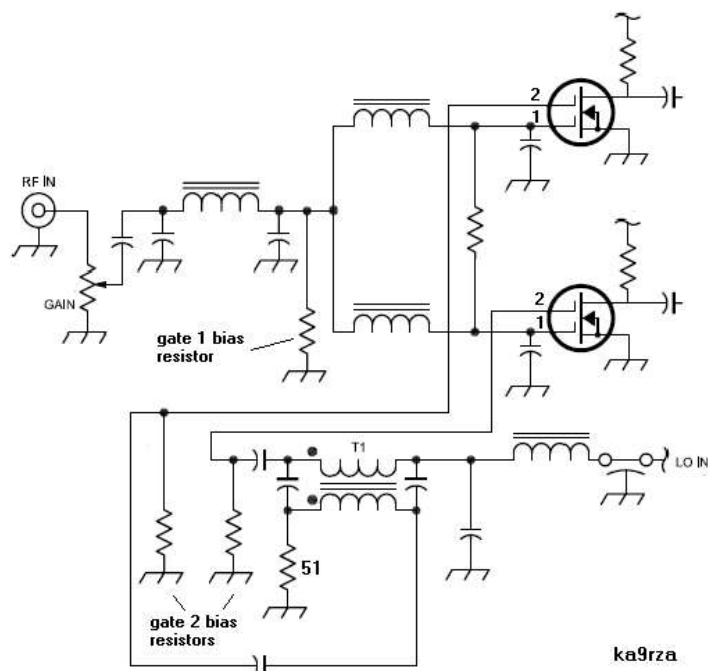


# Analyzing Theoretical Mosfet RF Quadrature Mixers For Prototyping

Dannie Ray Jackson

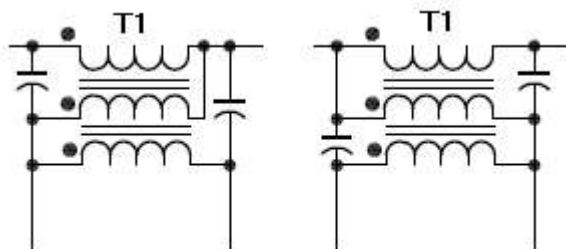


The purpose of this small text is to look at some simple Quadrature Mixer ideas and analyze what might happen before actual design of a prototype begins.

The phase shift transformer T1 in the left hand schematic is borrowed from Rick Campbell's "Biaural Week End Receiver" project depicted in QST and the ARRL HB 2005 Ch 14. Virtually every thing is the same except for the addition of two dual gate Mosfets in place of the SBL-1 or TUF-1 passive mixers and there are bias resistors added

also. Consequently Rick's circuit reveals he has a very low output impedance on T1 which goes to a high impedance gate on the two Mosfets above. If the vfo or crystal oscillator input at LO IN has sufficient energy then we may use low value resistors for the bias resistors on the gate 2 positions of the two mosfets. This then will work in the case where the impedance of T1 at output to the gates is looking to see a low resistance load.

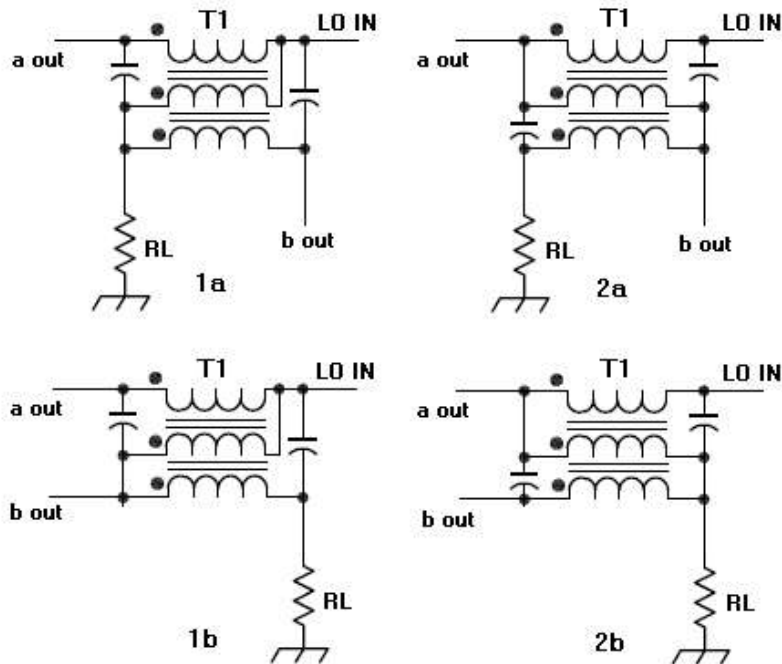
The gates do not care if there is a low resistance to ground on them so long as there is enough voltage swing across the low resistance to effect a good signal voltage on the gate. However if the value is too low then problems of operation can occur and so there has to be compromise in design if needed.



