.0 dB NF up to 3.5 GHz. Sub 1 dB NF at 5.7 GHz are in site with Broadband MMICs (7-12 GHz) available that produce 1.2 dB NF on a sample bases at the time of this writing.



Shown to the left is a LNA circuit board we manufacture for the 900 and 1296 transverter with a 2 mm x 2 mm active component (U2) in the center of the board. This MMIC has 4 solder pads on opposite sides and a solder “Ground Pad” in the center that needs to be re-flowed to the board. Machine soldering after Pick-n-Place by machine is the only way to reliably attach the component. For reference, the other components on this board are 0805 and 1206 size. BUT—how do you replace a machine soldered component when you make an “OPPS!” This issue was briefly discussed in the beginning of this paper but to finish the explanation, two of these circuits are manufacture as “Daughter Boards” with the main transverter board so the kit builder has a spare. This circuit is optimized for the 23 and 33 CM bands. Our goal is to provide a circuit that requires hand solderable components in positions of volatility. But, if a LNA of the machine assembly architecture is chosen, if damaged, it will be on a throw-a-way daughter board and the complete LNA circuit will be replaced at the same cost as a standard FET replacement. Just details to work out that will provide the best performance in the most economical fashion.

CIRCUIT COMPLETION

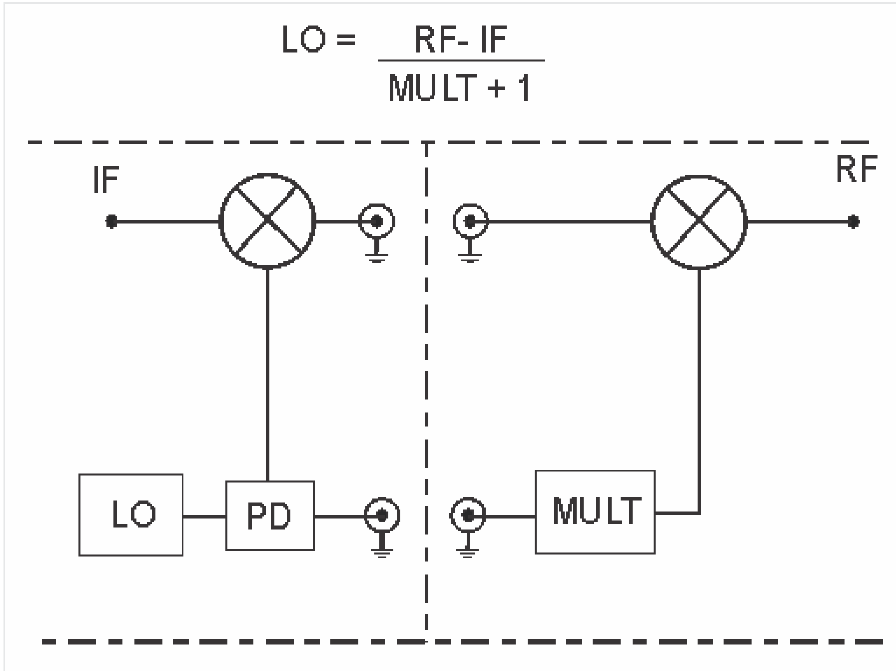
To tie it all together, it has been decided to utilize a Band Decoder to control the transverters switching function of Frequency, Filter selection and switching of AUX controls for add on power amplifiers, sequencers, and Low noise amplifiers. A band decoder is a simple way of control all functions together as an assembly. All of today's modern transceivers are including some sort of band switching output control utilizing an almost standard "Coding System". Some transceivers offer selectable coded outputs that can be setup to perform certain function at a button push.

To further justify Band decoding, most of us are utilizing computer control in our stations with various logging and radio controlling programs. Most offer coded band switching outputs as an option. They are simple to utilized and understand. When set up correctly they will reduce band switching errors. Then for those of us that consider this an over kill or just something they would never be comfortable with, a simple selector switch option will be available that can be remotely mounted at the control center of your station.

