WCF EXPERIMENTER

WCF EXPERIMENTER SET TO RESTART IN JULY

By Darrell Davis, KT4WX

During the month of July, the WCF EXPERIMENTER will be restarted. The newsletter will be published sometimes in the months of January, April, July, and October.

We are looking for articles from our LOCAL authors. The WCF EXPERIMENTER will be edited by Jim Weslager K3WR who is our editor for the WCF PRESSER.

We do not want the WCF EXPERIMENTER to be what "*Geoff N1GY and Darrell KT4WX did this month*" as it tended to be sometimes in the past.

There are quite a number of you out there who are very talented and have designed and built some extraordinary projects and we would love to hear about it. If you have a Tip or Trick on something you discovered to make something work better or more efficient send that in as well.

If you have an article you would like to submit for publication in the WCF EXPERIMENTER, please send it to Jim Weslager K3WR via email at weslager@gmail.com. Jim can work with almost any format out there.

When sending in photographs, schematics, etc., send it to Jim in the highest resolution possible so your images turn out the best that they can.

If you have seen an article from an author on a website or another newsletter that you think would look good, please send that suggestion to Darrell Davis KT4WX via email at kt4wx@arrl.net so they can be contacted and permission obtained to run the article from its author, if the article is appropriate.

SIXTH ANNUAL TECHCON

The venue has been set for the 6th Annual TECHCON. The 6th Annual TECHCON will be held on Friday February 21, 2020 and Saturday February 22, 2020 at the Charlotte County Emergency Operations Center in Punta Gorda.

Our Friday Afternoon Seminar will be an Introduction to the Internet of Things given by Jon Pellant W1JP who is an ARRL Technical Specialist and the ARES Emergency Coordinator for Charlotte County ARES. Thank you, Jon for being willing to do the Friday Afternoon Seminar for TECHCON 2020. Be sure to put TECHCON 2020 on your calendar.

WEEKLY ARRL WEST CENTRAL FLORIDA TECHNICAL NET

Do not forget about the weekly ARRL West Central Florida Technical Net on Thursday evening at 2100 on the NI4CE Repeater System.

For more information on the NI4CE Repeater System, including a list of frequencies, coverage map, etc., go to the West Central Florida Group website at http://www.ni4ce.org. They also have a Facebook page at https://www.facebook.com/ni4ce.

The NI4CE Repeater System is owned and operated by the West Central Florida Group Inc. and the ARRL West Central Florida Section wishes to thank the West Central Florida Group for the use the NI4CE Repeater System for the Technical Net and all the Section Nets.

Wishing you success in your latest project on the workbench and keep your soldering iron hot but in its holder when not being used :-)

ARRL TECHNICAL INFORMATION SERVICE

One benefit of ARRL membership that is often underutilized is the ARRL Technical Information Service. This service is provided by the ARRL Lab and is overseen by Zack Lau W1VT, who works for the ARRL Lab. If you have a question about a technical topic you can get a hold of the ARRL Technical Information Service by the following means:
Web: http://www.arrl.org/technical-information-service
Email: tis@arrl.org

On the ARRL Technical Information Service web page there is a quite a list of resources that may help you with your project and or problem you are trying to solve. Email inquiries are answered during business hours and any questions sent in after business hours will be answered the next business day or the following day, typically. If you are not an ARRL member, they will ask you

to consider joining the ARRL, then be glad to assist you.

ARRL TECHNICAL SPECIALIST - BE ONE

If you have an area of technical expertise, consider becoming an ARRL Technical Specialist.

The qualifications are:

1) You have to be a member of the ARRL,

2) Have technical knowledge and or experience in a specific area of amateur radio technology or general amateur radio experience, and,

3) Have a sincere desire to help other hams with technical questions by email and or telephone.

If you are interesting in applying to be an ARRL Technical Specialist go to the ARRL Station Application Form on the Section website at http://arrlwcf.org/section-forms/station-appointee-application-form/. The form goes to Darrell Davis KT4WX, our Section Manager and Geoff Haines N1GY, our Technical Coordinator for review and if approved you will be appointed an ARRL Technical Specialist. Once approved you will receive a nice startup package from ARRL HQ to help you answer questions from those who ask for your assistance.

To those of you who are already ARRL Technical Specialist, thank you for what you do for amateur radio and giving assistance to your fellow amateur radio operators.

A HOME-BREWED RESISTANCE SOLDERING RIG

By Geoff Haines, N1GY
ARRL Technical Coordinator - West Central Florida Section

Geoff Haines, N1GY

Every once in a while, most of us come across a task that requires that we learn a new skill or buy a new piece of equipment or both. Such was the case when I decided that I had to learn how to install SMA connectors in order to modify a new speaker mic that I purchased at the Orlando Hamcation.

My first attempts were very poor. I got too much solder on the center pin which made it impossible to insert said pin into the housing. Eventually I got the job done properly but it was very obvious that a different approach was needed.

Several years ago I wrote a evaluation of several battery powered soldering tools (QST June 2007) One of the tools tested was a battery powered resistance soldering tool called "Cold Solder", I think. I could be wrong. It has been over 10 years and I am getting on. In any case that prompted an Internet search on the subject of resistance soldering. The resulting hits were astonishing. Proper commercially available resistance soldering tools cost anywhere from $400 to $1200. WOW!

The saving grace was that there were a number of articles on building a DIY version for MUCH less cost and achieving the same result. The two articles that I referred to most were both from the model railroad hobby where the construction of very detailed model steam locomotives requires much soldering and also requires that almost all of the solder be out of sight. No blobs or swoopy fillets here. Some of the builders have thus embraced resistance soldering.

The two authors that I referred to most were Paul James from Blenheim, Ontario, Canada and Vance Bass from Albuquerque, New Mexico.

Both are from the model railroad community. I combined Paul's power unit design with the tweezers that Vance designed.

A bit of background may be useful here. The concept of resistance soldering is fairly simple. One places two electrodes in contact with the work piece you wish to apply solder to. Current flows between the two electrodes and because the resistance of the work piece is higher than elsewhere in the circuit the area of the work piece between the electrodes heats up and the solder flows. Depending on the size of the work piece this can happen quite quickly so most units use a foot pedal or switch to turn the electric current on and off. This leaves both hands free to manage the application of the electrodes. One advantage is that nothing outside the space between the electrodes heats up at all. Sensitive components stay cool and fine wires do not suddenly dissolve.

