THE WCF EXPERIMENTER

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FROM THE EDITOR:

This edition of the WCF Experimenter is going to have both a new column courtesy of our Section Manager, Darrell, KT4WX, called Bits and Bytes and unfortunately another one of my articles from the past. The latter, only because no one else in the section, except KT4WX, has seen fit to submit anything to the WCF Experimenter. I find it very hard to believe that of all the literally thousands of hams in West Central Florida, none of them has ever built a device or gadget or developed a procedure that other hams would find useful.

I know that you are out there. Please become a mentor and source of information to your fellow operators. If you built it or used it, email me with a description and information. Believe me, between me and the author we can turn even that into a polished article. That is what an editor does, even at QST or any other magazine. We can add pictures, diagrams, convert simple text into almost step by step instructions, whatever the particular device or process needs.

The continued existence of the WCF Experimenter will rely on the hams in West Central Florida stepping up to the plate and adding their input to the text of each edition. Believe me, if I have to re-run only my old material, I might as well just refer everybody to my own web site. I don't want to have to rely on my material, I need your input to make this e-publication viable.

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Geoff Haines, N1GY

BITS AND BYTES – All About Microcontrollers

By Darrell Davis KT4WX
ARRL WCF Section Manager and ARRL Technical Specialist

Welcome to the next installment of Bits and Bytes, our microcontroller column for THE WCF EXPERIMENTER. Now instead of editing the whole newsletter, I get to write my column in each issue (although I produce THE WCF PRESSER now, which is a general newsletter for the West Central Florida Section each month, so I just traded one newsletter for another). However being Section Manager has kept me fairly busy and

the only regret I have, is I do not get as much project and workbench time as I used to have but that is how the cookie crumbles.

MICROCONTROLLER TERMS: The last time I dealt with RISC versus CISC. Let us get into a few more terms that will be unfamiliar to newcomers.

- **RAM: Random Access Memory**. This is the memory used by the program that is running on the microcontroller to store information that is being acted upon by the microcontroller program. This memory is what is called volatile memory and it only retains the data stored in it while the power is applied. Turn the power off and the contents in RAM are lost. Also another key fact to remember is that the main program that runs the microcontroller is not typically stored in RAM. Only the data the main program acts upon in some fashion is stored in RAM. Also another key of this type of memory is any portion of it is accessible in any sequence. It does not have to be read form beginning to end, which is a great time saver. There is an excellent Wikipedia entry on Random Access Memory at http://en.wikipedia.org/wiki/Random-access_memory.

- **ROM: Read Only Memory**: This is the memory used to store the main program that runs the microcontroller. This memory once programmed is either usually not changeable or readily changeable in the field once programmed. Originally in days gone by this type of memory was programmed onto integrated circuits by the manufacturer from source code provided by the end user and was not changeable in the field. Today most manufacturers use some form of EEPROM, which stands for Electrically Erasable Programmable Read Only Memory. They are programmed by the application of a programming voltage when being programmed and is not ordinarily used in normal operation. Once programmed the EEPROM will act like a ROM chip. There is an excellent Wikipedia article on Read Only Memory at http://en.wikipedia.org/wiki/Read-only_memory.

- **Clock Rate**: This term refers to how fast, in MHz usually, how fast the clock that runs the microcontroller operates. The faster the clock, the faster the microcontroller can fetch and execute instructions. There is an excellent Wikipedia article on Clock Rate at http://en.wikipedia.org/wiki/Clock_rate. Unlike desktop computers today, most microcontrollers have a clock speed of 4-24 MHz on 8 bit processors. Mid range microcontrollers (ARM Cortex M0-M3) operate in the 25-75 MHz range. High end microcontroller clock speeds can be in 100-300 MHz range. Remember, microcontrollers do not need high clock speed like a desktop computer to perform the task they are designed for very well.

  The clock in a microcontroller is what sequences the microcontroller in its fetch and execute cycle. It is analogous to the timing belt or timing chain in an automobile. Without it a car cannot run and without a clock a microcontroller cannot run either. There would be nothing to sequence events to happen and the microcontroller would just sit there, use power, and do nothing useful.

In days gone by microcontrollers required a crystal or a RC network (Resistor-Capacitor) network to provide the clock, or timebase, to operate the microcontroller. Today, many microcontrollers have their own internal clock or have the option in most cases to use the internal clock or to use an external clock (with a crystal or an RC network). This was designed by the manufacturers to reduce parts count and save cost. Only in more critical applications, is an external clock necessary.

