



PCARA Update



Volume 17, Issue 3 Peekskill/Cortlandt Amateur Radio Association Inc. March 2016

Be prepared

At February's meeting there was discussion about increasing PCARA's profile with local governments (City of Peekskill and Town of Cortlandt). This brought up the subject of members taking FEMA's Independent Study Courses on the National Incident Management System (NIMS) and the Incident Command System (ICS) available at <http://www.training.fema.gov/is>. Coincidentally, the March 2016 edition of *QST* (Vol. 100 / No. 3, pp. 81-82) has an



article entitled *Education - The Foundation of Preparation: A brief guide to FEMA's Independent Study Courses for the public service communicator*. This article provides an excellent introduction and overview of NIMS and ICS. An initial goal for PCARA would be to have as many members as possible take courses **IS-100.b: Introduction to Incident Command System**, and **IS-200.b: ICS for Single Resources and Initial Action Incidents**. Further discussion to follow at the March meeting.

PCARA has taken a club table at the Orange County Amateur Radio Club Spring Hamfest on Sunday April 24, 2016 at the Town of Wallkill Community Center, 2 Wes Warren Drive, Middletown, NY. If you have any items for sale, please feel free to bring them along. For more details please visit the OCARC web site at <http://www.ocarc-ny.org/>.

Our very own Karl, N2KZ has proposed a PCARA FM Simplex Challenge to take place on Saturday



Why is Molly wagging her tail? Is it because Bob N2CBH will shortly be taking her for a walk? Find out on page 4.

May 7, 2016 (rain date May 21), to see how far participants can communicate from high spots around our region. See 'Adventures in DXing' on page 2. Details need to be hammered out at the March and April meetings. Please try and keep these dates free for some amateur radio fun.

The next PCARA Foxhunt is scheduled for Saturday May 14, 2016 and the role of the fox will be played by Mike, N2EAB. We will be starting from the Beach Shopping Center in Peekskill, NY at 3:00 p.m., and finishing up at a local restaurant for some post-foxhunt celebration. Details and rules to follow. Please try and join us!

Our next regularly scheduled meeting is on March 6, 2016 at 3:00 p.m. at New York-Presbyterian / Hudson Valley Hospital. I look forward to seeing each of you there.

- 73 de Greg, KB2CQE

PCARA Officers

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Special recycling edition!

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Net night

Peekskill/Cortlandt Amateur Radio Association holds a weekly net on the 146.67 MHz W2NYW repeater on Thursdays at 8:00 p.m. Join net control Karl, N2KZ for news and neighborly information.

Adventures in DXing

-N2KZ

Big and Little

It was a pleasant Saturday afternoon, just after one o'clock. I had a rare free moment to spend. I found some time to disappear into my office and hooked up



Karl's Rock-Mite QRP transceiver.

my Small Wonder Labs Rock-Mite transceiver. Powered by eight AA batteries, it emits a thunderous signal of 200 milliwatts CW onto a tiny slice of 20 meters

around 14.058 MHz. That's one-fifth of one watt!

I heard a strong signal calling CQ. QRP operators are used to being humble. I listened and waited for someone else to reply. There was enduring silence. Maybe my time had come! My hand went to my straight key and I gave it a try. KE8BII DE N2KZ N2KZ N2KZ K. Did he hear me?

A big reply returned: N2KZ DE KE8BII UR 579 NR EAST LANSING MI QSL? BK. What a moment! I almost fell off my chair! He heard me! As usual, we quickly exchanged information on names, places, rigs and antennas.

I actually copied his name correctly. KE8BII was from a Chinese family and his first name was Teng. What a sweet rig he had: A new Yaesu FT-991 running 100 watts to a dipole. I was using a dipole, too. Then I told him all about my rig! I was running only 200 milliwatts QRPP! Teng was chugging out 500 times the power of my Rock-Mite. 500 times stronger! How often does that happen?

Teng is a very interesting ham. He has a great collection of worldwide QSLs on his QRZ.com page and enjoys digital modes like RTTY and SSTV. He gets a lot of mileage (literally) out of his impressive station in mid-Michigan. We chatted about Michigan and Yaesu rigs. We both own Yaesu FT DX 1200 transceivers and love CW. Good times!



Now I have made a pact to spend more time with my meek but mighty Rock-Mite. I wonder just how far its tiny signal can travel? From

the looks of things, I think I need to get it a passport! Do you think I could be heard with even less power? Maybe I can modify a garage door opener to operate on 20 meter CW. Could I be heard in a pile-up if I had a gain antenna? Dare to dream - just keep on CWn!

You Can Too!

An invitation to all procrastinators! You can learn the art of Morse Code free and easy! The International Morse Preservation Society - also known as FISTS - offers free code buddy partners to practice with you on the air or even over the phone. This one-on-one program has introduced a lot of friends and produced many devoted CW operators coast-to-coast and beyond. Yes, we can send to you at very, very slow speeds! You will find yourself comfortable with a key in no time! Read all about it at: <http://fistsna.org/codebuddy.html>.



Another fun way to embrace code is to join us on the third Sunday of each month to 'Get Your Feet Wet.' Tune in and you will enjoy live meetings on the air of FISTS members welcoming newcomers to the world of Morse. Our teachers are quite used to sending at very slow speeds and have long experience copying beginners' code replies. You'll be in good hands if you join in! Details at: <http://fistsna.org/operating.html#feetwet>. You'll find a familiar name at the bottom of the page!

Simple Simplex

Regular members of the PCARA's Old Goats Net are plotting, scheming and planning a brand new journey to adventure and on-air fun. On Saturday, May 7th, we will participate in a grand experiment on 2 meter FM. It will be a grand simplex challenge! Members will pick one of a multitude of high altitude places to operate from. How far can we be heard? We will find out!