As usual, my first order of business was to download both articles from the Internet and then begin to search my copious parts containers for materials that could be used. I did have to do a bit of shopping after the search. Purchased were a transformer similar in size and output voltage to the one Paul James used. I got a very good deal from my local electronics shop as the transformer was used and the proprietor was not aware he even had it so I got it for less than $6. A computer style power cord was found at the same shop for about $2. An enclosure was fashioned from a 4" x 4" x 4" NEMA box from Home Depot. The bamboo tweezers were obtained from Bed Bath and Beyond for less than $2. Almost everything else came from my overly stocked parts stock.
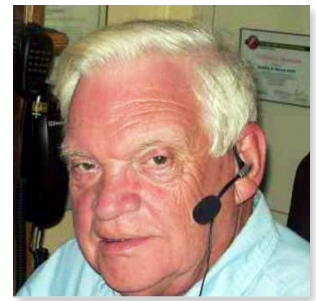
The only item I had to order through the Internet was a pair of brass fittings that are called 90335-KNGI ACE Connector, 2/BG, 8-18 awg - They were obtained from Galco Industrial Electric.

Once I had most of the parts in hand, construction commenced. I had already done some testing to determine what voltage the transformer put out of the secondary taps and based on my research decided that the two taps that resulted in approximately 8 volts would be used. I had also determined which two of the three primary wire inputs would be connected to the mains power. I was very careful when testing these aspects because the 110-volt power was out in the open and not insulated from a careless hand. I got through that part of testing without difficulty but extreme caution is advised.

I planned out the holes that needed to be drilled for power in, power out, the dimmer switch and the LED power indicator. Once they were drilled, assembly began. First the transformer was placed at the bottom of the NEMA box where it was a neat fit. I thought about adding some wood shims to wedge it in place but I found that the weight of the transformer was enough to keep it in place. The box is unlikely to move off my workbench very often, but "your mileage may vary" as they say.

Next the dimmer switch was wired in between the transformer primaries and the mains power cord. The ground lead from the dimmer was connected to the ground line of the power cord as well. About three to four feet of 12 gauge zip cord was installed through a pre-drilled hole in the front of the unit and secured to the secondary wires from the transformer by first crimping with bare metal butt splices and then flooding the connections with solder to keep resistance to a minimum. Remember the resistance at the work must be the

highest resistance in the circuit or it is some other connection that will get red hot and fail.

A simple bridge rectifier and resistor circuit was built to supply a red LED with the appropriate current and voltage and it was installed across the hot and neutral from the power cord. It is intended and indeed the control method has been built to control the mains power going to the unit via a pedal operated switch which will be on the floor. Thus, when the foot switch is pressed, the LED will light up. When the foot switch is not depressed there is no mains power anywhere in the system. Safety first.

At the other end of the 12 gauge zip cord, a bamboo toaster tongs or tweezers were attached to the wires as is shown in the photo. Installed on the ends of the wires were the ACE connectors. The other end of each connector holds the soldering tips which I made from 3/32" copper clad steel welding rod. It was relatively simple to chuck a 2" piece of the welding rod into my drill press and then use a metal file to create a tapered tip on the rod.

After that was done, I bent each tip in my vise to an appropriate angle for use. I secured the 12 gauge wires to each leg of the bamboo tongs using a combination of heat shrink tubing at the pivot end and wire ties on each leg. The ACE connectors are insulated with heat shrink as well and I also added a cover of ABS plastic to each leg as well. These were also secured with heat shrink tubing.

The voltage across the tips may only be less than 9 volts but the current available is quite high, certainly enough to give the victim a nasty burn if not worse. Again, safety first.

Using the tool is actually quite easy. Using the assembly of an SMA connector as an example, I

tin the center conductor of the RG-316 coax using a standard soldering iron of about 40 watts. I then insert the center conductor into the pin of the connector and touch the pin with the resistance soldering tool. This melts the solder and connects the pin to the center conductor. It also leaves no solder on the outside of the pin meaning it can be readily inserted into the SMA housing. The crimp tube is then brought up over the back end of the housing to capture the shield between the outside of the housing and the crimp tube. A standard crimp is then applied to the crimp tube locking the shield to the housing. Job done. It is advisable to add a short length of heat shrink over the crimped tube for aesthetic purposes.

If one is going to use this tool for regular soldering of components, a certain amount of practice is advised. It is necessary to have both of the tips in contact with the work and to apply solder only to the area between the tips. It is also vital to not apply power until both tips are in contact with the work. Otherwise a fairly large spark or arc can emerge and your work will have a major divot in it. The heavier the material, the longer it will take to heat up. Having said that, Paul James noted that his design was able to heat up fairly heavy gauge materials easily. I have not attempted anything heavy yet.

This is the front face of the power module. You can see the LED power indicator and the exit point of the 12 gauge zip cord. Ordinarily I would use a strain relief grommet here and at the back where the mains power cord exits, but the wall thickness of the NEMA box makes that

impossible so I used wire ties on both sides of the wall to restrain the cords from shifting. I added an ON/OFF switch which cuts off all power to the rig for safety's sake. The hex wrench on top of the box is for replacing the metal tips of the hand piece when required and is now stored on the hand piece holder pictured below.

This is the top of the power module. The dimmer switch allows adjustment from 0 to about 8.4 volts AC. The dimmer switch also had an on/off function which is not used at present since the unit already has an ON/OFF switch. The dimmer had to be replaced since the first one was somewhat elderly and went belly up very quickly. The new one required some re-positioning of the voltage levels but appears to be working fine so far.

Here is the transformer as it sits in the bottom of the NEMA box. The mains power cord exits at the top of the picture and the 12 gauge zip cord exits at the bottom (not clearly visible in this picture. The coiled up orange, red and white wires are not used at all. Out of the picture are the dimmer switch and the bridge rectifier circuit for the LED.

The transformer was marked as having a 120 or 130 volt primary, I used the 120 V leads. The secondary had a max of about 17 volts AC, using the center tap I got 8.4 volts which was suitable for my purpose. Not shown here is the ON/OFF switch that was added later.

Here is the underside of the dimmer switch mounted on the lid of the box. The black wires connect from the hot wire from the power cord and to one of the leads from the primary side of the transformer. The green wire is secured to the green ground wire of the power cord.
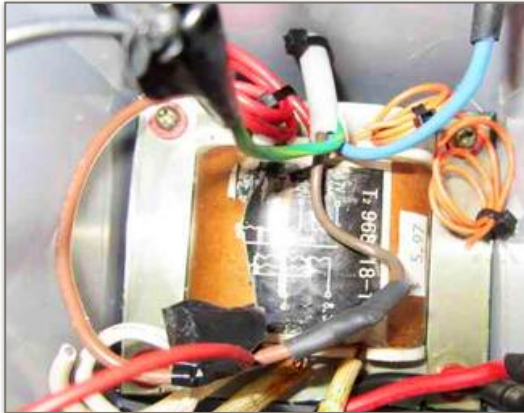
The dimmer shown unfortunately died before I even got to use the rig. I replaced it with a similar on that did not need the defeating of the push on push off switch as it had a much simpler on/off switch at the end of its rotation. Naturally the indicated voltage positions had to be altered as well. You will note that the corners of the mounting plate were clipped at a 45 degree angle to allow the dimmer to fit snugly into the lid.

The foot switch that I used comes from MPJA.COM here in Florida and cost less than $6. It is rated at 10 amps. With rewiring it also makes an excellent foot PTT as well.

