

The KK7B 2m AM Project

Rick Campbell March 2020



Glamour Shot of Heathkit Twoer with Electrovoice EV727 Microphone

When I was a 14 year old boy with a Novice License, the kid up the street had a Heathkit Twoer, and he was already working on an improved homebrew receiver. My big brother had a '64 Plymouth Valiant, Slant 6, dark blue, 3 on the tree, and I imagined how much fun I could have in that car with the little Heathkit Twoer and accessory vibrator power supply. I had a copy of the 73 Magazine "73 Transistor Circuits" issue, and can vividly recall thinking about how to build a little 2m superregen receiver on a tiny PC board. But even then, I figured that the kid up the street knew what he was doing...a better receiver.

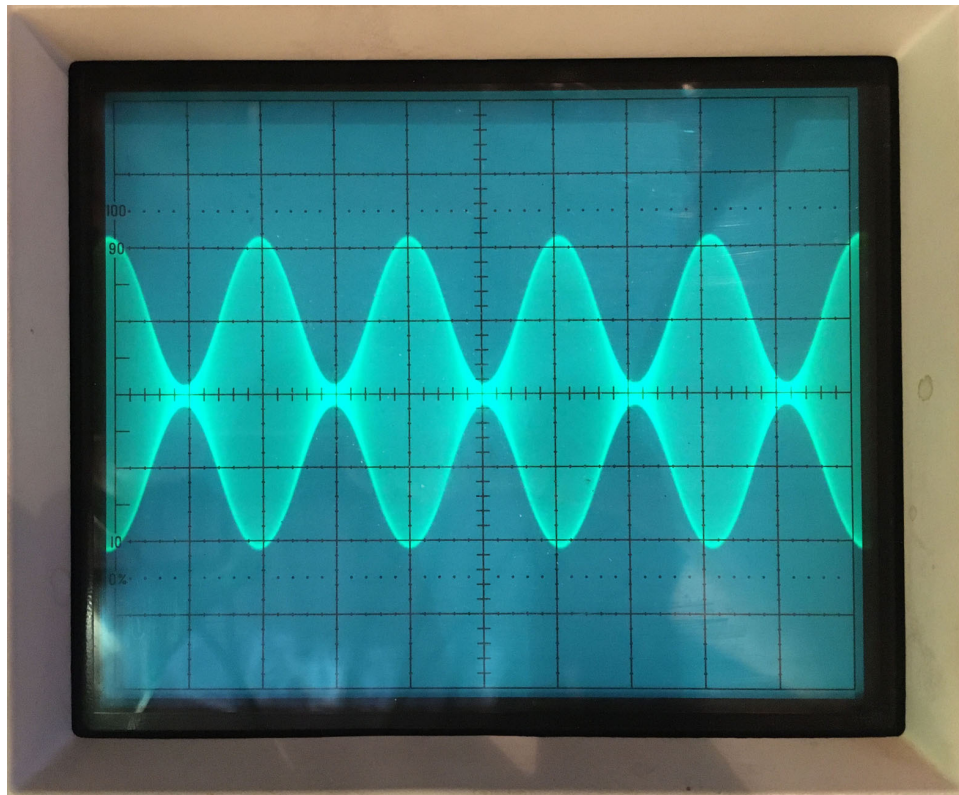
By the time I graduated from high school, left active duty with the Navy, and had a college bedroom lab where I could do real receiver experiments, I'd moved on from superregens and AM entirely. I had an all homebrew 2m SSB-CW station, worked Oscar 7 right after it was launched, and for the next half century spent my career designing and building good receivers.

I briefly messed with AM Stereo in the 1980s, I loved the hi-fi sound, but with no application for that in amateur radio, my interest waned. Then in 2012 I returned to university teaching.

I tried to interest my students in SSB, but the response was something like “isn’t that what old guys do with ham radio?” FM was a non-starter, no one cared what was inside the Baofeng.

We played with QRSS on 10.140 MHz for a while, with my students writing their own DSP code, but I was supposed to be teaching Analog/RF/Microwaves so that was an issue.