You don't need a lot to participate. If you own even a modest HT or mobile rig all you have to do is find a spot and join in the group. You can be a single operator or arrange groups for your site. More advanced power and antenna arrays are welcomed, but your 300 milliwatt HT can participate just as well!

The details of the pre-registration and the event itself are still being fine-tuned. I expect our simplex challenge will be very much like an expanded edition of our weekly Goats Net. Each check-in will get on the air and say 'hello.' On the second go-round, we will attempt to have everyone touch base with everyone else and attempt to see just how low in power we can go and still be heard.



Simplex Challenge.

Another round will challenge everyone to see who can cover the most distance with the lowest wattage. The persons achieving the best miles-per-watt ratio will be awarded with certificates at the end of the event when we meet at a local restaurant to exchange experiences, hand-

shakes and smiles. We already have a good list of high-altitude places where PCARA members will be found. What's your idea? We can add it to our list!

Stay tuned to The Old Goats Net Thursday nights at 8:00 pm on the PCARA 2 meter repeater (146.67 MHz, -600 kHz, offset 156.7 PL) for the very latest on the event. A formal invitation to all will follow in next month's *PCARA Update*. If you have any suggestions or questions, please feel free to contact me at N2KZ 'at' arrl.net. Don't say "All I have is an HT." We will prove just how far an HT *can* go!

Where It All Began

The original idea for our simplex challenge began with some informal and lazy experiments between myself and Malcolm, NM9J, many months ago. With all my trials and tribulations with several 2 meter mobile antennas, I tried all sorts of places and situations to reach Malcolm's home QTH on simplex. Ray, W2CH, also joined me in other simplex tests during my drives home from work down in Stamford, Connecticut.

Most memorable was my time auditioning an oversized Diamond NR22L mobile whip. Malcolm and I

skedded to try it out during a prolonged drive I took up and around the highest point in Westchester: Mountain Lakes Park in North Salem. We achieved truly spectacular results and we were barely trying! I can only wonder what



our results will be in May, but I am really excited to find out!

Connecticut Radio Update

Last month, we told you all about the closing, re-opening and stunting going on at WSTC 1400 Stamford and WNLK 1350 Norwalk. Both stations are still simulcasting endless music with no announcers except for a top-of-hour ID. It has been reported that their music format is an iTunes shuffle of about 5000 songs. I guess it's pretty obvious that the owner of the two stations,

Sacred Heart University, is just keeping the frequencies warm while they look for a new owner.

Never missing an opportunity, FM wizard Dennis Jackson, K1QHV, purchased a very low power FM translator in Stamford W276AV operating on 103.1 MHz with a mighty 3 watts. (You may remember our profile of Dennis from the February 2014 edition of *PCARA Update*.) Situated atop an apartment building just north of I-95, W276AV originally went on the air back in 1988 as an alternate signal serving the listeners of classical WQXR. Back then, WQXR's main transmitter was on 96.3 MHz while local WSTC-FM was on 96.7 MHz. The translator on 103.1 FM was an easy way to bring WQXR to people near the WSTC-FM tower. It all made sense.

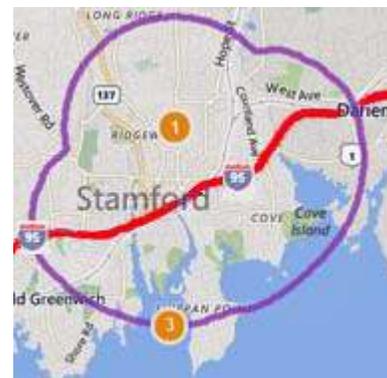
As time went by, W276AV's owners changed and the translator lost direction. It dropped WQXR and had been re-broadcasting several other New York City FMs over the years. At one point, the translator's receiver drifted off frequency and re-broadcast static and noise.

In 2010, the translator was sold to the owners of Hispanic music station "96 X", WXNY. W276AV was back in its original task again re-broadcasting the station on 96.3 MHz from New York City. Right around Christmas 2015, W276AV went mysteriously silent!

Guess who bought the translator? As always, Dennis has a plan! He has applied to the FCC to move W276AV to the WSTC tower south of I-95 and eventually rebroadcast the AM signal of WSTC 1400 giving it a 24 hour a day FM voice to augment the two AM stations already on the air. An amazing and clever plan it is! If Dennis' application is approved, he will increase its power from 3 to 10 watts and move the frequency of operation to 105.5 MHz.

Who will eventually buy the WSTC and WNLK AM radio combo – and – will they consider using Dennis' translator? One thing for sure. A ten watt signal, into a two-bay antenna, high atop a 400 foot tower in the clear, will most definitely be heard!

Keep up with all the latest news and information about our club and all our events! Try our PCARA Facebook page, browse our club web site at pcara.org now and then and tune in The Old Goats Net on 146.67 MHz Thursday nights at 8:00 p.m. Don't say I didn't tell you! Until next month, 73 and good DX de N2KZ 'The Old Goat.'



FCC 60 dB μ service contour for 3W translator W276AV, 103.1 MHz, Stamford, CT.



A funny thing happened while walking my dog. N2CBH

Title search

I must start out and tell you that the biggest issue with this article was what to call it. It all started quite by accident really. I finally decided on “A funny thing happened while walking my dog”.

Dog litter

I was walking our dog Molly one day recently and I happened upon something that had been irresponsibly recycled. Molly wasn't impressed! Well, the item discarded along the highway was a portable air compressor — the type designed to be stored in your trunk in case of a flat tire or for filling bicycle tires.