Here is a photo of the bamboo tweezers with the zip cord wires temporarily attached.

This picture shows the connectors that will join the wires to the operating tips on the tweezers. The tips (not shown) are made from 3/32" copper clad steel welding rod with the ends filed to a conical tip. I have also changed the electrodes that I use for the SMA pins to ones that have flat surfaces facing each other so that the pin can be held by the hand piece for soldering.

The hand piece is now complete. I installed the wires shown in the picture of the bamboo tweezers into the brass fittings and then placed the supplied heat-shrink tubing around them leaving the front set screw area uncovered so I can replace the copper clad steel tips when needed. I also placed two strips of 1/8" ABS plastic on top of each side of the tongs to minimize the possibility of electric shock or burns.

A brief test of the rig shows that it may need to be

turned down from 8.4 volts to around 5. It certainly heats up the test work very quickly to soldering temperatures. At the 8.4 volt setting it is almost too fast, creating a control factor. Five volts may be a better setting, testing will continue. The copper clad steel electrodes that I made from 3/32" welding rod are holding up well but I am going to continue testing with smoother conical electrodes to see if there is an improvement in control and positioning. Other styles of electrode will also be tested.

Here is a very rough and ready diagram of the circuit. The LED power indicator .is fed through a bridge rectifier via a 50K resistor and lights very nicely. The Dimmer switch controls the output voltage between 0 and 8.4 volts AC The transformer takes 110 Volts AC and puts out 8.4 volts AC into the tweezer handle. THe whole unit
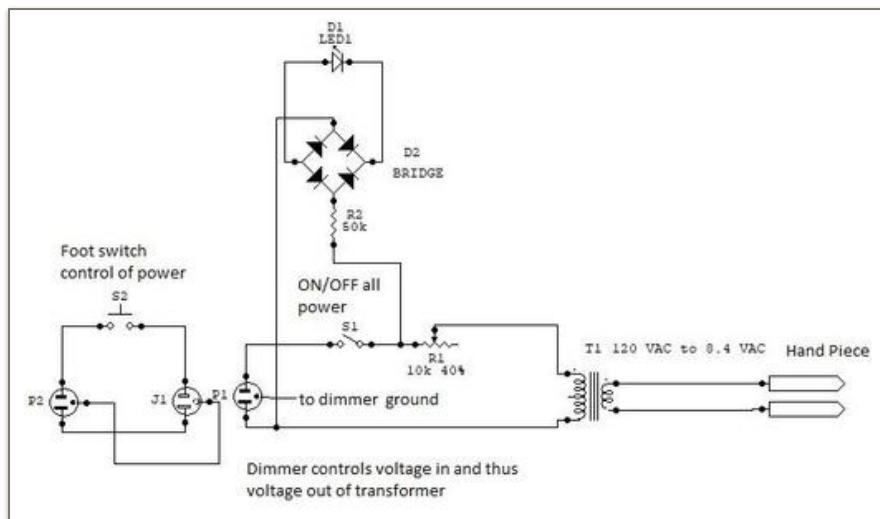
is fed via a foot pedal on/off switch that is operated by the user so as to keep both hands free.

This holder, rough and ready as it is, was made from a powdered drink mix container and mounted on a small slab of plywood. Holes were drilled in the plywood not quite through to hold the hex wrench and the spare electrodes. One set of electrodes has conical tips on the operating end and the other set has flat angled ends to perhaps give a better contact area with the work.

Since I completed construction of my resistance soldering system. I spent part of the day testing it out. At the setting of 4.8 volts

(approximately) I was relatively quickly able to build two RG-316 cables, one with SMA male connectors on both ends and one with an SMA male connector on one end and an SMA female connector on the other. I had no problems with either and both were tested and found free of short circuits. I plan to place SO-239 to SMA female adapters on one of the male SMA connectors on each cable thus creating two "rig savers", one for HT's that have a SMA female connector on the radio like Yaesu and some Wouxons and the other for the Baofang style where the connector on the radio itself is a Male SMA.

I have already ordered the SO-239 adapters and they should be here by mid-week. The new electrodes and the resistance soldering rig were

also put to the test by soldering two pieces of 3/32" copper clad steel welding rod (actually the same stuff that the electrodes are made of). The job took an extra few seconds to heat the welding rod up but the solder flowed nicely and made a secure solder joint length wise between the two pieces.

Tomorrow, I am going to look for some brass material at my local hardware store to test solder larger and heavier materials. I will also see if raising the voltage setting will speed up the soldering of the heavier materials.

I must admit that I am quite pleased with how this project has worked out so far. Better than I expected and very usable for the tasks I have tested it on so far.

Design of an HF QSD SDR for the Arduino and Raspberry Pi

Edward Cholakian, KB1OIE
ARRL Technical Specialist

This paper describes the implementation of a software defined radio for HF reception to be used on two popular single board computer form factors, the Arduino, and the Raspberry Pi. The goal of the design is to produce good quality receivers that are inexpensive and open sourced for further experimentation and software development. The design includes an RF front end and bandpass filters, a quadrature sampling detector, analog to digital converters with drivers, digital signal processing (DSP), display interfaces, and digital audio stages for a complete receiver without the use of an external computer. Alternately the radios can run as remote controlled local or internet connected server of the received digitized data. A prototype for an Arduino using a 32 bit Microchip MIPS based processor with fixed point DSP has been built, and two new multilayer boards are currently being tested. The required digital signal processing algorithms have also been written in C using only double precision floating point hardware for ARM and x86 implementations.

Keywords
SDR, Arduino, Raspberry Pi

1. Introduction

The original impetus for this project was to design a replacement for a desktop general coverage HF receiver built by a well-known radio manufacturing company. Rather than trying to update the previous superhet design it was more direct for me, a embedded hardware and firmware engineer, to use digital rather than all analog techniques to realize the new design. It was also desired to support various digital modes directly within the new radio. A further departure from a traditional radio design was in not using a large number of mechanical user interfaces for control in favor of more

graphical touch display user interfaces.