**variations on T1**

One of these variations on T1 will allow us to have a better match to the Mosfets and the required phase shift. Since I am only analyzing at this moment and not prototyping I am telling you some ideas to check out in the designing phase of these types of circuits. We will get them figured out and then know what works best and have it all simplified and perfected if

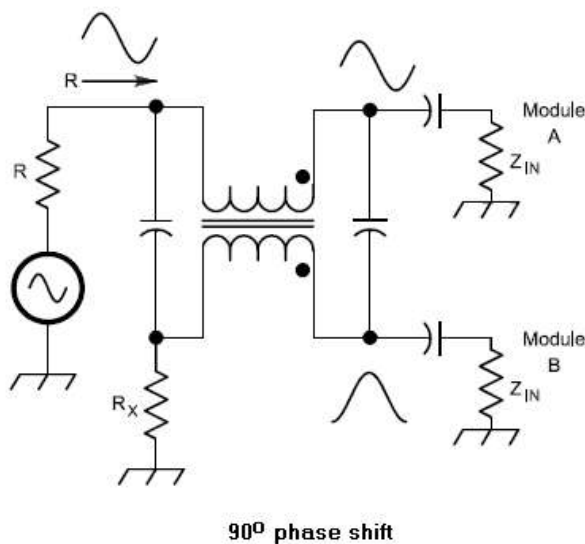
you choose to explore these circuits and develop them. I will give you ideas for T1 to try and thus you can use those ideas that work in actual test to discover the perfect design idea and we will make the item as simple as can be for wide spread use.



variations on T1

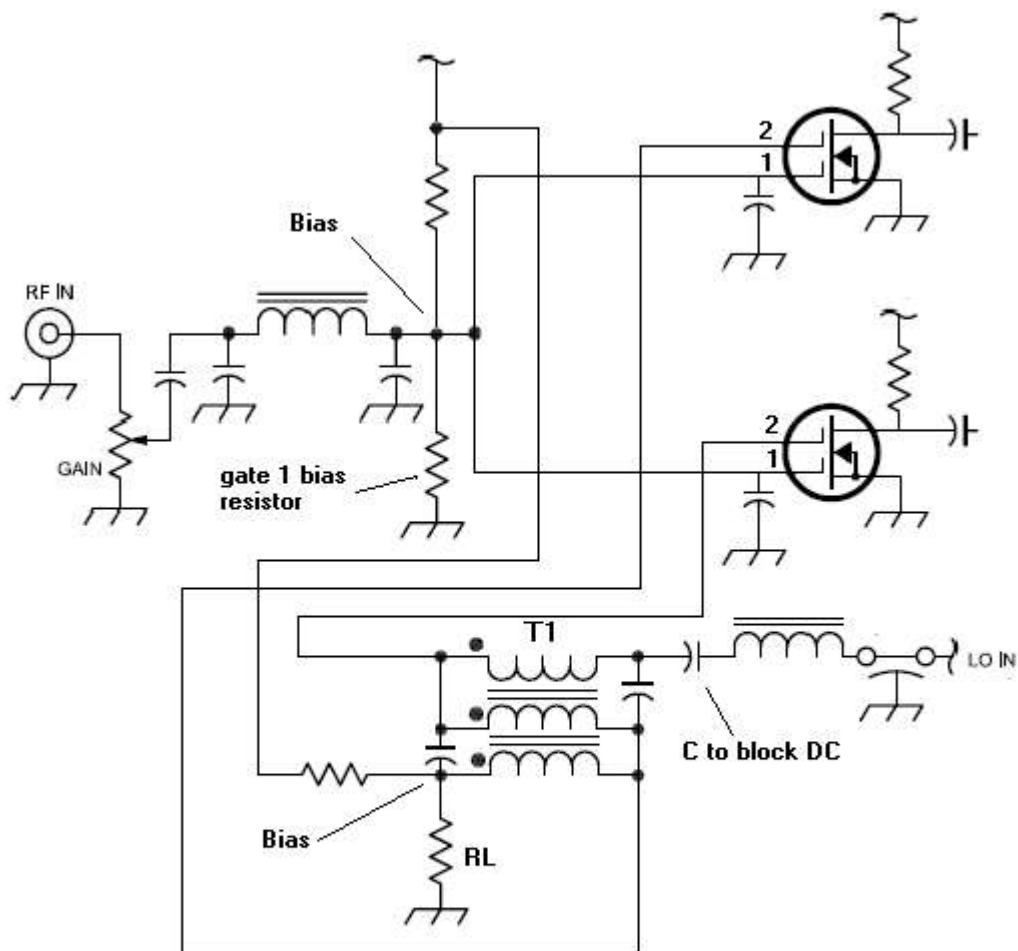
These circuits look a lot like a balun transformer and so the output will be balanced to the two Mosfets as their terminations: I can think of 4 more variations which I feel you can figure out in your prototyping experiments.

