# Georgia Sierra Gets a Voice Transplant - Operation Successful

**By Bob Confrey WA1EDJ and Sam Billingsley AE4GX (North Georgia QRP Club)**

Over the last six months a small group of NoGa-ites (North Georgia QRP club members) have been working on a project to build a homebrew version of the Norcal Sierra from the ARRL Handbook templates. Each participant had different MOD requirements and special features they wanted to try. Our goal was learning by experimenting and home brewing, as much as possible, so buying off-the-shelve kits and products was to be minimized.

Sam/AE4GX and Bob/WA1EDJ were particularly interested in using an audio output annunciator (AFA – Audio Freq. Annunicator) for a frequency counter since we were using a 10-turn pot to tune a varactor VFO. The VFO MOD was based on Mike Branca W3IRZ the "Georgia Sierra" QRP Transceiver article published in the ARCI Jan 2000 QRP Quarterly (see reference). Mike had elected to use an available frequency counter kit with LCD output. Bob and I were looking for a lower power requirement and smaller implementation for trail friendly use. We both had some experience with PIC programming but were looking for short cuts and didn't want to reinvent the wheel if it was available but at the same time wanted to be able to customize the code and circuits to suit our needs.

A QST Dec 1998 article by Dave Benson NN1G "Freq-Mite – A Programmable Morse Code Frequency Readout" looked like it was the ticket but the article mentioned he only supplied programmed PICs and we wouldn't be able to add and MODs of our own. The article did have a schematic and general input sensitivity and frequency response data. We found out that Small Wonders Labs (see reference) was selling complete Freq-Mite kit for $20. While that's not bad we wanted more control on the operating characteristics and layout. The Freq-Mite used a different PIC than the 16F84 we were familiar with so we needed some help here. The Internet comes to the rescue.

We put out feelers on several of the ham related reflector lists including Ham-Pic reflector out of the NJQRP site (see reference). Bob and I subscribe to ham-pic list since we are generally interested in the creation and use of ham related PIC products. Well we got suggestions and pointers on frequency counter front-ends and possible PIC code to perform the frequency counting and morse output function from several sources. The best code suggestion was from Bernd Kernbaum DK3WX, a ham in Germany, that had previously published some PIC based articles in SPRAT (see reference). Bernd had a very useful piece of code that he was willing to share and only requested that we mention his name and call and credit his code segments we used in our efforts. This email dialogue occurred over a several month period. We reestablished contact with him recently to obtain the permission to use his work and identity in any non-profit article targeted for the ham community.

We checked out the PIC creator, Microchip, at their web page (see reference) and got their data sheets and detailed applications notes on the use of the internal timer and counter features of this particular chip.

So using the schematic from the QST article and Bernd's code we burned a PIC, etched a prototype board and tried it out. Well it was good news and bad news. The code worked but the sensitivity and frequency range of the counter transistor front-end was not adequate for our needs. We hoped to use the output from the HB Sierra premix BP stages but the levels are at the –20dBm to –15dBm in our rigs and the ten meter band module needs to have a 32 mHz BP to mix with our unique 4.000 mHz I/f. The 4.000 mHz I/F is another W3IRZ MOD and not standard in the Norcal Sierra. The QST article graph had indicated that this sensitivity and freq range might be too limited for our needs and sure enough that's what we found with the initial breadboard. Close but no cigar. So we needed a better front-end for the PIC counter but still wanted it simple. Our earlier queries had yielded several other front-ends to other PIC implementations so we tried several. We had problems with one or the other of the two limiting characteristics (sensitivity and frequency response).

Neither of us are electronics engineers but in the best ham tradition we started looking at the pieces we had collected and started trying out various combinations of circuits.

The best we found that met our needs was a small portion of the PIC front-end from the K2. Wow the K2 has a PIC? We didn't even know that until someone responded from a list. Well the good news is the K2 schematics are on the Internet (thank you Elecraft <see reference>) and the two cascaded transistor amp stages were picked.

