THE RICHMOND HAM

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July 2023

THE RICHMOND AMATEUR RADIO CLUB RARC Meeting in person!

Our monthly meeting is on Friday July 14th, 2023, 7:00PM, at the Bon Air United Methodist Church, 1645 Buford Road.

This months meeting will be in-person and also on Zoom.

https://us02web.zoom.us/j/88518058584

This Month's Program:

July Program: Gordon H. Waller, scientist, NRL. Batteries for portable applications.

Richmond Amateur Radio Club Meeting Minutes

June 9th 2023

The regular meeting of the Richmond Amateur Radio Club was called to order at 19:02 on June 9th, 2023 on Zoom and in-person by President Rick Waller, (KA4OHM).

Members Present: Check-ins on Zoom and in-person at the Church.

After a breif introduction of members present the business meeting was called. Minutes of last months meeting were approved unanimously.

Old business: None

Treasurers Report: Ken Leidner, (WV0L) gave the Treasurer's Report. We had an ending balance of $20,951.54. New members Thomas (N3GTG) and Donald (KQ4INY) voted in unanimously. Welcome to you both!

New Business: None

Committee Reports: Ken, K4ZUT reported that of the 3 students in the General class, two had passed their exams and the third was waiting for field Day. He also explained that their teaching method had evolved into a more hands-on approach with the goal of passing the exam AND understanding!

Win (W4WIN) reported that the D-Star internet conection had been restored and that the new repeaters would be installed as time permitted.

Business Meeting was closed at 19:17.

Show and Tell: Rick, KA4OHM, Presented a new TYT 3 band HT.

Dan, W4ERF demonstrated his Homebrew Direct conversion receiver.

A presentation followed by Darrell, WW4F of his Hobby PCB 500 watt amplifier

Meeting adjourned at 20:02

Meeting minutes submitted by A.Hamel, WA1UQO.

RARC VE News

We have two different groups that provide testing. One is free, but only offers testing sessions on the second Saturday of odd months except June (Field Day) replaces July. The next session will be on Saturday September 9th 2023 at

Chesterfield Library Bon Air Branch
9103 Rattlesnake Rd
North Chesterfield, VA 23235

The other one cost $15.00, but offers testing sessions on the 1st Saturday of every month.

RARC offers Free VE Testing Sessions on the second Saturday of odd months except June (Field Day) replaces July. Currently all testing starts at 10:00 AM and is at: Chesterfield Library Bon Air Branch 9103 Rattlesnake Rd North Chesterfield, VA 23235.

Pre-registration Required. Walk-ins Accepted. Pre-Registration required for Techs and for special needs applicants. Anyone taking the Tech exam needs a FRN from the FCC (Google obtaining a FCC FRN) and bring that info to the session. If you have questions about a session, please see our website, www.rarclub.net or contact Allan, WA3J, at 804-399-8724, or ve@rarclub.net

KC4TS Cats Vet (Cats Volunteer Examination Team) offers VE Testing Sessions that cost $15.00 on the 1st Saturday of every month. Currently all testing starts at 10:00 AM and is at: Gospel Light Church 2109 Anderson Hey Powhatan VA.

Check-in is between 10am and 12pm and we stay as long as needed to finish all the exams. Walk-in candidates are welcome! You just need a valid ID, an individual FCC FRN, and the testing fee of $15 which goes directly to the ARRL (cash or check made payable to "ARRL VEC"). We can

provide pencils and a very simple calculator or you can bring your own. See http://kc4ts.org/ for more information.

Club Info...

RARC meets on the second Friday of each month at 7:00 PM, at the Bon Air United Methodist Church, 1645 Buford Road.

We offer 10-week license prep classes in September and March with exams following. Members provide VE testing sessions on odd-months during the year.

Join the Richmond Amateur Radio Club.

You don't have to have a ham license, just have a genuine interest in the hobby.

Annual Dues are:

80 and over	$0
Regular Membership	$22.00

Lots of information about the Club and our activities is available on our website, www.rarclub.net.

Nets

RARC has the first and only D-STAR digital repeater in the area: 147.255 (+ 600), 443.7125 (+ 5) and 1284.0000 (-20). In addition to our Wednesday local D Star net (below), we link Module C (VHF) to REF 062A for the National Capital Region D Star Net on Wednesday nights at 9pm. On Tuesday nights at 9pm, we link Module C (VHF) to REF 054C for the North Carolina D Star Net.

The RARC D Star Net meets on Wednesday nights at 8:00pm and is accessible on our three D Star modules, all of which will be linked together via REF 062D. So if you are in RF range of the repeater, you can join the net on any of the three RF modules and be heard by everyone.