2. System Overview

A great deal of literature is available on the design of an SDR using a direct conversion quadrature sampling detector (QSD) topology and was referenced. Please see these for further explanations of the QSD SDR techniques. The design choices made in this implementation are described here.
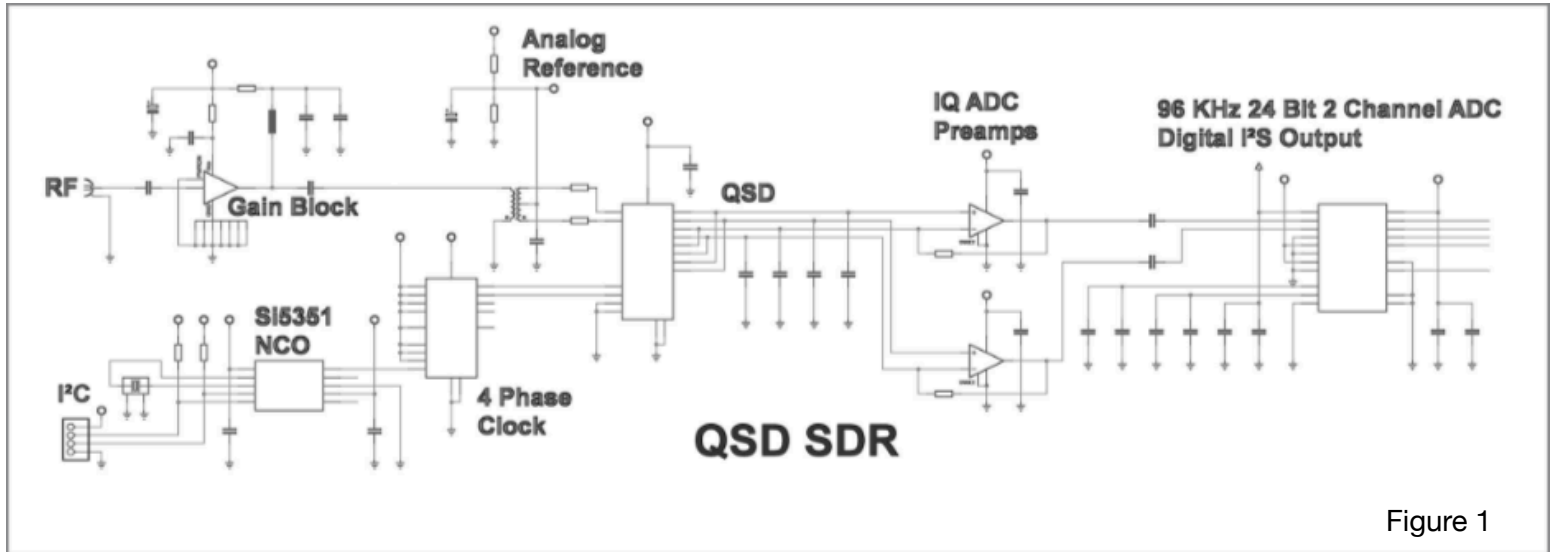

Figure 1

This design uses a double balanced QSD for low dB loss through the mixer.1 A 1:1 ratio center tap .3 to 300 MHz transformer is used at the input on the SDR board. RF input to the SDR board is through a SMA connector. Front end switched filter banks required to reject residual images due to amplitude and phase imbalances in the mixer are external to the SDR board and controlled by the radio's processor.

2.1 A QSD is a two or more channel sample and hold circuit that is used to process an RF signal into frequency shifted analytical components. Mathematically the two analytical components, I and Q, represent the input signal on both the real and imaginary planes. Electrically the two output signals are an input signal that is shifted down in frequency and separated 90° in phase. Using the IQ signal format it is easier to process the signal information content digitally. Ideally mixing can take place with no images.

Each sample and hold circuit is built using an analog switch and capacitor. When the switch is connected to a input signal its instantaneous voltage is integrated with a capacitor. This circuit is arranged so that four capacitors are charged in turn covering 90° of signal each, that is 0°, 90°, 180°, and 270° at the clocking frequency. A numerically
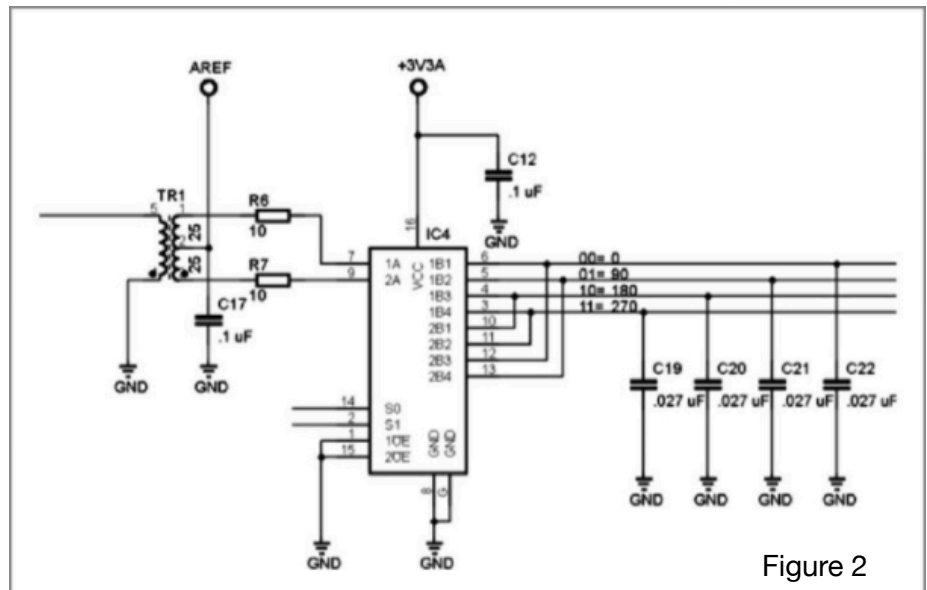

Figure 2

controlled square wave oscillator is used to clock a counter to generate the two bit switch sampling control sequence.

Signal pairs from the capacitors, 0° and 180°, and 90° and 270°, are combined by subtraction in two operational amplifier buffers to produce the IQ signals. The bandwidth of the received IQ signals before the opamps are determined by the charge time constant of the sampling capacitors and the input impedance through the RF chain. The cutoff frequency c = 1 / (2·Z·C) where the impedance (Z) is a combination of the input impedance, the RF transformer turns ratio and differential splitting, internal on switch resistance of the analog switches, the series swamping resistors (used to reduce the percent variation of the analog on switch resistance), and a factor of four multiplier effects due to each charging capacitor being driven for only ¼ of a cycle. The voltage gain in the 1:1 differential RF transformer is 0.5, and the gain in the opamps is by their feedback resistance divided by Z times 2. Note that the opamps used in this design require a low input impedance for the best noise performance.

The analog to digital converters used in this design can run at a sample rate up to 96 KHz but are run here at 48 KHz. The ADCs actually sample at a much higher rate than the set sample rate, but include internal decimating digital bandpass filters to output the reduced sample rate. This greatly reduces the complexity of the antialiasing filtering required before the ADCs. The output of the ADCs are two channels of data encoded into a single 64 bit per frame I2S encoded stream to the processor.

RF gain is realized in three sections: in a fixed RF gain block in front of the QSD mixer, in the low noise opamps used to drive the analog to digital converters, and inherent in large dynamic range of

the ADCs themselves. The first stage of gain is made using a TI 12 dB fixed gain block amp. The TI TRF37A73 chip is designed to operate to gigahertz frequencies, but is tuned here to operate over the entire MF to HF spectrum. With the current values used in this design the gain through the RF transformer, QSD, and opamps, calculates to 35 dB for a total gain of 47 dB to the ADC.