The importance of the band switching circuitry is that it will have some additional complexity. There will be instances where the Synthesizer frequency will change but the Band Pass filter will not. This switching circuit will also select the amplification or attenuation in the LO circuit driving the mixer and any additional Gain and/or attenuators that may be required in the TX or RX sections of the transverters. For instance, there is a possibility that if the RX gain drops off above 13 CM, an additional gain stage may be required to maintain a flat level to establish a decent noise figure. This additional gain stage will need to be switched out of line at the lower frequencies to maintain a constant level of conversion in the IF transceiver.

Other additional circuits may be required or added as an option such as a simple circuit to route the PTT output line as the bands are changed to control added LNA's or power amplifiers per band. A signal to control to a multiband sequencer to control all additional auxiliary equipment could also be provided along with some sort of feedback to positively confirm band of operation. Other options such as a power output detector circuit and an Internal / External reference detector besides the standard LOC indicator with the synthesizer needs to be worked into the design.

As of late with the implementation of the Satellite bands, a type of cross band operation will be required. This requires a band switching scheme connected to the PTT lines and an easy way to direct the switching scheme depending on various modes. It may be built in or become user selectable if desired. So— we still have some design decisions to make.



One of the other changes in Rev C was to implement a separate port for a future higher microwave transverter option or to provide interfacing for an existing higher band transverter. Setting the DIGILO frequency to a single frequency and then splitting it with one signal mixing in the multiband transverter and the other sent to an external higher frequency transverter. Once there, it will be sent to a 5-24 GHz mixer through a filter/multiplier stage if required. The IF signal from the 5-24 GHz mixer will then be one that can be converted to the original 2 M signal derived from the same LO frequency in the multiband transverter. This will be discussed in the presentation but the math of it is simple to follow.

5760 MHz. - *2808 MHz LO* = 2952 MHz. – *2808 MHz LO* = 144 MHz.

10368 MHz. – 7668 MHz. (*2556 MHz LO* x3) = 2700 MHz. – *2556 MHz LO* = 144 MHz.

24192 MHz – 21643.2 MHz. (*2402.8 MHz LO* x 9)

= 2548.8 MHz. – *2404.8 MHz LO* = 144 MHz.

The Rev C version also has an option to send a 2M or 23 CM signal out of a separate port to operate a standard single band transverter on any of the higher bands. We are also researching the possibility of adding 70cm to the same port perhaps with an additional 3-4 pole RF switch and some extra band decoding switching when required. Perhaps a Rev D will evolve before an actual circuit board will be produced but the goal remains to be as simple as possible keeping within the economic goals set.

CONCLUSION:

With the availability of the latest state of the art components that are still changing in performance day to day, a multiband transverter design may be a challenge to complete but definitely will be the future of transverter design. It will eliminate complexity and lower the cost of a complete all band VHF/UHF/Microwave system and extend the range of the finest HF transceivers on the market today. It will enable simpler equipment setups and make portable operation equipment smaller and more contained allowing easier setup and operation.

As the technology further progresses, products such as modular multiband power amplifiers and higher frequency transverters will be available to compliment any VHF/UHF/Microwave multiband transverter system eliminating the need for complex switching schemes. RX and TX Modules could be added to your system as you desire, when you desire. This will further enable the simplicity in setup and use utilizing any of today's Multiband transceivers. With band decoders and computer control, band switching is a push of a button or a simple key click. Then set up and operating on multiple bands will become very simple if all of the RF is in one Box!

A question has been raised in the past presentations concerning the "WHAT IF" something goes wrong with the multiband transverter? You will lose operation on all of the bands. Well, the objective of the design is to first make the end product less prone to problems by first making the design simpler with less support circuit required. This now means less can go wrong. Then second, making it affordable, even more economical than a single band transverter, would allow one to have a back up ready to drop in if needed. Then with the modular approach with the major components that may fail under extreme conditions, a simple repair can be done even in the wheat fields of Kansas so to speak. These are issues we all have to consider with all of our equipment and especially when portable for which this multiband transverter is mainly designed for. So-- If your IF Rig or your Keyer and now today, your computing device breaks during an operation, what do you do? We hope this new multiband transverter will eliminate a lot of multiple transverter system problems of the past.

FINNALLY:

Unless there are major breakthroughs in pricing and performance, we fell we are set to finished both designs and make circuit boards and enclosures. We hope to have this design in production by spring of 2019. Thanks for reading and see you on the bands!

Steve, N2CEI