To sum it all up: In the microcontroller world, ROM (or in our case EEPROM) is used as program memory or OS memory, RAM is used to hold the data the program is working with and in many cases I/O Ports are treated just like RAM when programming the microcontroller, and the clock speed is how fast the microcontroller clock is operating.

Below are a couple of diagrams to illustrate again that a microcontroller has all of these in one chip versus having them on several chips, a great advantage:

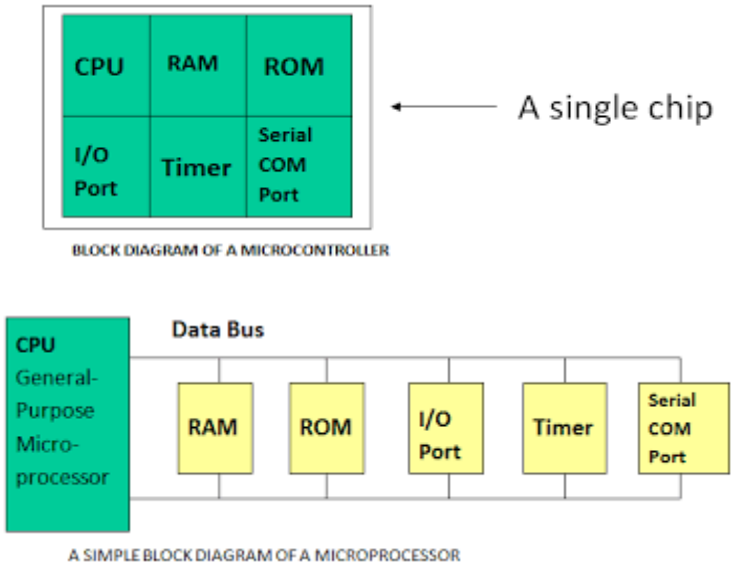


Figure 1 – A microcontroller versus a microprocessor block diagram. Courtesy of http://www.learningembedded.com

FEATURED MICROCONTROLLER - PICAXE: We will introduce a new microcontroller family each time we have Bits and Bytes. This month we will introduce the PICAXE. What is a PICAXE you say? The PICAXE is a family of microcontrollers that are based upon the Microchip series of 8 bit PIC Microcontroller. The PICAXE is a BASIC interpreter already programmed onto a PIC Microcontroller that looks to execute a program upon power being applied.

When you write a program for the PICAXE, you would use the PICAXE Programming Editor, available for download from the PICAXE website at http://www.picaxe.com, to write, debug (find errors or bugs), and test your BASIC program. The PICAXE Programming Editor is an IDE (Integrated Development Environment) developed by Revolution Education Ltd., the developers of the PICAXE environment, to do everything for PICAXE development in one application. The PICAXE Programming Editor has a nice simulator built in as well, for simulating programms running before you ever load the program onto a PICAXE. This package is for the Windows Operating System, but there are packages as well there for download for Linux and Mac platforms.

Once you have initially debugged your program you use the PICAXE Programming Editor, with a simple interface circuit, to write your program to PICAXE Microcontroller. Then built the circuit on a breadboard to test your circuit and program. Then you will go through no doubt numerous program writing, debugging, load, and testing cycle before you get your program just like you wanted.

If you cannot wait until my next column, you can view my “Introduction to PICAXE” PowerPoint slide presentation from the ARRL West Central Florida Section website at http://arrlwcf.org/download/wcftechconference_2015/IntroductionToThePICAXE.odp. It will give you an Introduction to the PICAXE, how to get started, a sample program, and resources on how to get you started.

In my next column we will continue talking about the PICAXE, which is a great place for beginners with microcontrollers to get started, some more terminology we will define to increase your skills if needed, and any breaking news in the microcontroller world you need to be aware of. That is all I have for you in this installment. Have a great summer, stay cool if you can, and keep your soldering iron hot until next time. 73!