The ADC used here has two synchronized channels of 24 bits each with a SNR of 103 dB. The reference voltage is 3 Volts p-p. With the front end gain of 47 dB the ADC overloads with a S9+45 signal present in the receive bandwidth. The minimum detectable signal is about .07 v, although a more usable signal 2 bits above the noise would be .5 v.

3. Hardware Description
For this project both an Arduino and a Raspberry Pi based single board computer were chosen to process the digitized IQ data generated by the SDR radio interface boards into received audio. An embedded design using any one of a number of processors could have been selected for the SDR application, but these two platforms are well known and offered powerful computing and interface options at minimal cost.

For the first prototype radio a Diligent chipKIT Wi-FIRE Arduino board was used. This board is WiFi enabled and has a Microchip PIC32MZEF MIPS processor. The PIC32MZEF runs at 200 MHz and has two megabytes of Flash program memory and 512 KB SRAM all internal to the chip. It features a DSP- enhanced core with four 64-bit accumulators, single-cycle MAC, saturating and fractional math, and hardware floating point. It has many channels of I2S to support the digitized streamed IO needed. The audio amp used is a PmodAMP3 board, also made by Diligent, and is

external to the SDR interface and Arduino board. It is based on an Analog Devices SSM2518 chip. The SDR firmware controls two independent I2S channels running at different sampling rates. One is used to capture the IQ data stream from the SDR interface board. This data, in fixed point format, is loaded into one of two memory buffers through a FIFO using an interrupt service routine. When a memory buffer is full a flag is set denoting data is ready to be processed, and the interrupt service routine then switches to the alternate buffer for the next input sample. A foreground routine processes all stored raw IQ data into decoded audio data switching buffers each pass. The processing time is short compared to the fill time of the buffers leaving plenty of processing time to perform other tasks. The second I2S channel runs in a similar manner but is outputting audio data at a lower sample rate to a class D stereo amplifier driving two speakers. An I2C interface is used to setup and control the stereo amp, the three channel numerically controlled oscillator (NCO), and to switch the RF front-end bandpass filter banks when required. The NCO is used to generate the clock for the QSD mixer, the ADC, and the audio amp.

As a remote controlled server the full 48 KHz bandwidth of IQ data can be delivered with or without processing to an external computer, tablet, phone, or to the internet using Ethernet, USB or WiFi interfaces.

4. Firmware Description

The prototype radio firmware application supports only basic tuning and audio volume control, as in a simple desktop radio. AM, USB, LSB, and CW modes are supported.

All coding for the Arduino prototype was done using Microchip's MPLAB X IDE development environment in straight C and assembler under their Harmony framework. Microchip 16 and 32 bit libraries were called to implement the several fixed point finite impulse response (FIR) filters required to process the complex IQ data. Initial testing was done on a Raspberry Pi running at just 700 MHz with C code written to implement the FIRs using calculations done by double precision floating point hardware. The ARM processor easily supported the required processing load.

5. Radio Processing Algorithm

Figure 3 documents the hardware and processing steps to realize this basic SDR radio using FIRs on the MIPS based Arduino board. It only requires a few changes to the procedure to be used with the Raspberry Pi platform.

The first stage of processing is a 2nd IF frequency shift by a small amount to tune within the baseband at an offset from center frequency. This is done to move away from system noise that leaks into the received signal. A complex sine cosine multiplication of the signal by a software numerical oscillator preforms the mixing without images. The firmware takes advantage of a special case and shifts the frequency by 1/4 of the IQ sample rate to reduce the calculations required. At this rate the sines and cosines are always one, zero, or minus one and no trigonometric calculations are required.

The next stage both filters and decimates the shifted IQ data stream. The decimation is set to reduce the sample rate from 48 to 12 KHz. This lower rate reduces the subsequent processing required, and the filtering sets the bandwidth to that used in AM mode. AM demodulation is simply the magnitude of the |IQ| data, where each audio data sample is the square root of the sum of the squares of the I and Q elements. Single-sideband requires a further reduction in bandwidth and a Hilbert transform to shift the I and Q data 90° in phase between each other. Detecting the upper or lower sideband is determined by either adding or subtracting the transformed IQ vectors.

Antenna

Bandpass Filter Bank
RF Gain
QSD
NCO Clocks
ADC Drivers

NCO Clock 1
Tunned Frequency
with 2nd IF Shift

IQ ADC Master Mode
48 KHz Sample Rate
24-bit Data, 32-bit Channel/64-bit Frame

I2S Input Port
Slave Mode
48 KHz Sample Rate
32-bit Data, 32-bit FIFO, 32-bit Channel/64-bit Frame
4 Level FIFO
Interrupt is generated when buffer is full by one-half or more

NCO Clock 2
24.576 MHz

1024 32-bit Buffers

I Data   Q Data

Fixed Complex Low-IF Shift
by 1/4 Sample Frequency

Lowpass Decimating Filter
Reducing Sample Rate

Lowpass Filter IQ Single Sideband
Hilbert Transform Q Data by 90°

Magnitude I and Q AM   Vector Add I + Q Data USB   Vector Subtract I - Q Data LSB

NCO Clock 3
3.027 MHz

I2S Output Port
Master Mode
12 KHz Sample Rate
24-bit Data, 32-bit FIFO, 32-bit Channel/64-bit Frame
Interrupts are generated when the buffer is empty by one-half or more