This particular model, made by Campbell Hausfeld, had two features that struck me as being useful for another purpose. The unit had a 12 V battery that



Campbell Hausfeld CC2300 cordless air inflator & rechargeable 12-volt power pack.

was designed to run the small compressor motor and also had a cigarette lighter receptacle with on-off switch to control the lighter adapter. I suppose the intention was to provide some portable power on the road. The charging adapter was still in the compartment designed to house it and the unit looked otherwise intact. Immediately I thought this little unit, about the size of a lunchbox, could be used as the auxiliary power source for a radio.

Inside view

When I got the unit home, not knowing how long it had been out in the elements, I decided to take it apart first and see what the interior looked like. Inside was a small compressor motor and the 12 volt, 7 ampere-hour sealed lead-acid battery, identical to the type used in a typical computer UPS. All looked in order so I decided to plug in the charging adapter. The charge light came on and the cigarette lighter had 12V DC available at its terminals. So far so good. I tried the compressor and it actually ran with the charging

adapter plugged in.

I decided to charge the battery overnight and see where I was the next day. The next day I was disappointed to find that the battery had not charged. I quickly checked to make sure the charger was applying 12 V to the battery by disconnecting it and checking the terminals with a voltmeter. 13.8 VDC was there. A new battery was in order. No matter. I ordered two batteries from Amazon at \$17.00 a-piece as I also needed a replacement battery for an APC UPS that I use for my home PC. I managed to get two projects done at the same time!



12V 7Ah sealed lead acid battery for APC Back-UPS uninterruptible power supply is available for \$17.00.

Positive charge

I replaced the defective battery in both the Campbell Hausfeld unit and my APC UPS and set them to charge up. After an overnight of charging I decided to test the compressor unit with my Yaesu FT-817 low power transceiver. The FT-817 is capable of 5 watts output from 160 meters through 70 centimeters. It has general-coverage receive capability in addition to the ham band coverage. I connected it to the cigarette lighter receptacle and I was in business.



Yaesu FT-817 HF/VHF/UHF transceiver packs a lot of features into a small space. (Size 5.3" × 1.5" × 6.5").

I did a little figuring and decided that I could use the FT-817 with this setup and have many hours of operation. According to the Yaesu specifications, the key-down current in FM mode is 2.0 amperes and on receive 0.250 mA. With the 7 Ah battery it should provide at least 2-3 hours of key-down time and up to 28 hours of receive time. In normal use I figure that is just about all day! Of course the FT-817 has a battery compartment for nine AA batteries and these can be of

the rechargeable type, but I wanted more talk time — so this little setup would be perfect for a day in the country or at the beach. It occurred to me that this combination is the modern equivalent of a Zenith Transoceanic in more compact form.

Mechanical match

The next task was to determine how to package the FT-817 with the power source. I decided to mount



Front view of the cordless air inflator. Bob mounted his FT-817 on the left side. [N2CBH pics.]

I placed some rubber grommets on the screws and sandwiched the grommets between the metal brackets and the plastic case of the compressor to provide a bit of shock isolation. I am not sure how effective this will end up being but it made me feel better.



Close-up of the L-bracket that Bob used to mount the FT-817 transceiver on the side of the cordless inflator.

A tip for doing this kind of project is to take your time deciding where things will mount and where you will drill holes. The plastic case had a number of inner partitions molded into the design for strength and to

form a compartment for the battery. In order to “miss” the partitions I needed to measure and re-measure. The same goes for the radio cover. I only wanted to drill a total of two holes in the radio cover as I was going to reuse a pair of holes — one on each side — that held the cover in place.

Careful connections

With the FT-817, I needed to be careful not to place a screw hole where the end of the screw would come into contact with the heat sink or worse yet a component on one of the PC boards. I made sure to mount the radio high enough so that the rear of the radio would not scrape on the ground and so that the cables coming out the rear could be comfortably routed. A 90° PL-259 to SO-239 adapter was used to make the sweep for the antenna line easy to handle.



Bob mounted the FT-817 high enough on the compressor's plastic case for access to the rear connectors of the radio.

I routed the power cable for the radio to the cigarette lighter plug and tie-wrapped it off so that the cabling wouldn't get caught on anything in transmit or setup. Another item to attend to was mounting a microphone clip to hang the microphone. I decided to place the clip on the rear of the compressor cabinet. The nice thing about working with plastic is that holes can be drilled with ease. This really made this project easy to get done.



The microphone clip was mounted on the rear of the compressor.

Reduce, reuse, recycle

Here is another big takeaway from this project. I reused a lot of saved hardware and other miscellaneous items including the L-brackets. These were actually aluminum rack adapter rails for a long-obsolete product that my company made years ago. I still have a lot of these and they come in handy for this kind of thing. My advice is to never throw away screws, nuts, washers, or any small hardware. This stuff doesn't take up much room and can really come in handy. If you are like me you always need an extra nut or washer for some job around the house — so store and organize your small parts.

Perfectly portable

When the project was completed I had a nice portable transceiver setup for all bands. Plug in a rubber duck to the top of the unit and it makes for a nice 6m / 2m / 440 radio that can be carried to any room in the house for a QSO on the local repeater. I made a contact on 40 meters with this little rig connected to my base station antenna and got a 5-7 signal report from southern Vermont. Not bad — and that was just the beginning.



Her Master's Voice? Molly checks out the rechargeable power pack for the FT-817, assembled from parts found while Bob was walking the dog. [N2CBH pic.]

Adopt, adapt, improve

Working on the project reminded me of one of my first jobs as a broadcast engineer. On that occasion I was called upon to scratch-build things that the station needed and what was often done then was precisely how I approached this project. Take what you have available and adapt it to your needs. That's the ham radio creed. It's not surprising that my boss on that job was a ham and also my Elmer.

