



THE WCF EXPERIMENTER

EDITOR: GEOFF HAINES, N1GY

N1GY@ARRL.NET

Published Quarterly (Usually)

Summer Edition

FROM THE EDITOR: “The Experimenter” is always looking for articles to publish. If you have built something to enhance your enjoyment of amateur radio then it is likely others are interested in what you created. Maybe you are becoming familiar with a new mode or other aspect of the hobby. It is very probable that your knowledge can be of assistance to others getting started in that mode or even just looking for more information about the mode. Write something up, take lots of pictures and email them to me. I will happily adjust the syntax to fit the space available and publish it in our next issue. The Experimenter will be a zero page publication unless I get something to put in it. You do not have to be a professional writer or electrical engineer to get stuff published. Just be enthusiastic about your topic and the rest will take care of itself.

BUILDING A HAM SHACK THOUGHTS ABOUT A “BIG PROJECT”

1. Follow the 5P Principle:
PRIOR PLANNING PREVENTS POOR PERFORMANCE.
2. Step One is to inventory your equipment, present and projected in the future. This should include radios, computers, meters, speakers, microphones, antennas, coax switches, power supplies, furniture, in short everything that you have, will have or wish you had in your ham shack.
3. Prioritize your transceivers, which one or ones do you use the most? This unit should be in the most ideal spot for ease of use, comfort, etc.
4. Design your operating position, within the limits of space, budget, and

family harmony to be as comfortable as possible. If you aren't comfortable operating you won't operate long. You should at least have a comfortable chair and the work surface of the desk or table should be at an appropriate level.

5. If necessary, build shelving to hold the radio equipment in the ideal position for operating. Do the design on paper and use scale cutouts of the fronts of the radios and other equipment to decide on sizes and shapes of shelving or consoles that will be placed on the desk or table that will be your operating position. That way there will be no surprises when it is time to put the equipment into the place you designed.

6. Situate your power supply so that it is convenient to turn on and off and so that you can shut it down quickly in an emergency.

7. Position coax switches so that they are easy to use and securely fixed in position.

8. Provide adequate lighting for the operating position so that you can see and operate without strain.

9. ALL electrical (A/C or D/C) and ALL RF equipment MUST be grounded to the GROUND ROD. The ground rod should be within 10 feet of your operating position. Use heavy gauge wire or better still copper strap at least one inch wide to connect to the ground rod. See the ARRL Web site for more specifics on grounding systems. If your operating position is on the second floor or above you DO NOT have a grounding system and will have to use an "artificial grounding device".

10. Keep the wiring (electrical, coax, speaker wires, ground wires, etc.) neat and orderly. Something WILL eventually go wrong, and finding it and fixing it will be much, much easier if the wiring is neat.

11. Provide "surge protection" for all coax runs outside. Ground all "surge protection devices" as indicated by the manufacturer. This means in most cases, a direct heavy gauge wire connection to the ground rod.

12. If you are using external speakers, separate them so that it is easy to tell which radio is making the noise. Picking up the wrong mic to answer a call is always embarrassing.

13. If you are building the furniture you will be using in the ham shack, make it neat and presentable. It doesn't have to be Louis the 15th, but a board and 2 concrete blocks will not win any kudos from the XYL.

14. Provide adequate storage space, bookcases and the like, for magazines, parts, tools, spare equipment, etc. It will be much easier to find it when you need it, and you will need it, trust me.

15. Place a clock where you can see it easily from the operating position. Preferably one that is digital, 24 hour format, and set on Universal Coordinated Time (Zulu or GMT). Your log should be kept in UTC time so as to jibe with all your contacts times. Any QSL cards you send out should be filled out using UTC to avoid confusion.

16. Keep a log. You need this information to fill out the previously mentioned QSL cards. You also create a history of your station automatically when you use a log. Remembering a call sign, or a name, is much easier if you have the log to refer to. Electronic or paper, it doesn't matter.

17. Have some kind of system to organize your paperwork. Equipment manuals, service manuals, warranties, notes, band plans, frequency lists, etc. You do remember the contents of all the memory channels in all your radios? Ok I guess the rest of us will just have to write them down. I use loose leaf binders for everything, but whatever system you use, just be sure to have a system that works for you.

18. If you are a net control station, keep the preamble for your net together with your net log sheets, (another binder) it will make doing the net much easier. Also store any informational pages in the same binder. For example I keep the Eagle Net Preamble in a binder along with the net log sheets, and the forms that explain the ARL numbered message system, and the pages that explain how to properly fill out a message form, etc.

When someone has a question about procedure or the like, the answer is at your fingertips, not on a shelf on the other side of the room.

19. If there is a computer in the ham shack, and there usually is, use ferrite chokes on all cables. That means even the mouse, the keyboard, the AC power cords, everything. Listening to your keystrokes on the local repeater frequency is only half the story. Keying up your 100 watt radio and hearing your computer go nuts is the other result if you don't shield them from each other. Every cable or wire is an antenna. The ferrite chokes will keep the RF where it belongs and out of where it doesn't.