I2S Stereo Class D
4 Watt Power AMP
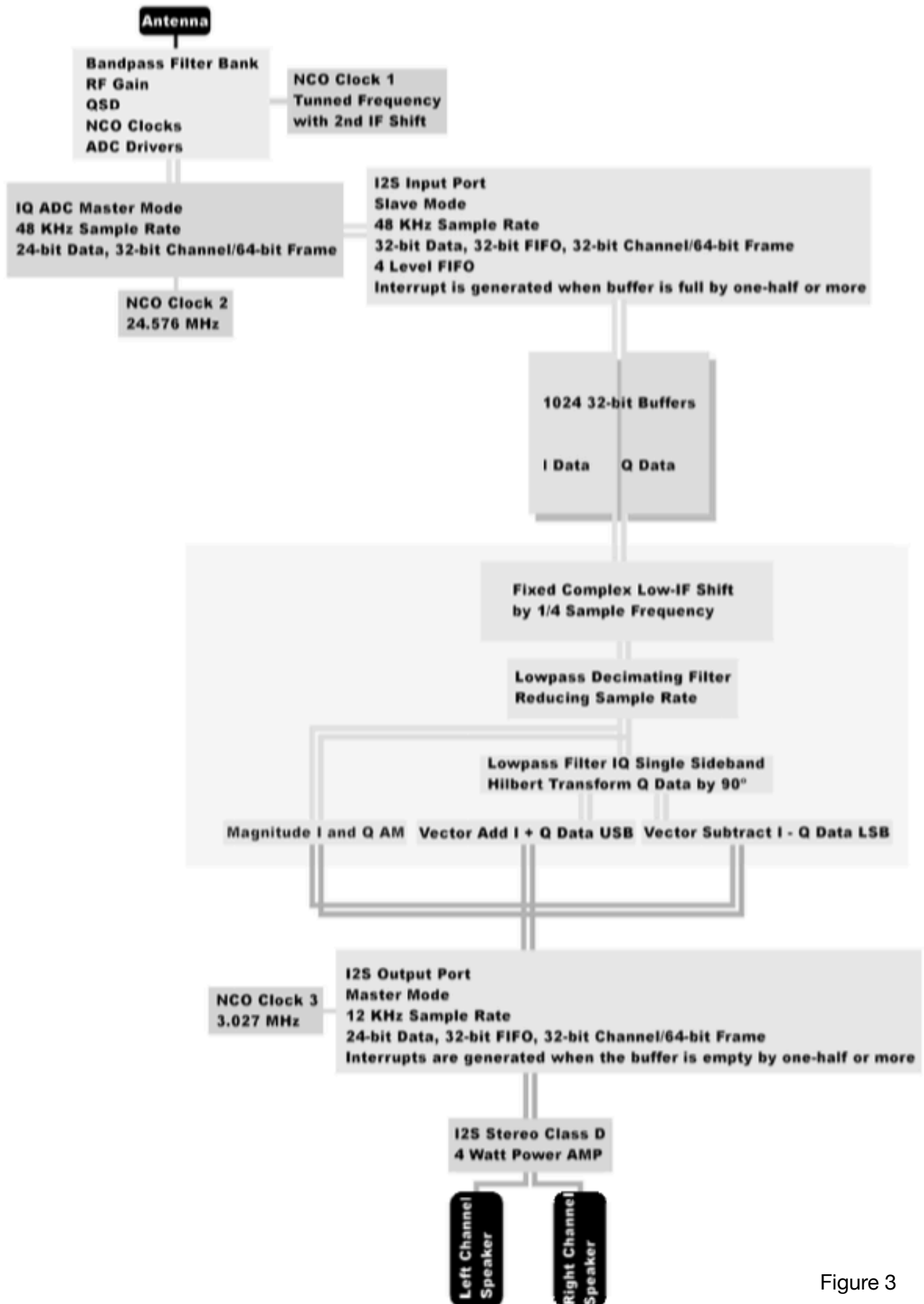
Left Channel Speaker   Right Channel Speaker

Figure 3

The bandpass characteristics in all the 88-tap FIR filters used can be easily changed in software by modifying the filters' coefficients.

Several automatic gain control (AGC) algorithms have been tried for voice or data, all in software only.
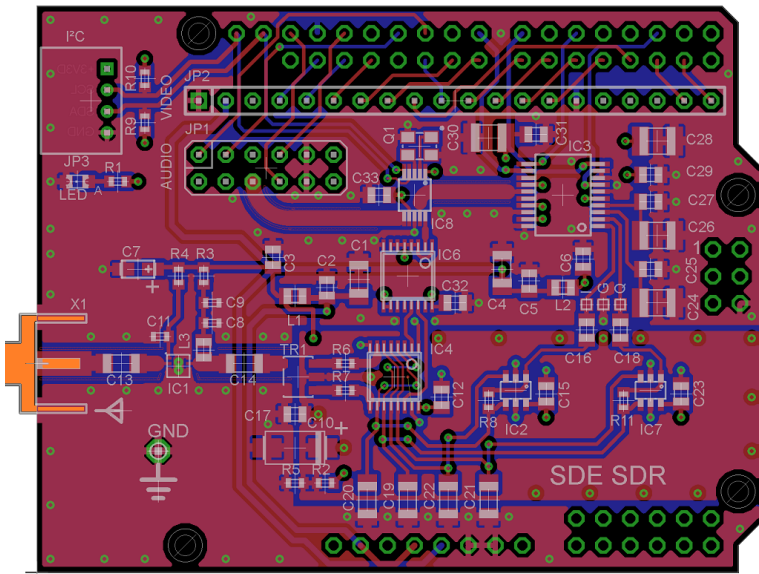
3. SDR Arduino Implementation

Figure 4

A new four layer Arduino SDR "shield" has been designed that closely follows the running MIPS based prototype. It has a single ground plane and a split power plane for the various power supplies. Using the extended IO that is present on the Diligent Arduino the shield adds a provision for connecting an external color graphic touch screen as a user interface. A panadaptor and waterfall display can be supported. The audio makes use of a PMOD connector to route I2S audio data off the board to an external amplifier. The sound quality is good, and the design is usable for music, as well as voice.

4. SDR ARM Based Raspberry Pi Implementation

The Raspberry Pi version of the SDR is the same hardware design as used on the Arduino board. On the Pi "HAT" a video port isn't required. The Pi has but one I2S port so that must be used for both data input and output with both running at the same 48 KHz sample rate. The extra processing at the higher sample rate is not a problem. The Raspberry Pi computers, although having less IO capabilities than embedded systems, have very fast processors and large resources. The Pi boards also benefit from having a full operating system. Program development for the board is currently being tested under both Linux, and Windows 10 using C# and C++.
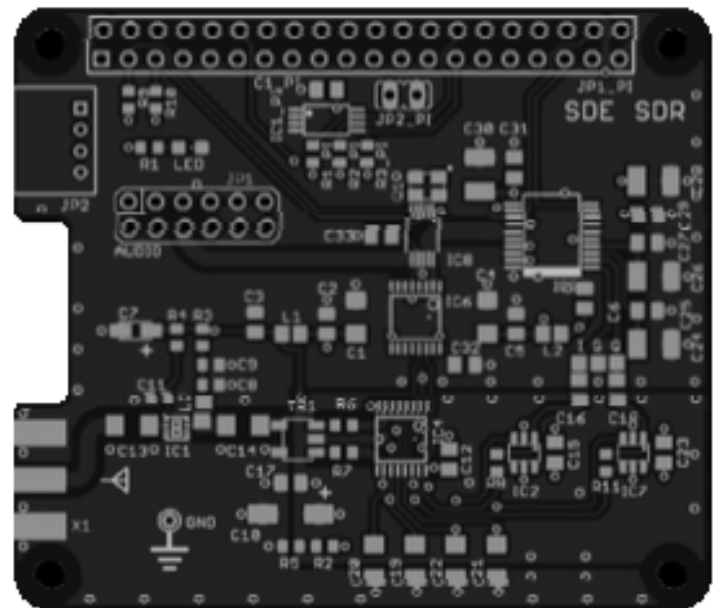

Figure 5

5. Conclusion

Two platforms of a QSD Low-IF architecture SDR design have been developed for use as either a stand alone receiver, or as a remote controlled IQ data server. Future work will include support for

digital modes for audio and data, including the reception of weak signals.