I once needed to come up with a single channel microphone preamplifier-to-line driver, suitable for driving a telephone line for station use. The whole

thing was made out of junk box parts and a cannibalized Sony portable cassette deck. The cassette deck had a built-in audio compressor which came in handy as I recall. I still remember doing this project and it became my project "epiphany". If you have the right tools and a little imagination you can come up with some really neat stuff and not spend a lot of money either. The project in this article used nothing more than simple hand tools and a portable drill. I had the radio. You know the story on the compressor. The rest was junk box stuff and a little elbow grease. The only thing I had to buy was a replacement battery and that cost under \$20.00.

Grab-n-Go box

Here are a few benefits of doing this project. I now have a nice little QRP setup for field use. This unit can also be used as an emergency "grab and go" rig. It makes a nice "carry it anywhere and operate" 50, 144 and 430 MHz transceiver for working local repeaters or for emergency field use.

There is nothing that needs setup, other than plunking the unit down where you want to use it and turning on the power. You are ready to go. Of course HF work will require a little more preparation but stay tuned because next month I will have another installment.

Keeping with the theme of rescue and reuse of materials I went ahead and made a portable HF antenna stand — for field

use with the radio configuration described in this article. Virtually everything for the antenna system was rescued and reused. Set-up time for the whole thing is literally just minutes. More on this next month.

- Bob, N2CBH



Grab-n-Go Rig.

On offer

Ray, W2CH mentions that he will be back at the March 6th PCARA meeting, once again offering radio / electronic items to members who might be interested in purchasing.



Ray W2CH selling stuff at the February PCARA meeting.

The Raspberry Pi microcomputer - N2CKD

Micro management

Microcontroller hardware and software is increasingly popular for controlling everything from robots to satellites to home automation and is easily within the price range of do-it-yourself hobbyists. Three popular single-board computers are now available in the maker marketplace and each has its own appropriate uses. They all share the common traits of low cost, small size and powerful microcontrollers.

The three choices are the **Arduino Uno**, **Raspberry Pi** and **BeagleBone**, ranging in price from \$25.00 to \$55.00. Their applications are many and various, as documented at numerous websites. If you need help deciding which to buy, see the article comparing all three at Make: magazine's web site, <http://makezine.com/2013/04/15/arduino-uno-vs-beaglebone-vs-raspberry-pi/>. I already owned an Arduino, so I recently purchased the latest, fastest version of the second choice, the **Raspberry Pi 2, Model B**. My next purchase will probably be a BeagleBone since it is similar to but more powerful than the Raspberry Pi.

My initial impression of the Raspberry Pi is quite favorable and I am having fun playing and experiment-

ing with it. I am using it as an inexpensive computer to learn Linux, plus programming and as



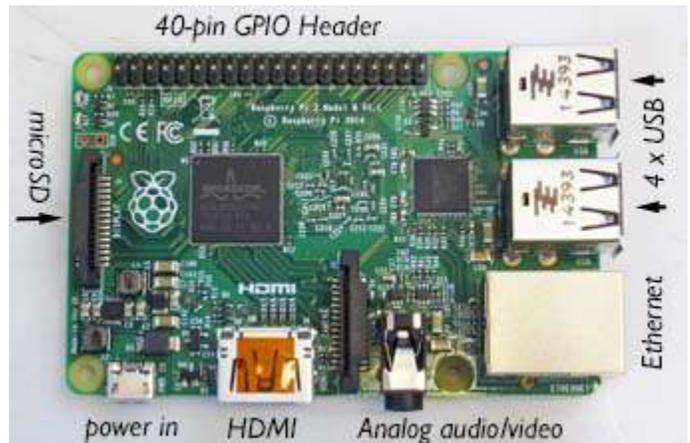
Raspberry Pi

a general-purpose Linux computer. I could use it as a dedicated web server, print server, media player, web browser, and even to check email. It runs almost as well as my Windows XP-based Intel PC. I like its **Raspbian** operating system (OS) because it boots-up and shuts down much faster than Microsoft Windows. If you are familiar with Linux then using Raspbian is quite easy.

The Raspberry Pi (or RPi) is ideal for experimenting with external devices using the general purpose input/output (GPIO) pins controlled via the Python or Scratch programming languages that are included with Raspbian Linux.

What you get

The Raspberry Pi 2 Model B is a tiny, credit-card sized second-generation unit based on the Broadcom BCM2836 system-on-a-chip, which includes a quad core ARM Cortex-A7 CPU, running at 900 MHz. It also has 1 GB RAM, HDMI audio/video output and a 40-pin GPIO port which includes 3.3V, 5V and GND pins for



The credit-card sized Raspberry Pi 2 Model B includes all the connections for a modern computer system.

I/O programming and experimentation. There is a 15 pin camera serial interface intended for the optional Raspberry Pi cameras. The unit is powered through a microUSB connector, suitable for attaching a 5 volt cellphone charger.

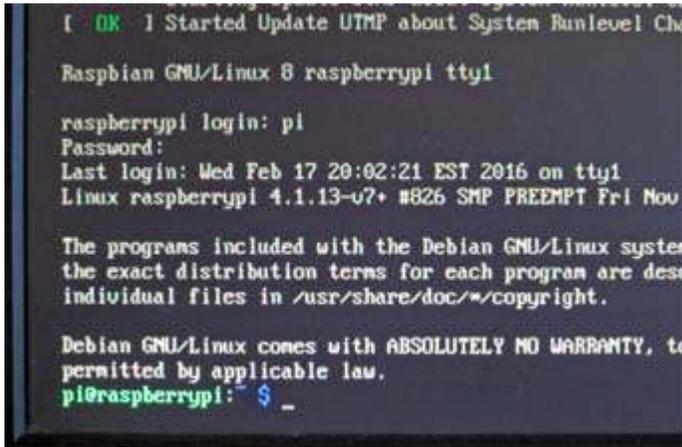
The Pi-2 has a microSDHC slot for local storage using high-speed flash memory. With a suitably-configured microSD card, it will boot up into the Linux-based Raspbian OS. There are boot-up options to overclock the Pi so it runs faster and to change the memory-split between CPU and GPU for better graphics processing. The Pi has no cooling fan or heat sink for the processor, so care is needed when overclocking.