A Different Way to Make A Tilt-over Mount and Mast

By Geoff Haines, N1GY

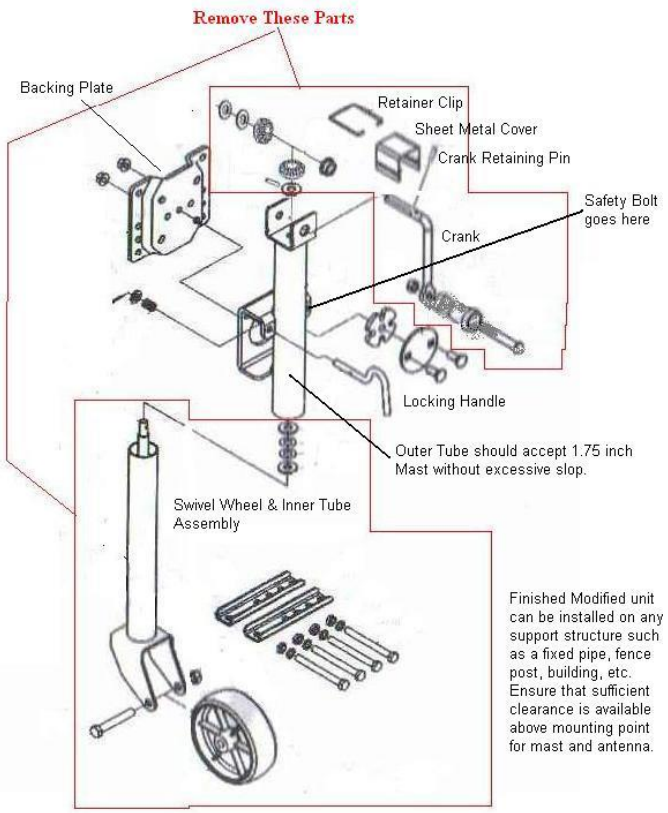
As I age, sometimes less than gracefully, I try to make the deployment of my portable amateur radio operations easier. One of the more difficult tasks has been the erection of my antenna mast. I have used a tilt-over type mount for several of my base station antennas in the past with great success, so I figured I could do it again. Commercial tilt mounts tend to be somewhat pricey and are generally not designed to attach easily to the “under the tire” mount that I built several years ago. My son and I were discussing the options available when I saw one

of his boating catalogs on the table. “A tilt-over boat trailer jack!” I exclaimed. “That’s the ticket”

The next several days were occupied with the design. How tall should the mast be? What is the inside diameter of the outer tube of the jack? How do you get the innards of the jack out? All these questions rolled around in my mind as we completed our vacation and returned to Florida.

Within a few days I had occasion to go by the Northern Tool store in Tampa. They had just the jack I was looking for and it was even on sale. As quick as the cashier could make change it was in the back of my car and on the way home. The disassembly of the telescoping portion of the jack took less than an hour. I simply drove the retaining pin out of the crank handle and removed the gears. This was the messy part of the job since they were covered in grease, but a can of brake cleaner and some rags helped a lot. With the inner tube (the one with the caster wheel attached) gone, I measured the inside diameter of the outer tube. I thought it would be a slip fit for 1.875” tubing. The outer diameter of the tube is a nominal 2”. Unfortunately, the jack manufacturer’s claim that the inner tube was 1 7/8” turned out to be a hair off. More about that later. I do not have any pictures of the disassembly process but it is relatively simple. The drift pin I removed from the crank allowed the crank and its associated gears and washers to be removed easily. If the tube holding the caster is rotated down a few turns and then pushed up, the cylindrical pin that holds the other gear in place falls out easily and the entire sub assembly can be pulled out the bottom of the outer tube. The outer tube is then rotated so that the top (where the gears were) is now the bottom. Since the rotating plate that holds the tube to the mounting bracket has an extra hole (one in each lower corner) and the bracket itself has one in each corner to match, an extra bolt with a captured nut as seen in Figure (add figure # here) can be used to provide a safety lock so that if someone accidentally pulls the spring loaded lock handle the mast will stay vertical.

The mount for the jack is normally clamped around the tongue of a boat trailer but the base has several sets of holes pre-drilled to accommodate various sizes of fittings. I chose to use 2 inch muffler clamps (short U-bolts) to attach the base of the jack to the 12 inch long 1 ½" ID pipe nipple that is the vertical portion of my portable mount. I originally planned to use stainless steel U-bolts but they were too long and the muffler clamps turned out to be exactly the right length and they are a more robust thickness to boot. I call my portable mount a "Bigfoot", but it really is just an 18" by 10" by 2" oak plank with a floor flange and pipe bolted to the outer portion. The inner portion is placed under a front tire by driving the car up onto it so that the weight of the car keeps the portable mount solidly in place. The nipple and flange are insulated from the ground so that it can be part of the antenna system without grounding it. With the boat jack in place, the bottom of the jack clears the ground by about 1 ½ inches when vertical and the tilt mechanism is similarly isolated from ground.