The idea behind exploring these transformers is so that the load resistor  $R_L$  is also the bias resistor for the gates 2 of each Mosfet. Here the same DC current is common to all of the coil windings. Since there are actually 8 variations on this idea; one of the variations will be most ideal. Keeping the construction simple and replicate-able.

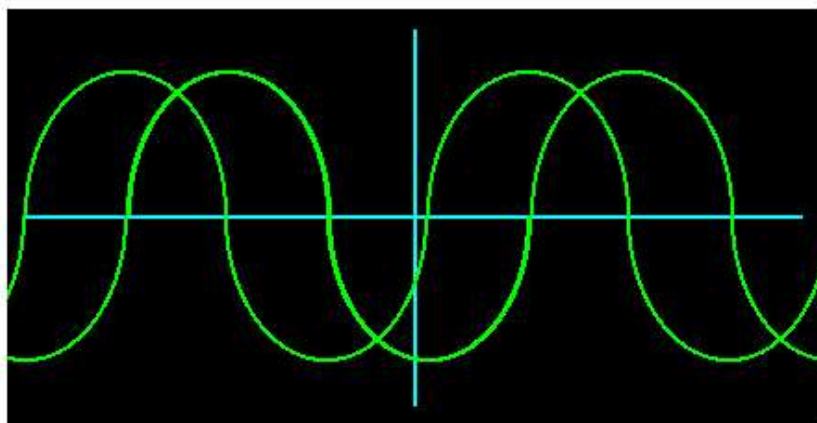


According to the ARRL Radio Handbook the transformer idea on the left will also produce a  $90^\circ$  phase shift. When I explore these ideas with my oscilloscope and signal generator I will be looking for broad banded response as well as degree of phase shift and which transformer versions create an impedance transformation. Exploration of all transformer ideas and their advantages will give the quad mixer design more options in terms of band width and impedance matching.