20. If space allows, get a big bulletin board to place in the ham shack. It is handy for that free world map you got from Yaesu, and it also is a great place for hamfest flyers, qsl cards, notes, frequency lists, etc.

21. Above all, have FUN with ham radio. If you are not having fun then you are in the wrong hobby.

THE UNFAIR MALIGNING OF THE UHF CONNECTOR

Edited By Geoff Haines, N1GY

The editor of the Contester E-Newsletter pointed us to the web site of The Savvy Microwave Group. In there was a piece by Dick Knadle, K2RIW about, among other things, the undeserved poor reputation of UHF or PL-259 Connectors. I have edited and paraphrased Dick's remarks.

There are many misinformed engineers and amateurs who have been led to believe that a UHF connector is the worst thing ever invented in the RF world due to its lower internal impedance. These people believe that each UHF connector causes a 1/2 dB insertion loss and a whole lot of VSWR at 440 MHz. I have heard several amateurs claim that their 440 MHz Brick amplifier will now have 1dB greater gain since they just replaced the two SO-239s with Type N connectors. This "Old Wives Tale" has been propagated for years and years. Everyone believes it. No one challenges it. Few people have ever taken the time to actually measure it.

Here is Dick's observation. He took a 432 MHz Stripline Parallel Kilowatt Amplifier and applied 700 watts through a UHF female and a UHF Male connector, and then into his antenna feedline. After 10 minutes of 700 watts throughput power the UHF connectors were barely warm.

He estimated, based on the temperature increase that 3 watts were dissipated as heat. That is an insertion loss of 0.019 dB for the pair of connectors. You say " how can this be, the internal impedance of the PL-259 is 35 ohms, it's got to cause a 1.43:1 VSWR? Well, it doesn't.

The mated UHF connector has an internal connector length of less than 0.9 inches. A free space wavelength at 432 MHz is 27.3 inches. That makes the phase length of the connector 11.9 degrees. If you plot this on a Smith chart or the mathematical equivalent, you will find that a 50 ohm antenna with an 11.9 degree long section of 35 ohm line causes an input impedance of (47.9-j7) ohms.

That is an input VSWR of 1.16:1, which gives a worst case reflected power caused loss of 0.024 dB. That is totally insignificant. Now at 10 GHz where the wavelength is 1.1 inches, that 0.9 inch connector length would be much harder to take.

A type N connector can tolerate low-duty pulses of 20 Kilowatts without a voltage breakdown. However, a steady state power of more than 1 KW could cause the N-connector to fail from RF overheating of the center pin. The UHF connector has a larger center pin that can better withstand high steady state RF currents. Also an internal impedance of 30 ohms maximizes the power handling capability of a connector and the PL-259 comes in at 35 ohms.

There are probably twice as many hams out there who can properly install a PL-259 connector as those who can do an acceptable job on an N-connector. The proper installation of an N-type connector is almost an art form.

The two major faults of the UHF connector are it's lack of waterproofing and the lack of a sliding finger connection for the outer conductor or shield. A proper tape and "coax-seal" job will generally take care of the moisture and checking to make sure your UHF connectors are properly seated and tightened will go a long way to take care of the second.

So, maybe it is time we stop saying such bad things about the poor old PL-259. It doesn't deserve all that flack. Properly used it gives a lot of bang for the buck. It has been around for over 60 years, and that's no coincidence.

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*. A lot has been going on since the last installment of this column and it has been too long. I will be putting previous editions of this column 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. Some of them will expand further upon terms we have introduced in a previous "Bits and Bytes".

USB: USB stands for Universal Serial Bus and as of this writing the USB 3.0 Specification is published. If you wish to read more about the USB specifications and standards you can go to <http://www.usb.org/developers/docs/>. USB 1.0 was first released in 1996 and its speed was 1.5 Megabits per second (Mbps). USB 1.1 was released in 1998 and its maximum speed was 12 Megabits per second (Mbps) The USB 2.0 Specification came was released in 2000 and 2001 and runs at a speed up to 480 Mbps, much faster than USB 1.1 did. The USB 3.0 specification was released in 2008 and is capable of speeds up to 5 Gbps!!

The USB standard was devised to get around the limitation of one device per port in the RS-232 serial standard. You can only hook up one device at a time to an RS-232 serial port and is not considered to be hot swappable. USB is "hot swappable" meaning you can plug it in and the other device automatically recognizes it and when you unplug it that condition is also recognized as well. Also a USB port, thanks to USB hubs can support more than one USB device. A USB Host port, with the proper USB hubs can support up to 127 USB devices!!

Now we will define some USB terms you may or may not be familiar with but that you will see in the microcontroller world. The USB standard has three modes of operation written into it as of USB 2.0:

USB Host: This is where the USB controller acts as a host and receives data from a USB device. An example of this in the PC desktop world would be the USB ports on a PC..

USB Device: This is where the USB controller acts as an interface for a device and communicates with a USB Host. An example of a USB device in the PC desktop world would be a USB Mouse, USB Keyboard, USB Programming cable, etc.