If you participate in the net via DVAP, DV Dongle or a Hotspot (such as Pi Star), you should link your device to REF 062D rather than to any of our modules which will allow you to be heard by everyone.

Any questions, contact Win – W4WIN at wingrant@gmail.com

Sunday	7:00 pm	50.135	USB
	7:30 pm	52.525	FM
Wednesday	7:00 pm	28.475	USB
	8:00 pm	147.255	D-Star Rptr
	8:15 pm	145.730	Packe

MRA

Interested in information or support of the Metropolitan Repeater Association (MRA)?

The sole business of the MRA is to own, operate and maintain the 145.430 repeater. For information please visit our website at https://sites.google.com/view/kg4mra/.

Show and Tell!

If you have an item, idea, latest and greatest, or whatever gizmo; please bring it to the RARC meeting. We have a table (usually) set up near the front where you can place your item and share/discuss it with others as they arrive. We also have a section of the agenda set aside for members to discuss their "Show and Tell" item(s). No need to be tentative; we are INTERESTED in what you are doing, how you are doing it and, in true Ham fashion, how much it costs!

A Few Field Day Pics!

KI4MCW. At field day.

On left KX4OK Todd, on right W3QI Mike.

Newly licensed 10 year old ham, Cora, passed her Tech exam at Field Day and promptly got some on air instruction from Todd, KX4OK.

Thanks to Lauren, WD4FMG for the pictures!

Spectrum Displays; New Interest in an Old Idea

With the introduction of SDR radios and transceivers with spectrum displays, such as the Icom 7300, hams have found the ability to observe activity across an entire frequency range or band. This is useful in eliminating the need to constantly tune up and down the band looking for active signals. Unknown to a lot of newer hams, however, is the fact that this technology actually dates back into the late 1930s.

As early as the pre-WW-II years, panoramic adapters had been used experimentally. In World War II, they proved very useful, and military specific versions had been developed for use by the Signal Corps. After the war, Hallicrafters introduced what was to become the standard, as an accessory to their SX-42 high end receiver. Other companies followed the idea, and devices made by Central Electronics and Panoramic Products, Inc., most closely took their lead from the Hallicrafters design.

The Hallicrafters SP-44 Panadapter was a CRT and vacuum tube based instrument that utilized a three inch green CRT for the display. It was connected to the radio by a connector that slipped over the plate pin of the converter tube, along with audio from the receiver's output. The range was only 200KC, with the receiver's tuned frequency in the middle of the display, but it was enough to draw the interest of many hams at the time.

According to one on-line source, technically, panoramic reception is defined as the simultaneous visual reception of a multiplicity of radio signals over a broad band of frequencies. The panadaptor is a really nifty and powerful piece of equipment that can be used for so much more then simply watching a section of the frequency spectrum. Some other uses include automatic visual monitoring, automatic aural monitoring, three way QSO's or conversations, watching for and spotting replies to CQ calls, finding clear frequencies, locating stations whose frequency is unknown, instantaneous signal strength meter, measuring the percentage of AM modulation, spotting distortion on AM signals, spotting spurious and RF parasitic, detecting splatter, detecting carrier shift and frequency drift, finding key clicks on CW signals, checking deviation of FM signals, identifying AM on FM signals, detecting residual hum on a carrier, frequency measuring and setting, quickly checking a band for activity or propagation, and on and on.

It is not known whether Hallicrafters actually made the SP-44 themselves, or whether they were contracted out to Panoramic Products. We do know that a wartime version was made for the Army prior to the 1947 release of the civilian version that was offered as an accessory to the SX-42 receiver. In recent years, interest in the SP-44 has intensified, and there is a market among collectors for these devices. Recently, the Museum of Yesterday was able to obtain one in excellent and still working condition, for which we were fortunate.
John De Majo, K5HTZ

The SWAP SHOP

Club members may list their wares in the newsletter. Send descriptive information to Armand at wa1uqo@arrl.net, or call me at 508-838-8353. The Swap Shop is presented in the newsletter as a benefit to our members. RARC takes no responsibility for items sold or traded in this newsletter. The ad will appear three times unless extended. Interested parties will contact you directly. ***You must be an RARC member to place an ad.***

For Sale: QDX 5-band QRP Kit with Case and Power Plug. Asking $80.00. Contact J.B. Edmons at edmonds.j.b@gmail.com. Can be brought to the 6M tailgate on the 15th.