It just so happened that one of my suppliers of aluminum telescopic tubing, DX Engineering, had that size in stock, along with all the other sizes to make a telescopic mast of almost any height desired. An order was placed and with the arrival of the tubing, the construction of the mast began. Since I already had a telescopic aluminum mast in hand, I simply had to add the larger diameter sections to the bottom of that mast to get it from 1.5 inches to 1.875". This required three lengths of tubing, 1.875", 1.750" and 1.625". I mentioned earlier that the inside diameter of the trailer jack main tube was a bit off. When the new tubes arrived, I found that the largest one (1.875") would not fit into the jack tube. The solution was easy. I had ordered 6 foot lengths of tubing knowing that I would be cutting them down to 4 feet to match the existing sections of the mast. I simply slid a two foot section of the 1.75" diameter tubing into the bottom of the larger section and joined the two pieces securely using a total of six sheet metal screws. This did make the mast a little taller but the beauty of a telescopic mast is that it can be any height you want below its maximum length. Together with the 1.500", 1.375", 1.250 and 1.125" sections from the old mast I had a mast that could run to 23 feet altitude maximum and could be lowered to NVIS height as needed. It is considerably more rugged than the previous mast, which would bend precariously if a relatively heavy antenna was mounted. To secure each length of tubing to its neighbor, the usual method is to use hose clamps. As with the previous telescopic mast, I chose to use a particular style clamp that so far, I have only found at one source.

MSC Industrial Supply Co. (www1.mscdirect.com/) has stainless steel hose clamps with a hand operated key permanently attached to the bolt that adjusts the clamp. This makes it a "no tools needed" affair to set up the mast in the field. There are other clamps that also appear to be able to be hand tightened but they use plastic keys or knobs. The MSC ones are the only ones I have found that are all metal. They are on page 4191 of MSC's "Big Book" catalog viewable on their web site.

I was concerned that the various antenna setups that I used with my original mast were all designed to use a length of ¾" ID PVC pipe as the mounting arrangement. This would slip over the top of the mast which was ¾" in diameter. Luckily, I discovered that the outside diameter of that same ¾" PVC pipe is a easy fit to slip *inside* some thin-wall PVC pipe that I had on hand. A few turns of vinyl tape made the fit just right and a few self tapping stainless sheet metal screws made the adaptation permanent. The thin-wall PVC fits over the 1 1/8" Aluminum tubing that is the top section of the new mast. Each thin-wall section is secured to the mast with the same type hose clamps that I use to connect the sections of the mast. With a little fabrication I was able to make an adapter to fit the "Octopus" array to the 1 1/8" aluminum tube. Next, I fabricated a new adapter to enable the use of wire antennas fed with ladder line. I had to make the attachment

point at least 12” away from the aluminum mast to avoid affecting the ladder line. This was accomplished by building a PVC “T” out of ¾” PVC pipe, reinforced with ¾” aluminum slipped

inside the PVC. I also added an aluminum brace to triangulate the “gantry” so that hoisting the antenna would not stress the mast too much. The braced end of the “T” is fitted with a pulley and rope to allow raising a wire antenna independently from the raising of the mast. This mounting adaptor also has provision for a VHF/UHF antenna mounting on the opposite end of the “T”. With that completed, any of my original antenna systems will fit the newly up-sized mast.

I plan on using my “Octopus” antenna array (QST December, 2007) but I can also use my homebrewed “Carolina Windom” (the “heavy” antenna that caused the previous mast to bend) as well as my “G5RV Jr.” antennas in place of the “Octopus” if necessary. The mast itself can also be used as a vertical antenna with the appropriate automatic or manual tuner in place. Radials would be needed to make the vertical perform adequately. Wire is cheap and it would not be hard to make 12 or 16 25 foot wires to attach to the tuner at the base and spread them out on the ground around the mast. Other writers have noted the use of inexpensive metal tape measures as radials which have the advantage of being self-storing.