6. References

Doug Smith KF6DX, "Digital Signal Processing Technology: Essentials of the Communications Revolution" First Edition, ARRL, Newington, CT

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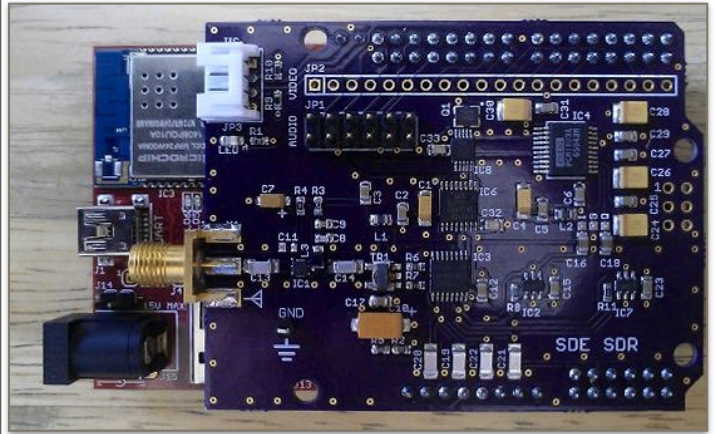
6TH ANNUAL TECHCON FRIDAY 2/21/2020 AND SATURDAY 2/22/2020

The 6th Annual TECHCON will be held on Friday February 21, 2020 and Saturday February 22, 2020 at the Charlotte County Emergency Operations Center located at 26571 Airport Rd, Punta Gorda, FL 33982.

For a Google map of the directions you may go to the TECHCON page on the Section website at http://arrlwcf.org/wcf-special-events/wcftechconference/.

The TECHCON general schedule is as follows:

Friday Afternoon Seminar: 1300 - 1700 hours Introduction to the Internet of Things by Jon Pellant W1JP, one of our ARRL Technical Specialists and ARRL Emergency Coordinator for Charlotte County. The facility will be open at 1200 for attendees to come and get setup for the seminar (computer program installations, etc.)

Friday Evening Social: 1800 - 2100 hours. At a local restaurant to be announced.

Saturday Main Session: 0900 - 1700. The doors will open at 0800 and opening remarks will be given at 0845. The morning presentations will be from 0900-1150. Lunch will be from 1200-1315. The afternoon presentations will be from 1330-1630. End of the day door prizes and closing remarks will be given from 1630 - 1700.
There will be two presentation tracks planned throughout the day.

If you plan on attending TECHCON in 2020, registration is now open. You may go to the TECHCON registration page at http://arrlwcf.org/section-forms/wcftechconfregistration/.

Registration is free and attendance is free. There will be door prizes given away at the end of each presentation track and at the end of the day as well.

We are calling for presenters to present at TECHCON 2020. The topic of presentation is entirely up to the presenter, as long as it is amateur radio and technology related. We have alumni returning from past TECHCON's. However we are always looking for new speakers for TECHCON as well. If you are interested in being a speaker for TECHCON, please fill out the Contact Form on the Section website at http://arrlwcf.org/section-forms/contact-info/ and Darrell Davis KT4WX, our Section Manager will get in touch with you about being a presenter at TECHCON. TECHCON needs presenters to stay vital and interesting.

Many thanks to those of you who plan on presenting at TECHCON in 2020.

6th ANNUAL TechCon 2020
WCF Country
West Central Florida Section

BITS AND BYTES – All About Microcontrollers

By Darrell Davis KT4WX

ARRL WCF Section Manager and ARRL Technical Specialist

Welcome back to our next installment of Bits and Bytes. This column, like the WCF EXPERIMENTER was in hiatus for a couple of years now and it is hard to believe it has been that long.   Now that the WCF EXPERIMETER is back in publication this column will also resume. Previous editions of this column are on my website at http://www.kt4wx.org. The past issues of THE WCF EXPERIMENTER are archived at the Section website at http://www.arrlwcf.org.

MICROCONTROLLER TERMS: We will introduce a few more "new" terms to you this month.

USB Type C (or USB C) Connector: Formally known as the USB Type-C Specification 1.0, this new USB physical connector standard is a 24 pin standard and is distinguished from its predecessors by its symmetrical layout. First introduced in 2015, USB Type C connectors have the capacity to support the following: (1) Two USB 2.0 ports pairs, (2) Four USB 3.0 port pairs, and (3) Four USB 5.0 V power lines (four pins for Vcc and four pins for GND). This standard is simply a physical standard that specifies the physical layout of the connector and cable. There are other standards that specify the data stream. Any manufacturer can make a cable that supports USB power and ports or just USB power if they wish.
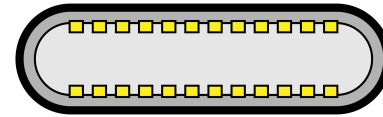

Figure 1: USB Type C Connector:

By Niridya and obtained from Wikimedia Commons

USB Type B Connector: Part of the original USB Specifications, it is the connector that is intended to go to a peripheral. There are implementations of the Type B connector in full size Type B, mini size Type B, and micro Type B in common usage still today. Printers still for the most part use full size Type B, other peripherals still use mini Type B, and smartphones and tables use micro Type B almost universally.

USB Type A Connector: Part of the original USB Specifications, it is the connector that is intended to go to the computer. There were mini and micro versions of the Type A in the original standards but you will not see them very often.

For more reading on the USB Hardware standards go to: https://en.wikipedia.org/wiki/USB_hardware.

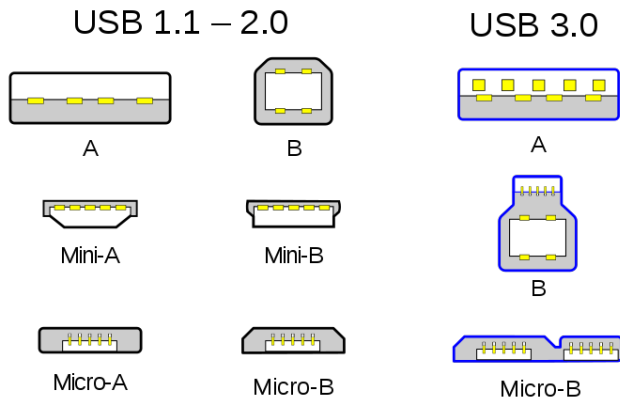For more reading on the USB standards you can go to https://en.wikipedia.org/wiki/USB.

USB 1.1 – 2.0

A   B

Mini-A   Mini-B

Micro-A   Micro-B

USB 3.0

A

B

Micro-B

Figure 2: USB Connectors and their related standards

Image drawn by RoLa and obtained from the Wikimedia Commons under the Creative Commons License.