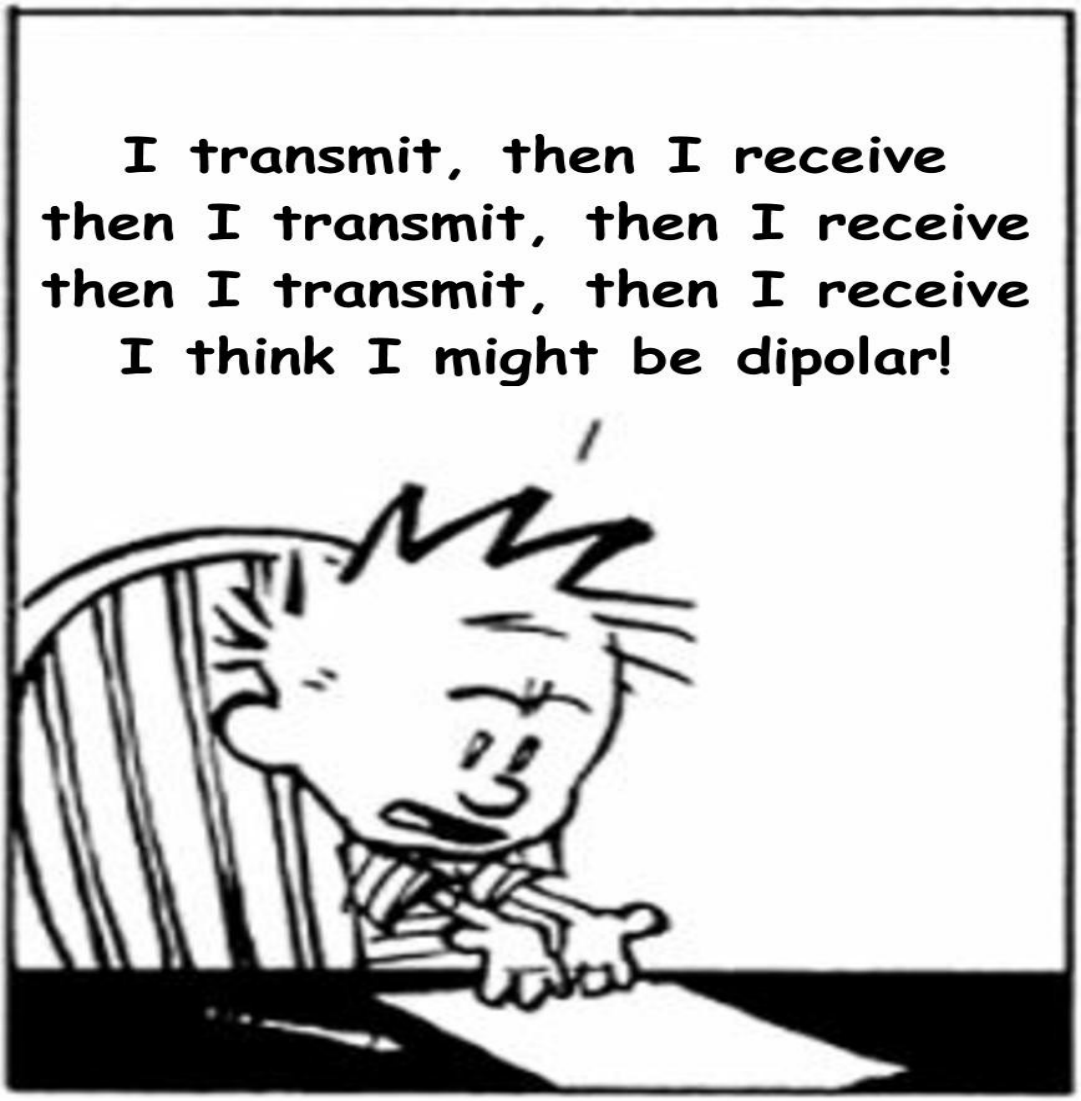
For Sale:
Comet CX-333 tri-band antenna. Used 3 years, still in very good condition and had a low SWR on all bands when decommissioned.
SPECS: Coverage: 2M, 1.25M, 70cm, VSWR: 1.5:1 or less, Max Power: 120 watts, Length: 10' 4", Weight: 3 lbs 8 oz , Connector: SO-239.
Construction: Heavy-duty Fiberglass, 2 sections
Asking $90. Contact Dave White, W4IIA for information.
804-501-8857

SK Estate Sale: Items include Heathkit SB-104A + Hand Mic, IC-730 + Hand Mic, Kenwood TS-440S + Hand Mic, Astron Power supply, 3 MFJ Tuners, Signalink SL1+ and associated accessories. The family is asking $500.00 for all.If interested contact Darren Faulkner at darrenthebaron@comcast.net