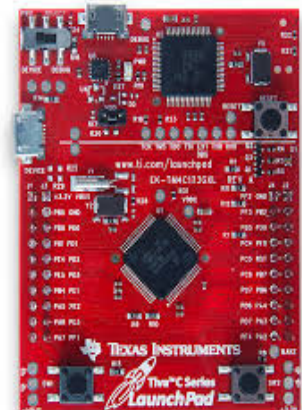
USB OTG (On The Go): This is where the USB controller does not act as a USB Host or a USB Device. This is not seen in the PC world but is often used in devices where it is not connected to a computer.

Flash Memory: This is comparable to a hard drive in the PC world. This is the term often used for the ROM memory, or in today's technology EEPROM, more specifically NAND or NOR Flash. This term is now used instead of ROM. The term is a reference to how the memory is loaded. It is of course, non-volatile.

FEATURED MICROCONTROLLERS - ARM CORTEX M Evaluation Boards: Last time we introduced the Raspberry PI. This time we will introduce a couple of modules that are very inexpensive and you can (1) Incorporate them right into your existing project designs or (2) Make excellent boards for initial project design and lend themselves well to project prototyping before one produces a final version.

The ARM Cortex M is a processor architecture developed by ARM Holdings Ltd.. ARM Holdings Ltd. does not manufacture the microcontroller chips themselves. They simply designed the architecture and instruction set. ARM Holdings Ltd., licenses out the manufacturing of the chips themselves to numerous microcontroller manufacturers. The various microcontroller manufacturers will design various implementations in hardware of the architecture and instruction set. This is why there are variations that are quite wide in what hardware is on the various types of ARM Cortex M4 processors. Texas Instruments and ST Microelectronics are two of these manufacturers.

Texas Instruments Tiva C Launchpad: First produced in 2013, the Tiva C Launchpad uses an ARM Cortex M4 Processor. The processor on board is a Texas Instruments Tiva TM4C123GH6PM microcontroller, which is a Texas Instruments implementation of an ARM Cortex M4 processor architecture. The TM4C123GH6 has a 32bit bus and runs at 80 MHz, has 256 KB of flash memory, 32 KB of RAM, up to 43 GPIO (General Purpose I/O Ports), 4 SSI (can be configured as SPI), 6 I2C Ports, 2 CAN Buses, and USB Bus that can run in host, device, or OTG mode and for the experimenter is available in a 64 pin LQFP (Low Quad Flat Pack).



Part of the Launchpad is a built in programmer that you use to upload your code (program) to the Tiva C microcontroller, and therefore you do not need an external programming interface. The programmer connects to your computer's USB port via a micro USB connector. There are also headers on the Launchpad to make external prototyping easy and even makes easy integration into another project, if you do not feel comfortable soldering LQFP chips. The price as of this writing from the TI e-store is \$12.99 plus shipping!

For the full data sheet on the Tiva C TM4C123GH6PM processor go to <http://www.ti.com/product/TM4C123GH6PM>. There you will find the data sheet (which is 1440 pages), information on development, tutorials, sample designs, and how to order chips and or samples.

ST Discovery Boards: ST Microelectronics also manufactures ARM Cortex M series processors as does Texas Instruments. There are seven ST Discovery Board that cover a range of ARM Cortex M series processors. The discovery board shown here used an STM32F411VET6 processor. This particular processor is a 64 pin LQFP processor, but is available in a 100 pin LQFP package as well. It has 512 KB of Flash Memory and 128 KB of static RAM, and can operate up to 100 MHz clock speed. It has a up to number of five SPI, three I2C, and three USART (Universal Serial Asynchronous Receivers and Transmitter) ports, and up to 81 GPIO pins. It even has the interface to connect an MMC/SD Card. As is common in most ARM Cortex M processors, many of GPIO pins serves to be available to implement these ports. They are referred to as multiplexed pins, a concept that can confuse a newcomer. You can read more about this specific processor at <http://www.st.com/en/microcontrollers/stm32f411ve.html>



Also the microcontroller programmer is on part of the board so no separate programmer is necessary. It has a microUSB port to interface the discovery board to your computer for flashing your program onto the microcontroller. Depending upon the board you have some extra hardware features as well, which aid you in prototyping a project. These also have headers to make interfacing to your project much easier, especially if you are not comfortable soldering a LQFP IC. You can also incorporate this board right into your project as well.

For more information on all the ST Discovery Boards you may go to www.st.com/en/evaluation-tools/stm32-mcu-discovery-kits.html. The price range of the ST Discovery Boards are in the \$10-\$50 price range. The lower end ST Discovery boards are between \$10 to \$20 as of this writing. That price makes it very affordable to experiment with and or incorporate into an existing project.

You may ask, “It seems like there are a lot of ARM Cortex M processors on the market?”. You are right. You would pick the one based upon what your design calls for in hardware resources or what you think your design will need in the future. In the commercial world, choosing the right processor controls the cost of the device to manufacture and can make the difference between profit and loss. For the home experimenter, this is not as critical but it nevertheless gives you a lot of choices.

That is all for this installment of *Bits and Bytes*. Until next time, keep your soldering iron hot and your microcontroller code coming.