FEATURED MICROCONTROLLER – RASPERRY PI 4: Last time we introduced several varieties of ARM Cortex M Evaluation Boards. This time we will introduce the recently released Raspberry PI 4.
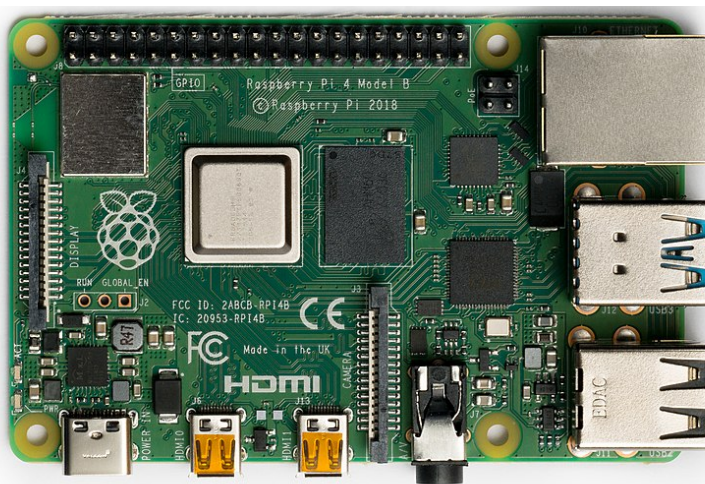

Figure 3: Raspberry PI – Top View

Photo taken by Michael Henzler and obtained from Wikimedia Commons under the Creative Commons BY-SA 04 license.

When you think the Raspberry PI cannot get any better, it does. The Raspberry Pi 4 was

introduced in late June and will start to come into stock into stock of U.S. distributors soon. I actually heard from one ARRL Technical Specialist that told me he actually was able to obtain one.
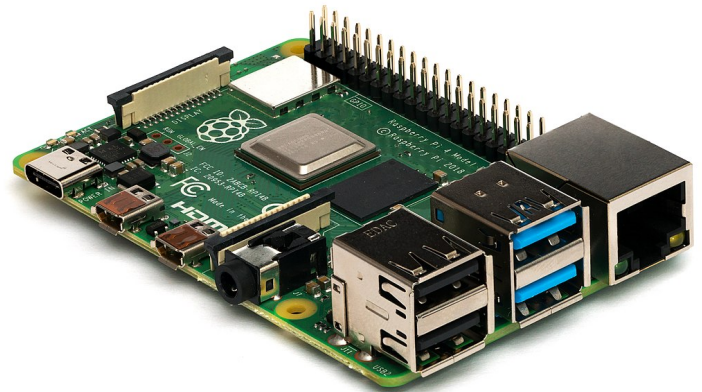

Figure 4: Raspberry PI – Side View

Photo taken by Michael Henzler and obtained from Wikimedia Commons under the Creative Commons BY-SA 04 license.

The new Raspberry PI 4 has a Broadcom BCM2711 SoC (which stands for System on a Chip 1.5 GHz 64-bit quad core ARM Cortex-A72 processor. This is a big step up from the Raspberry PI 3 just as the Raspberry PI 3 was a big step up from the Raspberry PI 2. The following are the feature changes and improvements in the Raspberry PI 4 from the Raspberry PI 3:

Available in three versions of RAM: 1 Gigabyte, 2 Gigabytes, and 4 Gigabytes. The 1 Gigabyte version is still $35, the 2 Gigabytes version is $45, and the 4 Gigabytes version is $55. This cannot be changed once it is purchased.

Two of the four USB ports to USB 3.0, so now the Raspberry PI 4 has 2 USB 2.0 ports and 2 USB 3.0 ports This is probably in keeping with newer desktop computers having one or two USB 3.0 ports, often used for faster access for external

hard drives (solid state or SSD) and for faster access to flash drives.

The Ethernet port is now a Gigabit port instead a of a 100 Mb Ethernet port.

There are two HDMI ports instead of one. They are now micro HDMI connectors instead of full HDMI and support 4K UHD resolution.

The power connector is now a USB Type C connector, instead of a USB Micro connector, probably due to the larger curren draw of the Raspberry PI 4. The USB Type C is a 24 Pin connectors and is more symmetrical in shape and slightly larger than the USB Micro.

A Bluetooth 5.0 transceiver instead of a Bluetooth 4.0 transceiver.

The Raspberry PI still has a 40 Pin GPIO header with several SPI, I2C, UART, and general purpose I/O ports.

For the full specifications of the Raspberry PI 4 you can go to https://www.raspberrypi.org/products/raspberry-pi-4-model-b/specifications/ on the Raspberry PI Foundation website. On this page are schematics, mechanical drawing, and documentation. (Note: At the time this article was being written, not all the links were active).

All other versions of the Raspberry PI are still available and have had some upgrades done to them since they were originally introduced to maintain backwards compatibility. It is nice to see the Raspberry PI Foundation is aware of the importance of maintaining products for a number of years after their introduction.
That is all for this installment of Bits and Bytes. Until next time, keep your soldering iron hot and your microcontroller code coming.
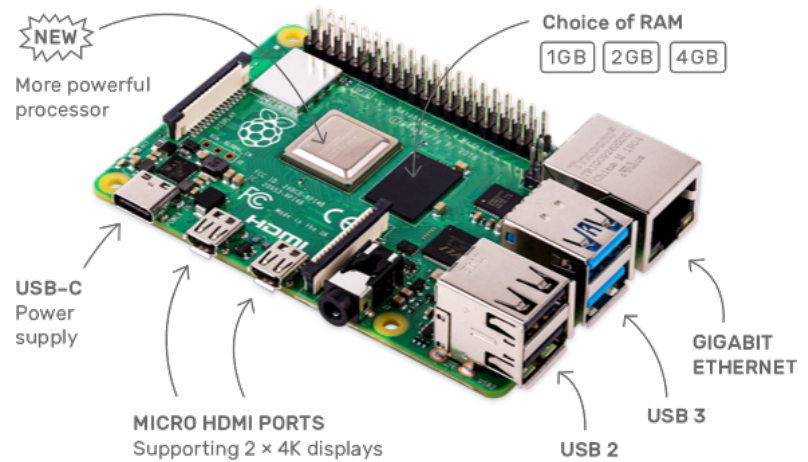

Figure 5: Raspberry PI 4 Layout
Image obtained from the Raspberry PI Foundation website.

"**Authors Note:** Since this article was written it has been discovered a minor design flaw in the USB Type C power port on the Raspberry PI 4 that causes e-marked chargers to not power the Raspberry PI. Eben Upton, the creator of the Raspberry PI, has stated in an interview that this problem will be corrected in the next revision of the board.

For details on this problem and how you can work around it with the current version of the Raspberry PI 4 that you may have you can go to https://www.scorpia.co.uk/2019/06/28/pi4-not-working-with-some-chargers-or-why-you-need-two-cc-resistors/ and read the excellent blog on this subject written by Tyler Ward.

Bottom line: Use either the official Raspberry PI 4 power supply or use non e-marked charger if the current supply is adequate to power the Raspberry PI 4. TechRepublic did an interview with Eben Upton where this problem is mentioned as well. To read the contents of that interview go to https://www.techrepublic.com/article/raspberry-pi-4-this-thing-is-a-pc-says-boards-creator-eben-upton/"