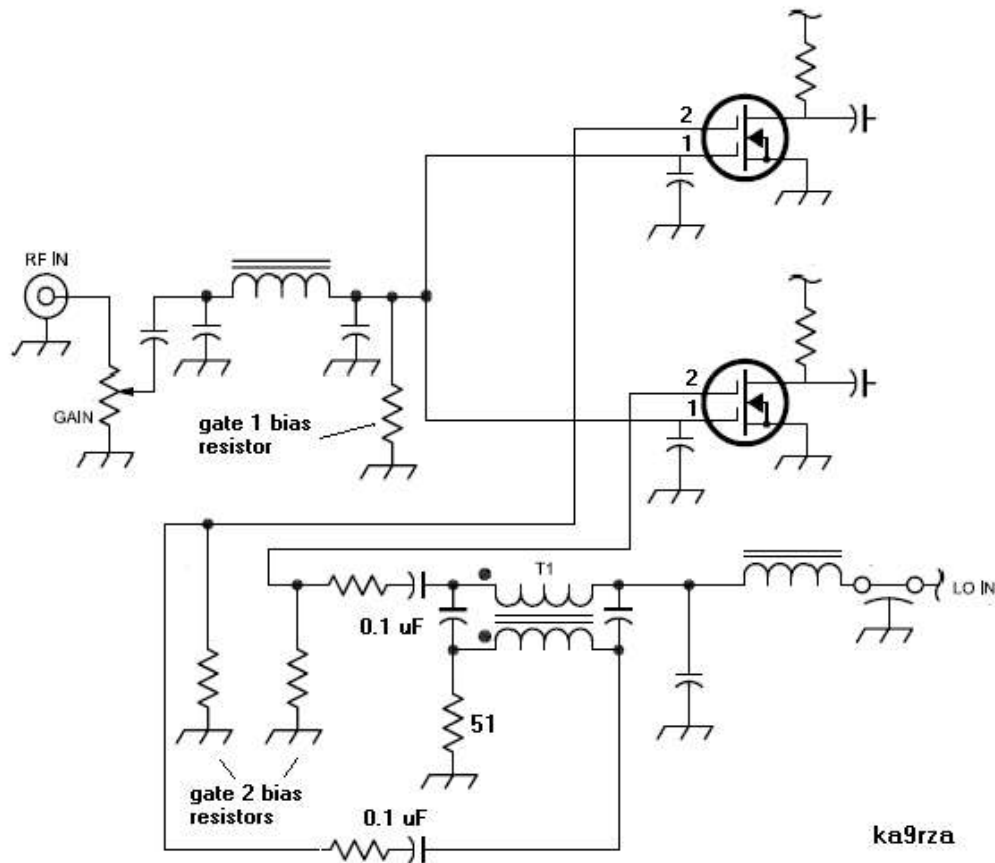


If you wish to use gate bias you may do so in this manner.



Dual traces at 90 degrees from each other.

Here is how the 90° phase shifted signals should look on the oscilloscope.