Thought For The Day

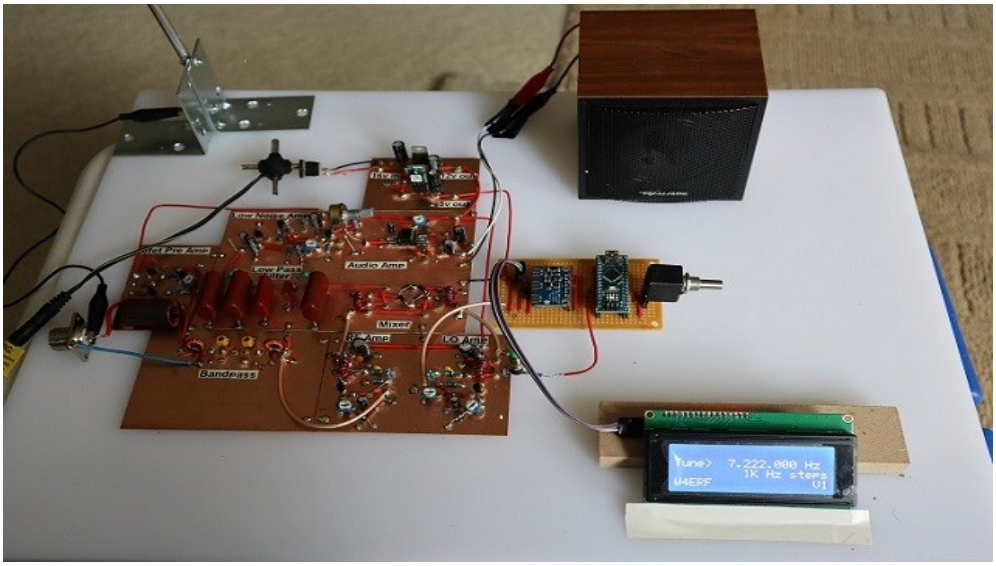
I always wanted to be somebody, but now I realize I should have been more specific.

Rick Waller	**KA4OHM**	**President**	**(804) 971-5815**	president@rarclub.net
Darrell Basinger	**WW4F**	**Vice President**	**(804) 672-7928**	vicepresident@rarclub.net
Dave Robinson	**KJ4LHP**	**Secretary**		
Ken Leidner	**WV0L**	**Treasurer**		



VWS 40 Meter Direct Conversion Receiver.

By Dan Brown (W4ERF)



Several months ago, as I was watching Youtube, I came upon a video from the Vienna Wireless Society (VWS) showing a direct conversion receiver they were constructing as a project in their makers group.

I put a comment in the video's comment section saying that I wish I could be involved in a project like that.

With that, Dean Souleles (KK4DAS) informed me that they were using Zoom Meetings for their project meetings and he invited me to participate.

I took him up on his offer and subscribed to the VWS maker group (vws-makers) on Google Groups.

Joining the group gave me access to several directories that included videos of past meetings and schematics.

I downloaded the appropriate schematics and started watching the videos. Each video focused on a particular subsection of the direct conversion receiver (Aduino control, SI5351 signal generator, mixer, amps, filters, etc.)

The first part of the build for me was to try to get an understanding of what a direct conversion receiver was and how the circuits on the schematics worked together to accomplish their functions.

As I understand it, a direct conversion receiver takes an incoming signal from the antenna and mixes it with a second frequency that is created by the Local Oscillator

When the two signals are mixed together (in the mixer), the mixer produces 4 primary signals. It produces a signal that is the sum of the mixed signals, the difference of the mixed signals and it passes through the two original signals (the RF from the antenna, and the signal from the Local Oscillator). Other harmonic frequencies are also formed but these are typically at lower amplitudes and will ultimately be filtered out.

Since this is a 40 meter receiver, the frequencies we are concerned with are in the vicinity of 7 Mhz.

Let's say for instance, there is a SSB transmission occurring on 7.200 Mhz. If we match that frequency with 7.200 Mhz coming from our Local Oscillator, we end up with the following frequencies...

RF = 7.200 Mhz

LO = 7.200 Mhz

RF+LO = 14.400 Mhz

RF-LO = 0 Mhz

Notice that all of the mixer output frequencies are 7.200 Mhz or greater with the exception of the RF-LO frequency.