We did substitute common 2N3904 transistors and all worked just fine. This two stage circuit is very similar to the original Freq-Mite article front-end except in the Freq-Mite the first transistor is setup as emitter follower and the second transistor is common emitter amplifier. So the two stage emitter follower amplifier from the K2 seemed to have the needed response up to about 30 mHz but we still needed 32.2 mHz for the ten meter HB Sierra module. My old scope appeared to show that the signal being presented to the PIC pin 3 was not quite defined enough to be reliable above 30 mHz. We pulled a Schmitt Trigger inverter IC out of the junk box and tacked it into place between the second transistor amp stage and the PIC. We put a 10K pull-up resistor on the output of the S.T. to insure maximum rise and fall of the wave shape into the PIC. Bingo. The input can now be lower than 100mVP-P on most bands and the readings are good through 32.2 mHz. This MOD did add an IC (cheap one thank goodness) to the board but the results are now reliable for the HB Sierra premix bandpass output signal to be detected, counted and outputted in morse during the receive period of the rig.

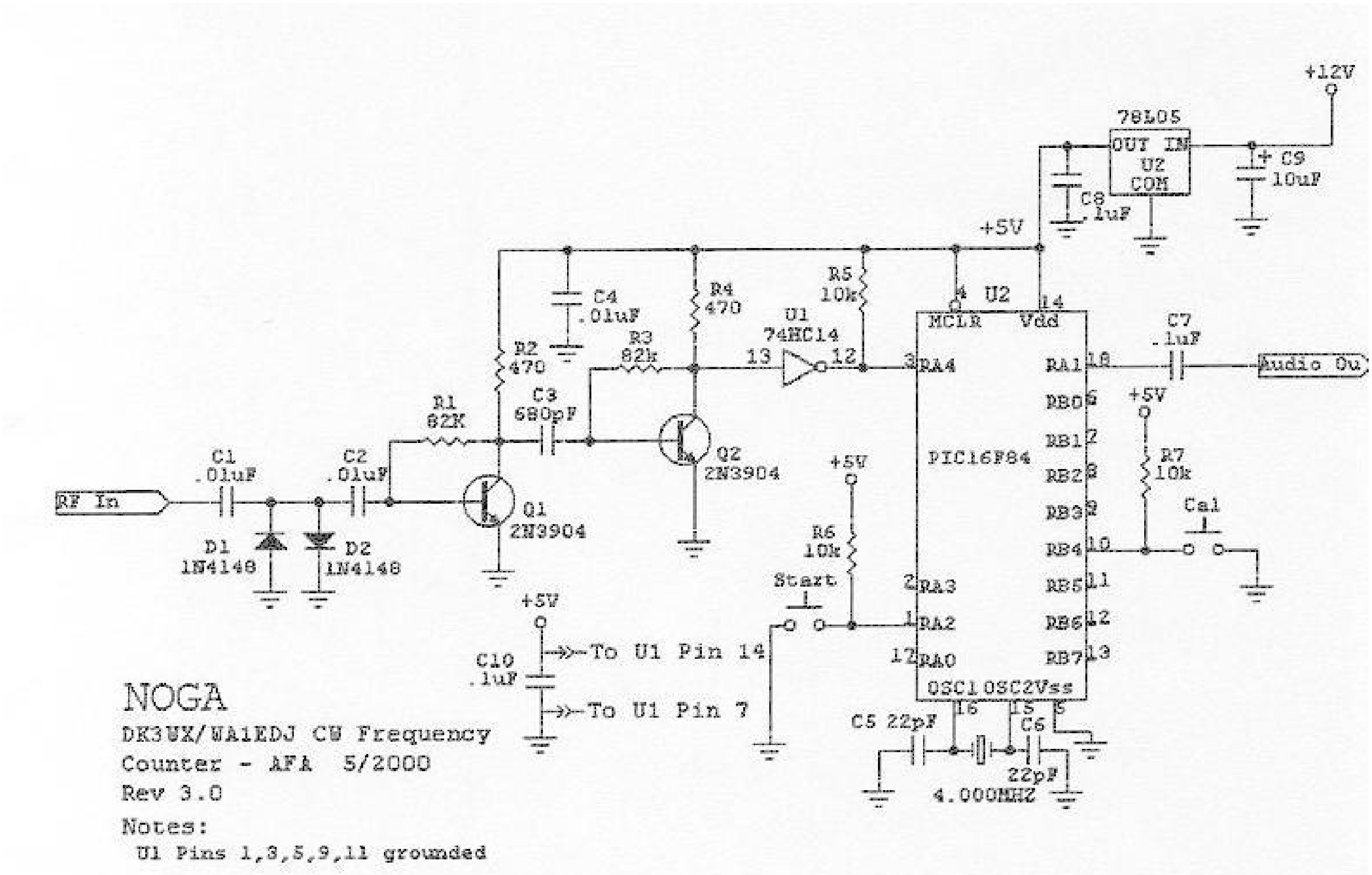


**Figure 1. AFA Schematic.**

Unfortunately the PIC is an 18 pin IC and the ST inverter is a 14 pin IC and they are not conducive to ugly construction but if you're willing to put the IC(s) on their backs and directly wire it up it's very possible. For hams anything is possible. We recommend one of the small Radio shack perf boards with holes and foil pads (RS part # in ref. Section) if you don't want to etch. It's not critical. That's the beauty of homebrew stuff you can tweak it anyway you want to meet your needs.

Although Bob is not an engineer he is a very professional electronic technician that is picky about the looks of a HB module so only etched PCB boards were an option in this case. So we had to commit the schematic to a PCB layout. If you have ever tried this manually when you have big pin ICs you know it is nearly impossible. So since we were developing other small boards this last year we had picked up a neat, simple PCB layout product from a little German company. It is a low priced product called PCB Developer's Individual Assistant (see reference). With it, most QRP sized projects can be laid out very quickly. The software package can produce component side screens has well as two top and bottom etches, if necessary. We needed only single sided etches for this project. BTW we used this package for the NOGAPIG (see reference) To illustrate the output of the package the component side looks like Figure 2 on the next page.