Our university department charter includes a requirement to prepare students for success in their careers, and a good number of my graduates end up working on projects with envelope tracking, linearization, and predistortion on high efficiency microwave amplifiers. They study books and papers by my old friends Steve Cripps, Fritz Raab, and Al Katz, and displays of transmitter output waveforms on their oscilloscopes. Somewhat like this one:



Near perfect modulation waveform of a little KK7B 2m AM exciter

That looked familiar from my childhood, and the following year I had a class of Analog Design students mess around with envelope modulation on 2m. We completed >1 mile 2-way QSOs with homebrew rigs on both ends on a class field trip along the Willamette River walk.

The following year we did something else, and then something else again after that, but I kept hearing little snippets of conversation where graduates who had built 2m AM rigs thought they had a lot more fun, learned more, and landed more interesting jobs after graduation. As usual, countless back and forth conversations with good friend Jim Davey K8RZ explored the topic.

Then one day it hit me that the generation that designed the comm systems in the NASA manned space flight program had grown up in the 2m AM era. The real kicker was when I found out that one of the best designers I know, Bob Larkin W7PUA, had designed the “Whippany Special,” a 2m AM club project transceiver during his years at Bell Labs.

455 kHz AM IF strip with AGC inspired by the JW Miller 8902 from the 1960s.

All of the components are present day off-the-shelf from Mouser. IF transformers from Xicon, 2N3904 and 1N4148.

Ugly construction for easy experiments.