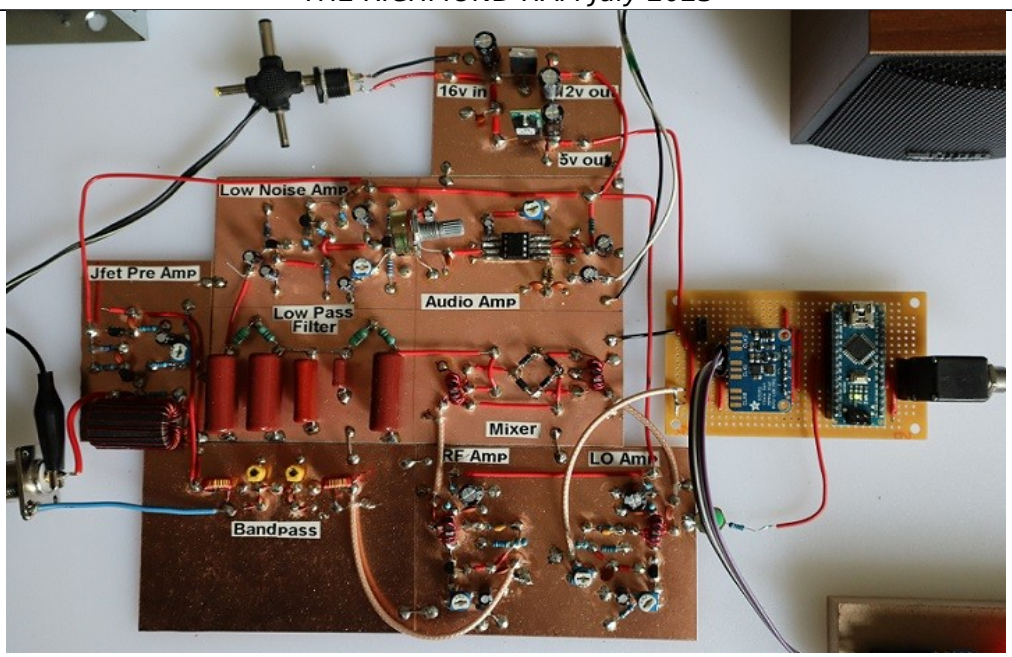
In the case of the RF-LO frequency, when we subtract these the only thing that remains is the audio frequencies that were being modulated on top of the RF signal. These audio frequencies are modulating around the 7200Mhz frequency which forms two side bands. The upper side band adds to the 7200 Mhz frequency and the lower sideband subtracts from it. By convention, the lower sideband is used on the 40 meter band. Amateur stations could also transmit using a fully modulated AM signal, but due to the inherent inefficiency and added bandwidth required for AM, LSB is primarily used in the voice portion of this amateur band.

All of the signals coming from the output of the Mixer are sent through a Low Pass Filter. The high radio frequencies are blocked and only the low frequency audio remaining from the RF-LO subtraction will be allowed to pass through the Low Pass Filter. The audio can then be amplified as necessary to drive a speaker and viola... we are listening to the transmission that is being received on 7.200 Mhz.

Changing frequencies is simply a matter of changing the frequency of the Local Oscillator. Whenever the Local Oscillator matches frequencies with an RF signal on the antenna, the audio being modulated on that signal will be heard on the speaker.

You will notice that if there is a slight mismatch between the frequency of the Local Oscillator and the RF signal being detected, you will hear a tone along with distorted audio. The reason for this goes back to how our mixer works. Lets assume the Local Oscillator is 1 Khz higher or lower than the RF signal being detected on the antenna. Being that there is 1 Khz difference in the frequencies, the mixer will output a 1 Khz tone along with distorted audio. As the frequency of the Local Oscillator approaches the frequency of the RF signal on the antenna, the output tone will become lower and lower until the tone completely disappears (zero beat) and the audio output will no longer be distorted.

My explanation of how a Direct Conversion Receiver works is overly simplified. There are additional filters, amps, etc. that are required to obtain the signal levels necessary throughout the various circuits.



The specifics of this project are as follows:

The antenna RF signal is routed to a 40 meter Bandpass Filter. This filter only allows a desired range of frequencies to pass on to the rest of the circuit. The band pass filter functions to block frequencies that are higher than desired and short to ground frequencies that are lower than desired.

From the output of the Bandpass Filter, the signal goes to a RF amplifier. This amplifier increases the voltage of the incoming RF signal and sends it to the Mixer.

The Mixer used in this project is known as a Diode Ring Mixer. It consists of 2 toroids that are wound in such a way as to make them into transformers and 4 Schottky Diodes connected in a ring configuration where the anode of one diode is connected to the cathode of the next diode. I don't fully understand the magic that takes place within the mixer. I know the primary thing that makes the magic happen is the non-linearity of the diodes. When the two input signals are mixed at different points of the diode ring the nonlinear interactions create additional sum and difference frequencies. Apparently, the Local Oscillator chops the signal coming from the RF amplifier. Half of the RF waveform gets inverted. This somehow causes additional sum and difference frequencies to be created. I must admit, I don't understand how it works, but it does work.