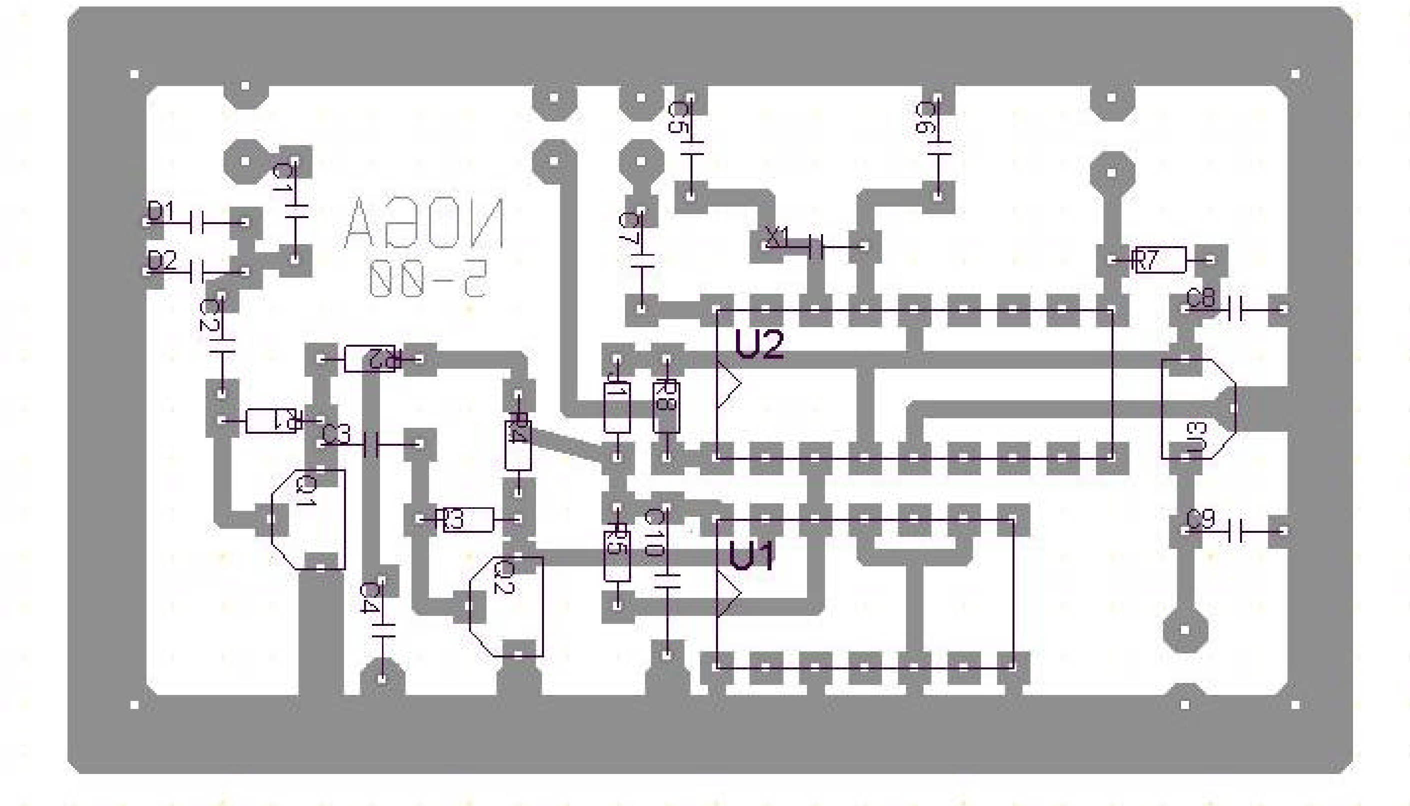


**Figure 2. Component side of board with xray to foil side on bottom.**

We use the very simple Press-n-Peel PnP Blue technique from Techniks, Inc (see reference) to get the camera-ready layout into the etched environment. Basically you need a clean x1 size original and a good copy machine to transfer the etched image to the PnP Blue film sheet. The blue film is ironed onto the copper foil and then the film is removed and the PCB etched. We generally do just one or two at the time since these are actually just prototypes. It's amazing how many times you miss something during this process no matter how careful you are. My hat is off to the professionals for this.