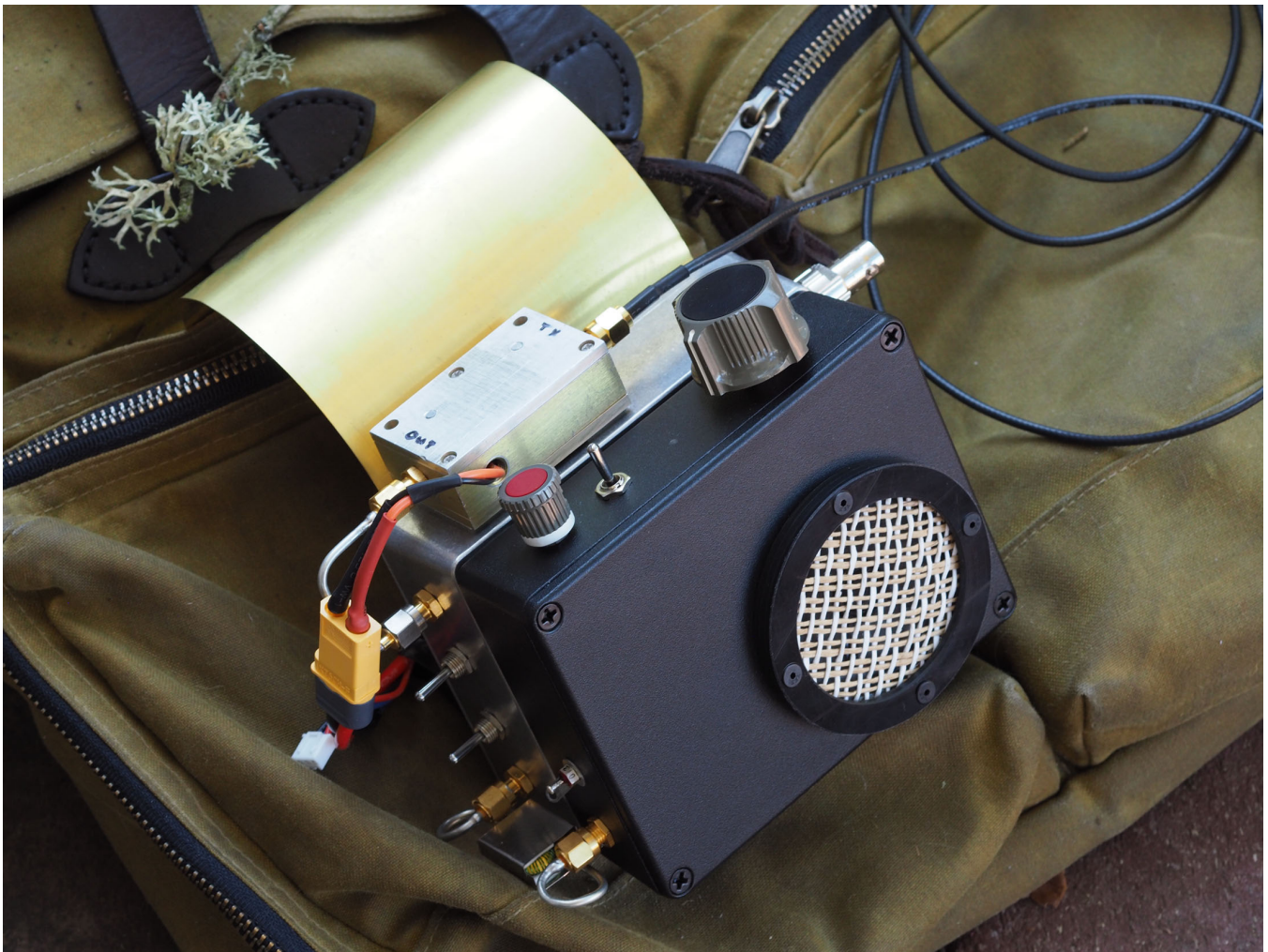
Prototype 455 kHz AM IF Strip

I'd spent my career developing RF front-ends and amateur and instrumentation receivers for CW, SSB, and DSP IFs. A quick search of AM demodulators came up empty. AM has been an afterthought for much of the last half century, and the last really serious AM IF design I found was in an RSGB Handbook circa 1970. All of it is now done on-chip...and I confess that after a career as an RFIC designer I'd rather just go play my violin than try to hack someone else's IC design, constrained by budget, management decisions, marketing pressure. Even so, I did two generations of new VHF AM receivers using the widely available TA7642 one-chip AM broadcast radio IC. They were not bad, but the AGC range was limited and every radio I designed using that IC as the detector-AGC system had to have an aggressive IF gain control in addition to the volume control. I now have the skills and tools to design it right, from scratch.

So I went back to the venerable JW Miller 8902 455 kHz AM IF strip module from the 1960s. It was a good solid design, but with positive ground, probably germanium PNP transistors, and a germanium detector diode. Fortunately I teach analog electronics starting with discrete device physics, so I first duplicated that original design using germanium devices--and came away impressed--and then redesigned the thing for silicon NPN and a silicon 1N4148 diode. Then I added a common gate J310 input stage to provide a good input termination to a diode ring or some clever 21st century mixer. The prototype is shown above.

That prototype 455 kHz AM IF strip with AGC works better than I deserve, and I have to give credit to the original JW Miller IF strip that served as my design starting point. Note that by the late 1960s AM Broadcast pocket transistor radios had devolved to a minimalist state, with only 2 IF transformers and a third red core LO coil. The JW Miller 8902 is much closer to the 6 transistor radio circuits common in 1960. My final design is good enough that it is a shame to put the radio in a little box with a tiny speaker. 2m AM can have broadcast quality audio.

With a good 455 kHz AM IF strip, I moved on to the familiar KK7B territory of converters, LNAs, filters, small and medium signal amplifiers. I had all the pieces to do complete 2m AM rigs, designed and built from scratch. I now have a half dozen of them...here's the Indy Special...