I hope to wake up in the middle of the night at some point with an Ah-Ha moment where my subconscious mind grasps the inner workings of the mixer and pushes it forward into my conscious mind... I'm sure the grand unified theory of the universe will follow shortly thereafter...

We talked about the RF input going to the mixer. The other input comes from the Local Oscillator.

The local oscillator, in times past, would have been a crystal oscillator or some other sort of resonant oscillator. In our receiver, the oscillations of the Local Oscillator will be created digitally. This will be accomplished using an Arduino microcontroller that sends instructions to a digital oscillator (SI5351). The Arduino also sends information to a 20x4 LCD digital display. This allows us to see what frequency the SI5351 is producing. This will correspond to the frequency the radio is being tuned to. The tuning is accomplished with a rotary encoder which looks like a potentiometer but you can spin it forever (there are no end stops). The rotary encoder internally consists of switches that are offset from

one another in such a way that if the rotary encoder is turned in the clockwise direction, the switches open and close in a particular sequence. If the rotary encoder is turned in the counter clockwise direction, the switches open and close in a different sequence. The Arduino monitors the rotary encoder, interprets the switching sequence and adjust the Local Oscillator frequency accordingly. Some rotary encoders also incorporate an additional switch that can be activated by pushing on the shaft of the rotary encoder. This switch can be used to change frequency step increments. (My rotary encoder did not have the additional incorporated switch, so I had to add a separate switch to accomplish step increment changes.)

The output coming from the SI5351 will be the Local Oscillator signal. This is fed to an LO amp that is virtually the same circuit as used for the RF amp. The output of the LO amp will be the second input to the Diode Ring Mixer.

One thing to be aware of with the SI5351 is... as its output frequency increases, its amplitude decreases. This shouldn't be an issue if you remain within a relatively small band of frequencies, but if you want to convert this Direct Conversion Receiver to work on another band (such as 20 meters) you may have to adjust the Local Oscillator Amplifier.

As we said earlier, the output of the mixer will contain 4 primary frequencies (the frequency of the Local Oscillator amp, the frequency of the RF amp, the sum and difference of the RF amp and the LO amp). From here the output of the mixer will go through a Low Pass Filter where only the RF-LO will be allowed to pass. This RF-LO signal will be in the audio range but it will be too weak to drive a speaker so the next stage (the Low Noise Amplifier) will boost the voltage to a more usable level and send its output to a Power Amp (the LM386 amp). This power amp increases the current to the point that its output can drive a speaker directly.

The final thing required to make this radio work is an appropriate power supply.

The amplifiers for this project all require 12 volts to operate, but the Arduino portion requires 5 volts.

Not to worry, as a ham radio supertech, building a small power supply should be a piece of cake.

Actually, it wasn't too difficult, but there were a few things to consider. It would be best to have regulated voltages to power everything. I didn't figure the radio would require a big power supply because it was receive only. I was going to use a wall wart. The wall wart would have to produce more than 12 volts at an appropriate current to power the circuits.

I had a universal wall wart that had a voltage adjustment switch that went from 3 to 12 volts. It actually put out about 15vdc unloaded. I decided to use it and it worked fine.

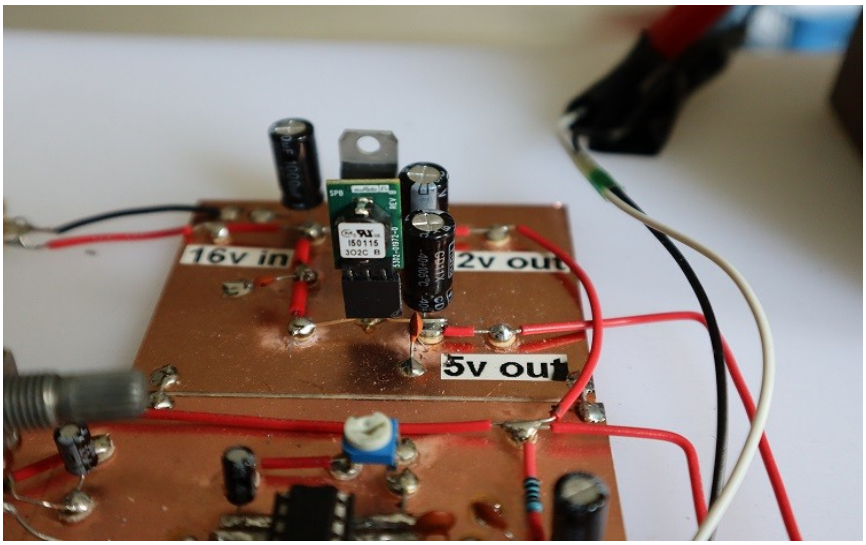
I put the output of the wall wart through a 12 volt voltage regulator (LM7812) and to a 5 volt regulator (LM7805).