Software

The recommended version of Linux for the Raspberry Pi is **Raspbian**, which is based on Debian, one of the earliest Linux distributions. It is a lean version of Linux, especially developed and officially supported by the Raspberry Pi Foundation:

<https://www.raspberrypi.org/>. I like Raspbian because it is stable and easy to learn compared to other Linux distributions. It takes less than 60 MB of RAM and in its idle state uses hardly any CPU power. Many applications work seamlessly with Raspbian, for example Focus-Writer for word processing, the LibreOffice suite and various media-players. Plus, you can use Python and Scratch programming languages to control the GPIO pins. If you don't know these programming languages, tutorials are available on the Raspberry Pi Organization website — <https://www.raspberrypi.org/learning/python-intro/> and <https://www.raspberrypi.org/learning/getting-started-with-scratch/>.

If you are not already familiar with Linux, then you will need to learn some commands for the Linux Shell which appears immediately after the Raspberry Pi boots-up. The Linux Shell (or Linux Terminal window in the graphical interface) is a powerful tool for getting around the file system and issuing operating system commands, just like you did with MS-DOS. You can



The Linux Shell is the command line interface that the Raspberry Pi boots to at switch-on.

learn basic Linux via tutorials and print out a list of Linux commands like I did from: <http://raspberrypiwebserver.com/linux-basics/>. After taking the tutorials I was able to write and execute simple Python & Scratch programs and issue Linux commands — so it is not difficult at all.

My Pi

I purchased a Raspberry Pi 2 Model B for \$35.00 and also purchased a preloaded Raspbian OS image on an 8GB microSD card plus clear plastic case from Allied Electronics, <http://www.alliedelec.com/>. You can purchase accessories from the same site and from other vendors. An excellent site for Raspberry Pi accessories and tutorials is Adafruit at <https://www.adafruit.com/>. Beware of

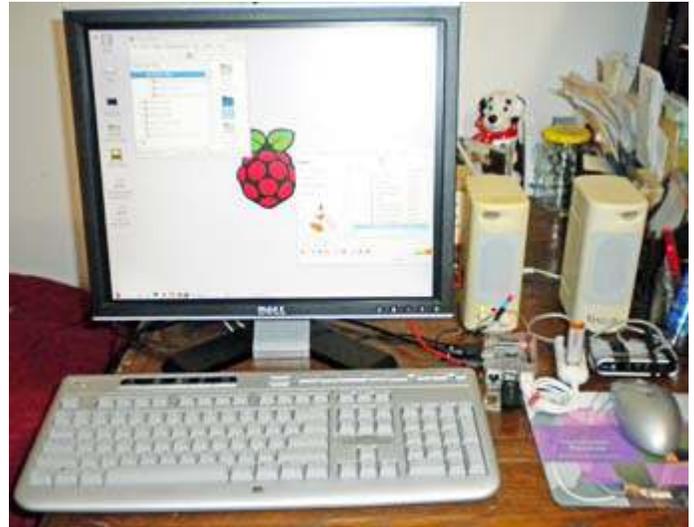
buying too many accessories and applications as this quickly adds to the cost of owning a Raspberry Pi.

For \$35.00,

you only receive the Raspberry Pi microcomputer board. It does not come with any accessories such as case, power supply, monitor, keyboard, mouse, speakers, Wi-Fi adapter, Ethernet or HDMI cables. You will need to provide suitable accessories from your own surplus parts box or purchase them. To keep the cost down, I scrounged around for accessories that other people had junked. From a discarded computer, I found a wireless keyboard/mouse, stereo speakers, an old Wi-Fi (802.11g) adapter and Ethernet & HDMI cables. For the Pi's power supply, I am using a 5V 700 mA microUSB charger from a surplus cell phone. I also found an excellent 19" monitor from a neighbor's curbside trash. It has a DVI input (no HDMI) so I bought an HDMI/DVI converter cable for about \$5.00 on-line (\$17.00 at Walmart).

The Raspberry Pi 2 Model B comes standard with an HDMI port (1080p) which connects to a standard

HD television or computer monitor. Video output to the HDMI port is the Pi's default setting, with digital audio played through the TV speakers. But you can also force analog audio to the included 3.5mm jack for headphones or external analog speakers using the `raspi-config` configuration tool. You may also need some breadboard-sized jumper wires with male/female connector ends to make connections to the GPIO Pins. You can purchase a breadboard 40 wire jumper bundle for \$4.75 from: <http://www.atomsindustries.com/>. [An alternative GPIO connection is the Adafruit Pi Cobbler Plus breakout cable which adapts the Pi's 40 pin header to any solderless breadboard. —Ed.]



Lovji's Raspberry Pi 2 setup includes a surplus computer monitor, DVI video converter, wireless keyboard and mouse, USB hub, WiFi adapter and recycled computer speakers. [N2CKD pic.]