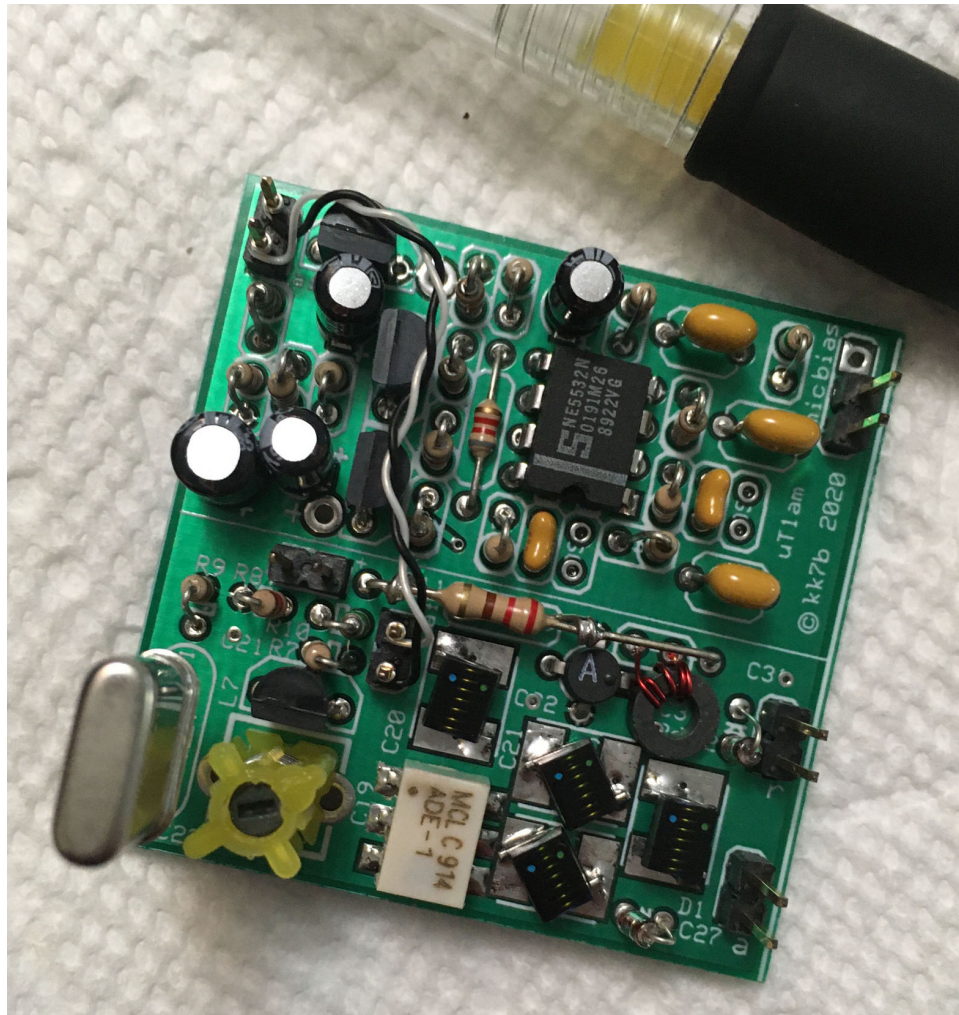
The Indy Special 2w carrier 2m AM transceiver with Drive-In Theater inspired window mount

Ever the romantic and still thinking wistfully of that '64 Valiant with its slightly tarnished halo, I sketched the Indy Special, a 2m AM transceiver worthy of one of my faculty heros: Indiana Jones.

Here's the Indy Special ready for some mobile DX, hanging like a Drive-In movie speaker on my VW window.



I was sad that International Crystal Manufacturing Company had gone out of business, as I'd like to have ordered some custom frequencies for my experiments. Then at Microwave Update in October 2019 someone suggested I try QuartSLab in the UK, and I sent them off an order, including some 7th overtone crystals at 143.800 MHz. They arrived a while later, and I was astonished to discover that the 143.800 MHz crystals oscillated at exactly 143.800 MHz in my test circuit. That was a lot closer than I expected, and 10 kHz better than the QuartSLab spec. That opened the possibility of building a crystal controlled transmitter on 144.270 MHz with a 7th OT crystal, and I did a little circuit board layout for a totally cute little 2m AM transmitter that is already making waves.



microT1am 2m AM transmitter

The little transmitter shown above, and a matching crystal controlled 2m AM receiver, are in the companion articles. They work really well. But in closing I have to say something. I've been saying, and even writing, bad things about the Heathkit Twoer for a long time. I finally own the one in the opening photo of this paper. It is really not bad. In all honesty, I think I'll probably enjoy operating it as much as I'd enjoy driving that '64 Valiant.

One final note. In the Pacific Northwest 144.270 is the AM experimental calling frequency. I invite others to use that as well. It is below the beacon band and above any local SSB.