The regulation of the 12 volts was no problem, but the 5 volt regulator was getting very hot.

I figured the regulator was having to drop at least 7 volts internally to provide the regulated 5 volts required by the Arduino and, since the LM7805 is a linear regulator, the voltage drop would need to be dissipated internally in the chip. This is what was causing the heat. I decided to put a resistor in series with the LM7805 regulator so most of the voltage drop would be across the resistor instead of the regulator. This worked, the regulator was no longer overheating but now the resistor was getting hot. A lot of needless power was being dissipated to support the regulated 5 volts.

The bottom line is, with a linear regulator, the power required to drop 7 volts at whatever current the Arduino, digital display and SI5351 was pulling would have to be dissipated somewhere and this caused my receiver to draw a lot more current than necessary.

Thankfully, I had a switching regulator that I got off of ebay a long time ago that was a direct pin for pin replacement for the LM7805 (see the picture below). I swapped the regulators and all of my problems were solved. I feared the switching regulator would interfere with the radio reception, but thankfully, it didn't.



And there you have it... A Direct Conversion Receiver.

I hooked my completed direct conversion receiver to a random length of wire that I strung across the second floor of my house and to my great relief... I started receiving stations on 40 meters !

The radio was actually working very well. I was very impressed.

I took it downstairs and it didn't work nearly as well.

I theorized it was due to the elevation change. The signals were much stronger up there.

My last modification to the radio was to build a pre-amplifier to compensate for the weaker signals downstairs. It consisted of a Jfet (J310) in a self bias configuration followed by a BJT emitter follower.

As it turned out, the pre-amp worked better than I hoped. It allowed me to pick up stations downstairs almost as good as I did upstairs. It also allowed me to use a small telescoping antenna instead of the long wire ran through the house. I think the extremely high input impedance at the gate of the Jfet was the reason. Smaller input impedances would drag down the already small signals whereas the high gate impedance of the Jfet (10 Mohms) didn't diminish the signals much at all.

The only remaining issue was with the Jfet preamp. It was amplifying everything. There was a very annoying 60 Hz buzz coming through. I went to my scavenged toroid junk drawer and pulled out several random toroids. I put a good number of wire turns around them to make them into chokes. I tried placing the coil of each toroid between the preamp input and ground. The first toriod helped, but the 60 Hz was still noticeable. The second and third toriods totally eliminated the 60 Hz problem, so I picked the smaller of the two toroids and wired it into the circuit... It would probably have been better

to add a real high pass filter circuit to input of the preamp, but the random toroid worked and it didn't affect the frequencies I was interested in, so I counted it as a win.

I took the radio to the RARC club meeting for a show and tell. It was very well received and I was able to pick up a few stations to demonstrate.

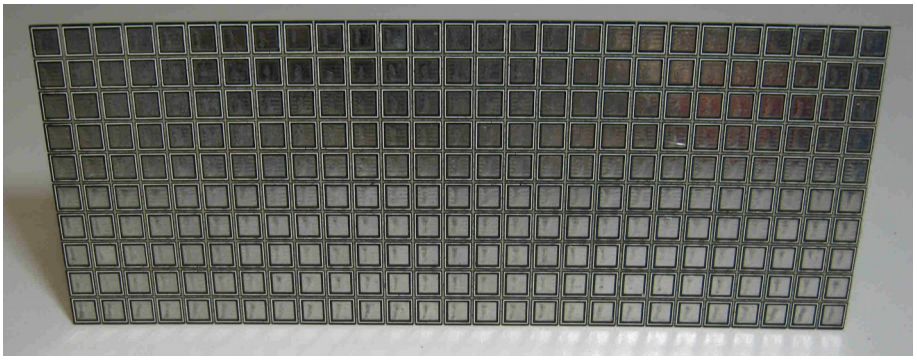
There was a great deal of interest in my construction techniques. Many of the operators there had not seen this type of construction technique before.

The construction technique I was using was mainly “Manhattan” style construction. For the Arduino portion I used a strip board.

The Manhattan style construction technique takes small pieces of singe sided PC board (usually a few millimeters across) and you superglue these small pieces to a single sided PC board. The small pieces of PC board are glued with the copper side up. What you end up with is islands that components can be soldered to. The circuit board islands are insulated form the PC board they are glued to by the PC board material. By putting circuit board islands wherever solder connections are needed, it is possible to quickly prototype a circuit. The PC board that the islands are glued to becomes the ground plane for the circuit.