Two items I purchased new were a plastic case for the Raspberry Pi and an 8GB microSD card, pre-loaded with Raspbian Pi NOOBS v1.4 software. If you are sufficiently experienced,

you can download Raspbian and other Linux OS images onto your Windows PC or Mac, expand the files then transfer to your own 8GB or 16GB microSD card for insertion into the Pi. The "NOOBS" download from the Raspberry Pi Foundation comes with Raspbian and the option to download other operating systems. You can download different OS images such as Ubuntu, RISC-OS etc. onto different MicroSD cards and boot different operating systems simply by changing the card in the Pi — or you



Raspberry Pi 2 storage employs 8GB-16GB microSD card (right). Adapter on left allows use in a standard SD card slot as used on many PCs.

could keep a spare backup copy of Raspbian.

The Raspberry Pi 2 Model B comes with an HDMI port, an analog audio/video port (3.5mm jack), a 10/100 Mbps Ethernet port and **four** USB



End-view of the Raspberry Pi 2 card shows the Ethernet port and four USB ports.

ports to connect USB-based accessories. I attached an external, passive 4-port USB hub so I use only one USB slot on the Pi— see photo alongside.



Lovji employed an external 4-port USB hub (right) that only takes up one USB port on the Raspberry Pi 2. [N2CKD pic.]

Each USB port can provide a maximum of 500mA to the connected equipment, so keep in mind that if your peripherals draw appreciable current, then you will need either an external, **powered** USB hub or a charger/PSU for the Pi capable of **2 amp** output. Standard cell phone chargers are usually rated at 700mA, so if you run a lot of accessories you will need a **2 amp** charger/power supply (available for \$5.00 at The Five Below store, Cortlandt Town Center).

The optional Raspberry Pi Camera Module is capable of taking full HD 1080p video/photos. The module can be controlled via programming and is ideal for home security applications.

Instead of the Raspberry Pi camera module you could substitute a standard USB webcam.



This microUSB 5 volt phone charger/power supply has 2A output suitable for the Pi.

The Raspbian OS includes a web browser called Epiphany, programming languages Python and Scratch, a basic text editor (Leafpad) and a basic media player (OMXplayer). Scratch is a visual programming tool allowing the user to create animations and games with a drag-and-drop interface. Python is the *de facto* standard programming language on the Pi that is easy and powerful to use. Raspbian includes some Python Games, including a version of Minecraft with programmable interface for the GPIO pins. You can play, browse and hack games and learn to write your own



Python Intro

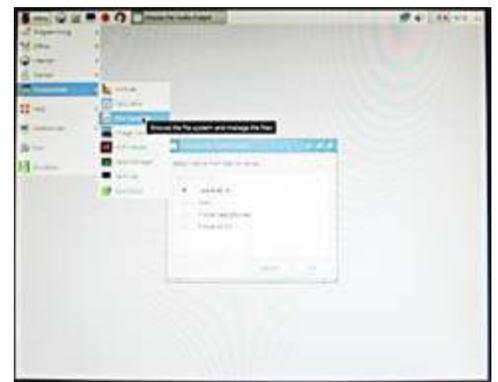
code. Also included is Sonic Pi which allows you to write code to make music on the Pi. Finally, the computer algebra system *Mathematica* is included, along with a few programs to demonstrate the Pi's capabilities.

Tutorials

Before using the Raspberry Pi, I started out by reading the Quick Start Guide available at <https://www.raspberrypi.org/help/quick-start-guide/>. I also read many other tutorials and articles. The next step was to learn some basic Linux commands, so I could type them into the Shell. They are available from the previously-mentioned <http://raspberrypi.com/linux-basics/>. I printed out the Linux commands to serve as a quick reference-sheet.

Software settings

I set my Raspberry Pi to boot to the graphical Desktop Environment (equivalent to Windows), instead of booting to the Linux Shell. An alternative is to type the `startx` command into the Linux Shell in order to enter the desktop environment.



LXDE graphical desktop environment.

I used the Linux command: `sudo raspi-config` to manage the Pi's settings such as over-clocking, memory split, time zone and US English keyboard settings. I changed the over-clocking and memory-split settings to slightly

higher than the defaults without any problems.

The Raspberry Pi does not come with a power on/off switch, so you must take care to shut it down properly, either via the Linux `sudo halt` command or from the Desktop Environment, by clicking the “Shut-down” choice on the drop-down menu. Then wait for all activity to cease before removing power.

Help is on the way

The Raspberry Pi organization provides excellent support on its website at <https://www.raspberrypi.org/resources/>. By looking into their Help, Forums, Education and other categories, you can learn a lot about the Pi’s capabilities and community resources. Here are some useful links:

Raspberry Pi Quick start guide:

<https://www.raspberrypi.org/help/quick-start-guide/>

How to install Raspbian to an SD Card, using either Windows or OS X:

<https://www.raspberrypi.org/learning/noobs-install/>

Raspberry Pi Beginner’s Guide by a Geek Girl:

<http://deviceplus.com/category/hobby/raspberrypi/>

Raspberry Pi – Preparation:

http://deviceplus.com/hobby/raspberrypi_entry_002/

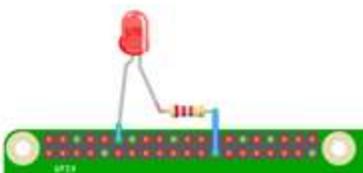
Several good tutorials are available on the previously-mentioned **Adafruit web site**: <https://www.adafruit.com/>.

A selection of online community projects, blogs, YouTube channels and tutorial sites are available at <https://www.raspberrypi.org/community/>

Applications

Everyone keeps asking — what can you do with the Raspberry Pi? And really, my answer is — what can you *not* do with it! Innumerable applications, tutorials, games, programming languages, plug-in shields, third-party HW/SW applications, and operating system images are all available for this full-function Linux based microcomputer at an incredible price.