Since the mast I built is only 23 feet tall, one set of guys is sufficient even if I use a relatively heavy antenna like the “Octopus”. In order to make setting the guys easier for me, I chose to go with a package of four 14 foot long 1”wide bright orange tie-down straps with ratchet handles. They are available at Harbor Freight and probably Northern Tool as well. Their extra weight would have been too much for a light duty mast, but with the mast now starting at 1.875 inches and the guys attached at the 1.5 inch diameter point on the mast, the heavy duty guy straps are appropriate. They attach to the mast at the 10 or 11 foot level. I have tried the three guy line setup in the past and I like the extra security of four. The military has standardized on four guy lines per level and they generally don’t do anything without testing it thoroughly first. The ratchet handles on the guy straps are placed near the ground anchors so the extra weight is minimized and the ratchets are accessible that way. Speaking of the ground anchors, several companies make excellent screw type ground anchors. I chose, based on past experience, to go a different route. Many years ago I picked up metal stakes that were originally used for tying down helicopters in Vietnam. I have used them for years and not one has ever pulled out until desired. They have a short metal cable with a spring loaded hook on the end of the cable. Very strong, they have a “W” shape like miniature metal highway barrier. A metal cap ensures that they can be driven in with a maul all the way into the ground. To remove them simply pull up parallel to the stakes orientation. Pulling in any other direction does nothing. Since I have no idea if they are still available or even where one could find them, you will have to choose an available ground anchor that works for you.

To attach the guy straps to the mast, some kind of “guy ring” was necessary. All the commercially available guy rings that I saw had a maximum mast diameter of 1.25”. I needed one for a mast diameter of 1.5”. I checked with a couple of fabricating companies in my area and they wanted more for the ring than I had invested in the whole project. I figured I had to go back to home-brewing if I was going to get what I wanted. While discussing the problem with my wife Audrey, she reached into the dark recesses of a cabinet and pulled out an old aluminum

candy dish we had gotten as a wedding present many years ago. I questioned the idea of using the item, but she assured me it would be OK. With the drilling of five holes, four 7/16” for the guy hooks and one in the center to fit the 1 ½” mast, the deed was done. The material of thecandy dish is very heavy gauge aluminum easily capable of taking the strains expected. Given that it also has a floral design stamped into the aluminum, it certainly must be the most unique guy ring in all of amateur radio. I am sure a commercially available guy ring would work just as well.

The first test of the new mount and mast combination was elementary. I placed the drive-on mount under a wheel of my car and installed the 23 foot mast into the jack tube in a horizontal position. I then pulled the spring loaded pin on the jack and proceeded to walk the mast up to a vertical position. As it reached the upright position the spring loaded pin clicked neatly into the matching hole in the base. I added the safety bolt on the other side of the jack tube and the mast was now secure. My wife and I have repeated the testing with each of the antenna mounting adaptors with and without the guy straps in place. All tests were successful. Obviously, the guy straps will be used at all times, but it was nice to know that the mast is strong enough that they are an added safety measure, not a critical part of just keeping the mast upright. With the guys in place and the base suitably secured to the ground with three 12 inch landscaping spikes, the car can be driven off the base and used elsewhere.

I will not bother you with the testing of the performance of the various antenna systems that we can deploy with this mast and mount. All that I tried worked up to their potential. Suffice to say that one can mount any antenna system that will perform at around 25 feet altitude whether it be of vertical or horizontal persuasion. With the appropriate number of radials and the 10 foot stinger extension in place, it can also operate as a multi-band vertical antenna itself if an antenna coupler or tuner is used.

This project is adaptable to many different types of antennas and to many different situations. It can be set up as high as 33 feet (with the 10 foot stinger adaptor) or as low as 8 to 10 feet for NVIS use in an emergency. It can be used for HF and/or VHF/UHF antennas. It can also be used for some park-side or beach-side DX when the need arises. With the increased risk of weather emergencies here in Florida, and the frequent opportunities for beach-side DX in calmer times, I expect to be using this system frequently in the future.

This final photo shows the entire mast, tilt mount, and antenna set up. You may note that the guy straps are green, not orange. Initially, the orange ones were not available in a 15 foot length, but as soon as they became available I changed to the longer orange ones.

Update: Because of my medical problems, I gave the mast and tilt mount to my son. He is now using it in Connecticut for his VHF/UHF antennas. When I visit Connecticut, I will be able to use the system there, so all is not lost.