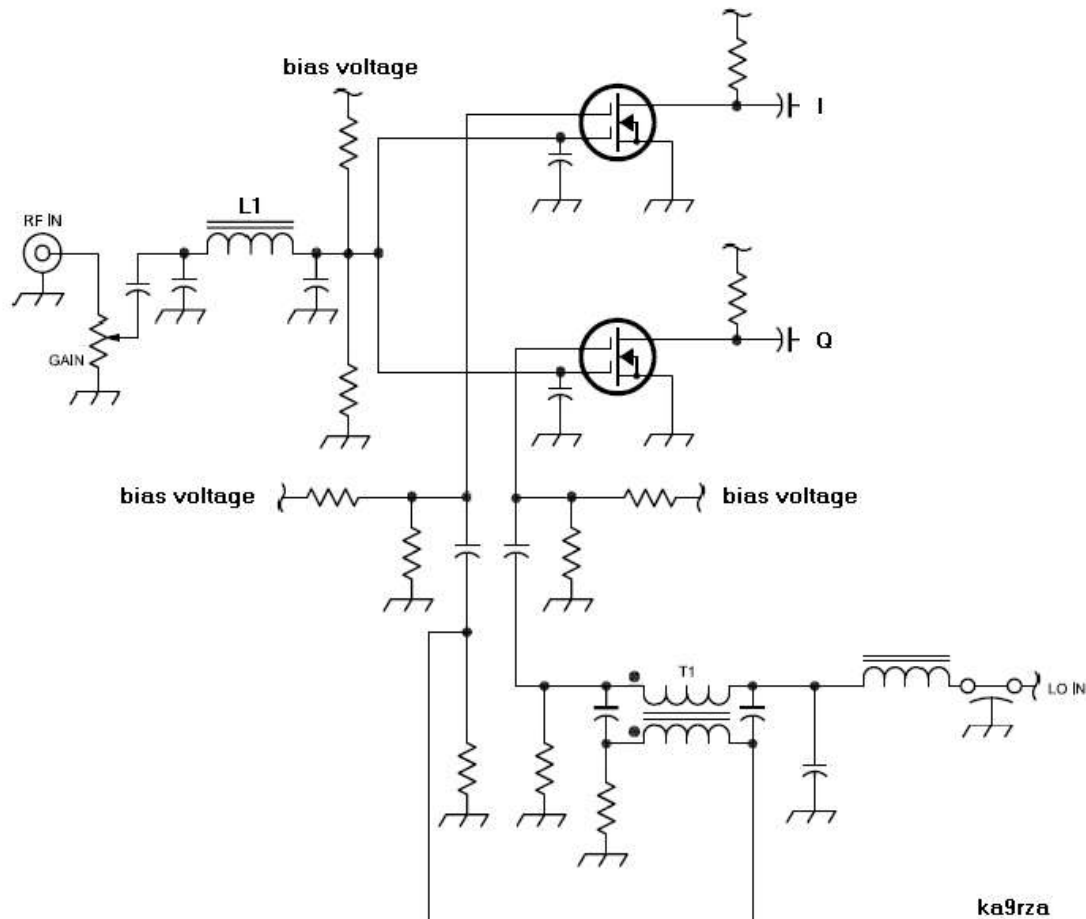


Another circuit idea!

Herein I have more less shared my ideas for circuits to design, then test and study to effect ideas for using Mosfets as quadrature mixers / detectors for use with the very interesting SDR software.

Currently I do not have the parts although I have all of the test equipment and so I am sharing my thoughts here with you in case you like to experiment and do have the parts. If you then wish to build the transformers and test them “out of circuit” and hence explore which ones will gives us a 90° phase shift and which ones will not, as well as what impedance transformations they achieve, then please do so and share the results of your studies with us all.

The reason for using Mosfets here is so that there can be some gain in our simple single conversion receiver and perhaps even add automatic gain to the front end. Likewise the Mosfets should have the lowest noise figure and so, check the data on the Mosfets you are researching. Also, to reduce noise even further use low noise resistors and capacitors in the gate circuitry.



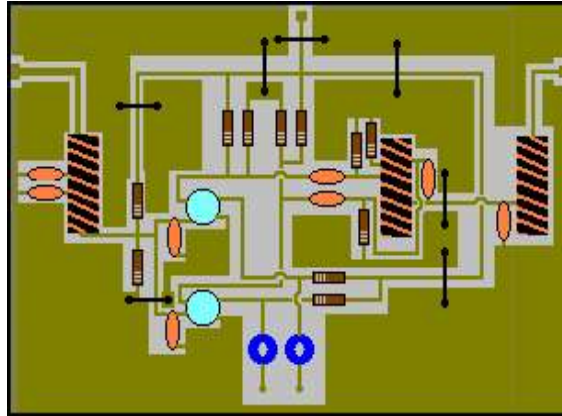
I will do some experimentation here but I must mail order parts since I live in the Daniel Boone Forest region of Kentucky way out here in the mountains with the rattle snakes. And so I do not have the same advantage of going to town for parts like I had when I lived in the city (around Louisville).

If anyone has any extra Mosfets and toroids and wants me to explore and develop as well as write more about the findings of simple devices such as these; then send them to me and I will stay busy. Copper clad circuit boards or any such part that you feel I might use in developing these circuits here. I will share all circuits and text for free.

If you develop a good circuit that has been tested then send me the circuit diagram and parts list in a pdf file with your name and call if you are an amateur operator; I will review it all and work it into a larger text.

I will always acknowledge you in these text and I will always make these text available somewheres On Line for free download.

I hope that before six months has passed there will be some developments made in the researching of this subject and that we have advanced to where we know more about this new frontier in radio. And hence have some very good circuit diagrams we can all use.



approximate board size  
and layout of circuit on page 6

Send your text to me at [wavelengths@netzero.com](mailto:wavelengths@netzero.com)

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