In the past few weeks, I have discovered many new Raspberry Pi applications, learned many of its capabilities and found out how it is being used by the Pi community. I also learned the Raspbian Linux operating system and gained a working knowledge of the Python and Scratch languages. I tried out a few experiments such as controlling LEDs by programming the GPIO pins. I downloaded a media player program and have used it to play Internet radio stations as well as music and photos from a USB memory stick. I also use



Controlling an LED via GPIO.

the Pi to browse the web. I discovered many applications from several web sites and YouTube. For example there is an application called Morse Code Virtual Radio with a complete Python program available on the Raspberry Pi Foundation site. I am looking forward to experimenting further with the Pi and discovering its true potential.

Other Hams are experimenting with the Raspberry Pi for Amateur Radio digital mode applications, so I look forward to learning about their experiences as well.

[Digital modes software **Fldigi** can be made to run on the Raspberry Pi – Ed.] A low cost (\$5.00) Raspberry Pi Zero model has recently been introduced, which is garnering a lot of interest. So let’s stay tuned to Raspberry Pi projects for Amateur Radio.



Morse Code Virtual Radio allows sending of Morse by connecting a key to the Raspberry Pi GPIO pins. The application plays a tone when you hold the key down. You can also decode the Morse that is being keyed so it displays on-screen.

Some amateur radio links:

Morse Code Virtual Radio:

<https://www.raspberrypi.org/learning/morse-code-virtual-radio/>

Asterisk Allstar on the BeagleBone Black and Raspberry Pi 2: <http://crompton.com/hamradio/BeagleBoneBlackAllstar/RunningFldigi> on the Raspberry Pi 2:

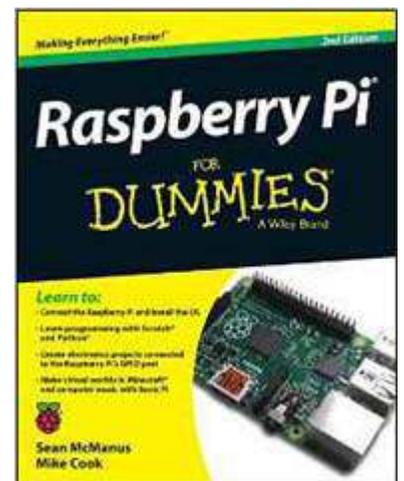
<https://www.jeffreykopcak.com/2015/10/13/running-fldigi-fmsg-and-flwrap-on-the-raspberry-pi-2/>

- Lovji, N2CKD

[Footnote – your editor would like to add one more resource to the list provided by Lovji, and that is the book: “**Raspberry Pi for Dummies, 2nd Edition**”, authored by the UK’s Sean McManus and Mike Cook, G8HBR.

While living in the Manchester area, I ran into G8HBR on several occasions. Mike was a member of Bury Radio Society and a Lecturer in the Department of Physics, Maths and Computing at what was then Manchester Polytechnic. Check out Mike’s web site:

<http://www.thebox.myzen.co.uk> – Ed.]



Essential₂ cores

This is one of the occasional *PCARA Update* articles explaining how chemistry is “essential₂” amateur radio, electronics and life in general. This time we are looking at **magnetic materials** and the way they modify the properties of an electrical inductor — as used in coils and transformers.

Air coil

In amateur radio we are quite familiar with air wound inductors. Examples range from the large coils employed in antenna tuners and for loading of HF antennas, down to the small inductors found in VHF and UHF circuitry. The inductance of a single-layer air-cored coil can be estimated with a formula such as this one:



Air-cored coil

$$L (\mu\text{H}) = \frac{r^2 N^2}{(9r + 10l)}$$

...where L is the inductance in microhenrys, r is the radius in inches and l is the length of the coil in inches. Note how the inductance increases as the *square* of the number of turns, N . For example, if we wind a coil with radius of $\frac{1}{2}$ " , length of $1\frac{1}{4}$ " and 25 turns, the inductance L is calculated as:

$$L = \frac{0.5^2 \times 25^2}{(9 \times 0.5 + 10 \times 1.25)} = \frac{156.25}{17} = 9.19 \text{ microhenries}$$

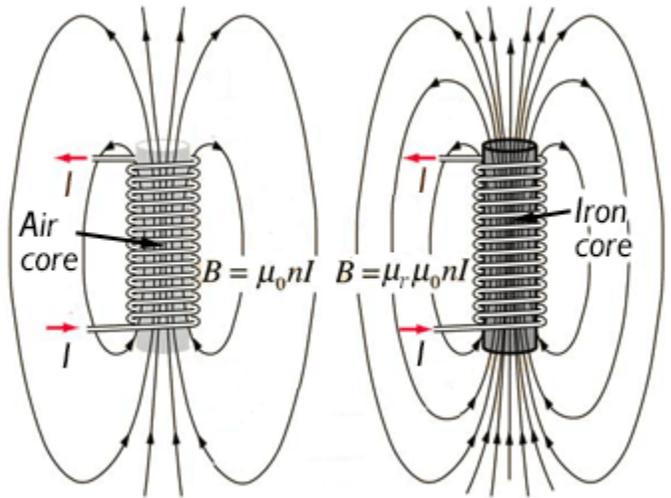
Doubling the number of turns from 25 to 50 would result in an inductance of 36.8 microhenries, four times the previous value.

Iron cores

If, instead of air, our simple wire inductor is wound around a material with **magnetic** properties, then the magnetic flux through the core of the coil increases, as does the coil's inductance. The new inductance — as calculated by the formula above — now has to be multiplied by the relative **permeability** of the magnetic material. For example, if our coil with 25 turns of wire was wound around a soft iron rod, with a relative permeability (μ_r) of 800,



Coil with a magnetic core.