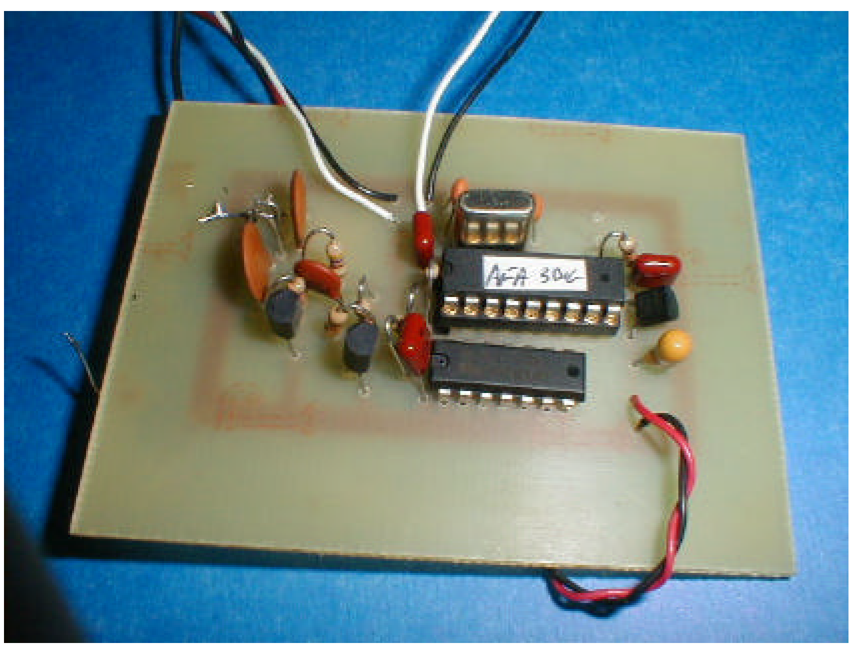

**Figure 3. Prototype board used in testing.**

We were lucky with Bernd's code since our Sierra implementation uses a 4.000 mHz I/F so you don't need to have offsets to add or subtract values (if you ignore the mHz digits) thus a direct reading frequency counter logic would do for us. Bernd has offset routines in his code and they could be enabled. We can customize the output for anything desired but currently we are using the three lower kHz digits (all are available) since we know the band and because we have to manually change the band module in the Sierra. The PIC has several unused I/O pins that could be used for a variety of functions. We can add them later. The other great feature of this particular PIC it is reprogrammable so we are free to experiment with different versions of code at will. The prototype is using 16mA while idle and 35 mA while the PIC is outputting, from an on board 5V regulator (12v to the board). We use a push button switch (N.O.) to turn on the board for readout so you're only running it for seconds at the time. The audio outputted value of the AFA tracks with my MFJ 359B SWR analyzer (with frequency counter). Since we're only interested in getting to a general area of the band the 1 kHz resolution is adequate. With a 10-turn control POT it's a BIG help.

Mounting and interfaces are going to be unique with the user. In my case I have mounted an AFA prototype board next to a NOGAPIG power monitor board and K8 keyer on an inside wall of my HB Sierra enclosure, in a kid's type lunch box. Since the AFA, the NOGAPIG and the HB sierra all have audio output I have coupled the outputs via individual gain controls to feed the headphones thus leveling out the three signals reaching the headphones.


**Figure 4. AE4GX's implementation of the previous AFA version into his HB Sierra.**

This has been a very useful learning experience for us and we would encourage everyone that has any interest or previous experience with software to checkout the PIC and see how easy it is to use. The PIC and its later versions should be found in many ham projects in the future. The latest version of source code for this AFA project can be obtained from the NOGA web page (see reference).

## *References:*


1. Mike Branca W3IRZ, “The ‘Georgia Sierra’ QRP Transceiver”, ARCI QRP Quarterly Jan 2000, pp. 29-31
2. Dave Benson NN1G, “FREQ-Mite – A Programmable Morse Code Frequency Readout”, QST Dec 1998, pp. 34-36
3. Ham-Pic reflector list http://www.njqrp.org/ham-pic/index.htm
4. Bernd Kernbaum DK3WX, ELBUG-Controlled CW Transceiver named ELBC two years ago published in SPRAT Nr. 94/1998. All control inputs and outputs, incl. frequency tuning and readout is possible with Keyer and Headfone
5. Press-n-Peel Blue Toner sheets - Techniks, Inc P.O. Box 483 Ringoes, NJ 08551-0463 Voice: (908) 788-8249
6. NOGAPIG – North Georgia Power Indicator Guard – check out NOGA web page for details: http://www.qsl.net/nogaqrp/
7. Small Wonders Labs at http://www.smallwonderlabs.com/
8. Elecraft, Inc. at http://www.elecraft.com/
9. PCB Developer’s Individual Assistant – V2.2 at http://www.waldherr.com/index.html
10. PC Board with DIP Pads – Small:  RadioShack.com Part # 910-3804 ($.99)
11. PICmicro Developer, Microchip, data sheets and application notes at http://www.microchip.com/
12. North Georgia QRP Club (NOGA) web page at http://www.qsl.net/nogaqrp/  (Go to club projects)