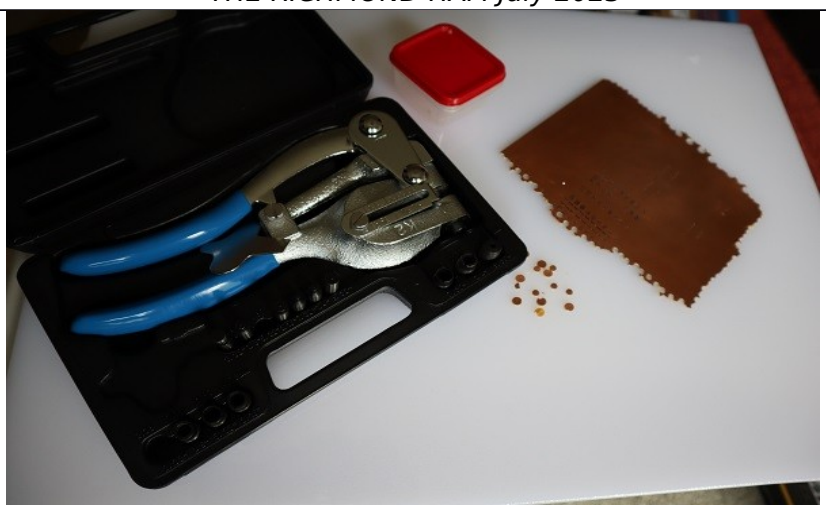
As for making the PC board islands, they can either be made or purchased. You can purchase “MeSquares”. They are little squares that are machined into a PC board that can be snapped off and used as needed. They are very convenient and look very professional. Their downside is they have to be ordered which can cause delays in completing your project and they cost more than making your own.

MeSquares



Another way to create the islands for use in Manhattan style construction is to use a sheet metal punch to create little round islands (this is the technique I use). Instead of using the punch to make holes in sheet metal, you use it to punch holes in a PC board and the little circular rounds that it pushes out are collected and used to make the Manhattan islands. The tool I us is shown below. Be aware, it takes a fair amount of force to punch the holes. The best technique I have found is to lay a towel on the floor and use my body weight to push down on the handle and pop out the rounds. Doing it this way is much less tiring and you can better control the PC board that you are punching.

Sheet Metal Punch



There are other ways to make the islands also. People get very creative. Some people use aviation snips to cut a PC board into pieces and use the cut pieces as islands. Others use small drill presses with home made bits to literally dig into the PC board and cut circles into the copper to make electrically isolated islands. You can check out Youtube to see what various people have done.

The second technique I used in this build was the strip board technique. The strip board technique was more practical for use with the Arduino and the SI5351 because of their closely spaced pins. The strip board technique is a through hole technique where the components are inserted into the holes in the top of the strip board and copper strips on the underside connect entire rows of holes together. To make a strip board work for your circuits requires a little pre-planning (I usually draw everything out on graph paper). If two items are on the same row, the strip will short them together. If you don't want those two items to be connected together, you can use a small drill bit to open up the trace (no need to drill all the way through, just opening up the conductive trace is enough). For items on a different row that need to be connected together, a wire jumper form one row to another can be soldered in to connect the rows.

Strip Board

The last technique I used was a modification of the strip board technique.

The audio amplifier used in this build was a LM386. It is an 8 pin, dual in line package IC.

I cut out a small portion of a strip board to fit the LM386 and opened up the traces in strip board so that when the LM386 was placed on top of the strips, pins 1 through 4 would not be shorted to pins 5 through 8. I took an 8 pin socket and splayed the legs out, and soldered the legs to the strip board as if it were a surface mounted component. I plugged in the LM386 and completed the rest of the circuit in the Manhattan style.

I was very pleased with how the radio worked out and its performance exceeded my expectations.

I would encourage everyone to try to build something like this. I learned a lot and it has motivated me to try other builds as well.

This is one of the things that appeals to me the most about Ham Radio... the culture of building things and experimenting.

I am by no means, an expert on Direct Conversion receivers and this article is not authoritative.

If there are any conceptual errors, please give me feedback. It will be appreciated. My goal is to obtain greater understanding.

A special thanks goes out to the Vienna Wireless Society for facilitating these projects and their willingness to allow distant hams to participate. If anyone else would like to build this project, I suggest contacting the VWS maker group (vws-makers) on Google Groups. The schematics and videos are available there.