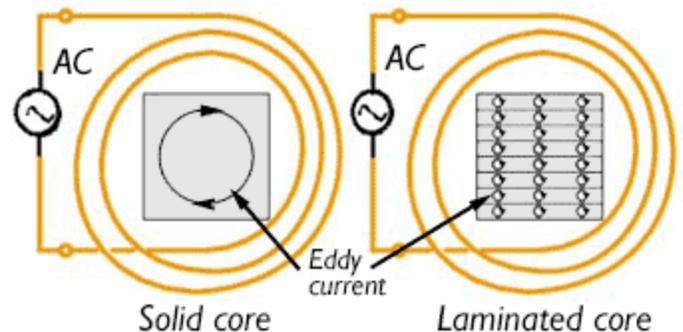


Winding the coil around an iron core (right) increases the magnetic flux density several hundred times compared to an air-cored coil (left).

the inductance increases to $800 \times 9.19 = 7352$ microhenries, or 7.3 millihenries.

(Don't mix up μH , the abbreviation for microhenries, with μ the symbol for permeability.)

Iron cores are employed in chokes and transformers for 50/60 Hz line frequency and audio frequencies. Unfortunately, iron is an electrical conductor and AC waveforms would produce large eddy currents in a core made of pure iron. In order to suppress eddy currents that would generate losses, the magnetic core is usually assembled from multiple, insulated layers or *laminations*.



Solid iron core (left) has a high eddy current loss. The laminated iron core (right) has a lower eddy current loss.

Steel alloys which combine iron with silicon are available which have higher resistivity than pure iron, and this further reduces eddy currents and hysteresis effects.

Higher frequencies

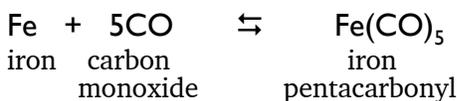
As we move from audio frequencies (0 - 15 kHz) to higher, radio frequencies, eddy current losses increase and different techniques are needed for an efficient magnetic core. These include the use of **metal powders** and the use of **ferrites**.

Metal powders

One way to reduce losses in a magnetic core is to use **iron** which has been prepared as a fine **powder**, combined with an insulating binder. This binder keeps the individual iron particles insulated from each other, so the eddy currents cannot circulate within the bulk of the magnetic core.

The fine iron powder used in these formulations is known as **carbonyl iron**. It is prepared by a chemical technique pioneered in 1925 by I.G. Farben in Germany. This part of I.G. Farben is now known as BASF.

The starting material is standard scrap iron (Fe), which is finely ground and reacted with carbon monoxide to produce iron pentacarbonyl, $\text{Fe}(\text{CO})_5$. This reaction requires high pressure and temperature, 150-200°C, with the iron carbonyl removed as a volatile gas. It can then be condensed into a toxic, oily, yellow liquid.

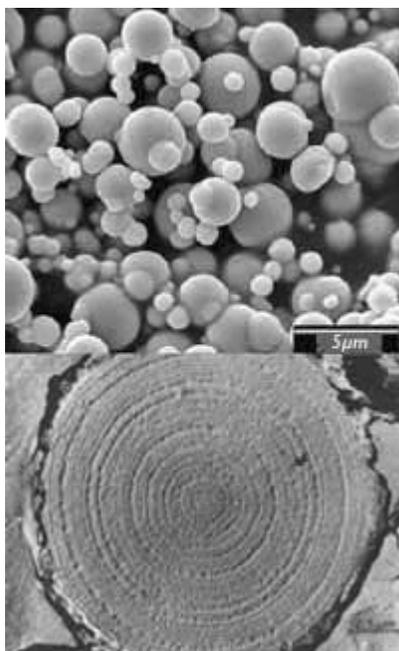


The liquid iron pentacarbonyl is purified by distillation (boiling point 103°C). This removes contaminants such as chromium, molybdenum and nickel.

In the next step, pure iron pentacarbonyl is vaporized and decomposed back into its constituents at a temperature of e.g. 250°C - 290°C. The carbon monoxide released during this treatment can be recycled for further synthesis of

the intermediate $\text{Fe}(\text{CO})_5$. Metallic iron is deposited in the form of high purity, microscopically small spherical particles of precisely defined structure and size — known as **carbonyl iron powder**. The process forms spherical iron layers on a nucleus, developing a shell or “onion skin” structure with an overall diameter of less than 10 microns. This “onion skin” structure is similar to a laminated core, suppressing eddy currents within the individual particles.

Particle size distribution is determined by the conditions of thermal



Top: BASF scanning electron microscope picture of carbonyl iron particles, scale = 5 microns.

Below: cross-section of one particle showing the onion-skin structure.

decomposition, including vapor flow rate and temperature. After the chemical process, individual grades of carbonyl iron are obtained by milling (breaking apart of secondary particles), classifying according to particle size, followed by mixing and coating. This final step surrounds each tiny particle with an insulating layer, intended to suppress eddy currents in the bulk material. For use in high frequency coils, the insulated coating is usually **iron phosphate**.

Hard boiled

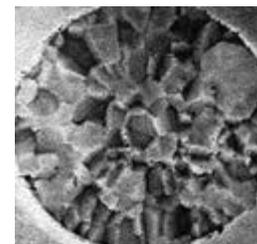
These grades of carbonyl iron powder are mechanically hard. Their combination of low permeability and extremely low core loss make them suitable for high-Q circuits at HF and even VHF frequencies. For example, one of the finer-size grades can be used over a frequency range of 20-200 MHz.

Production of actual magnetic cores from carbonyl iron powder requires addition of an organic polymer binder, such as an epoxy or phenolic thermoset resin. The resin is dissolved in solvent such as acetone, then added to the phosphate-coated iron particles to form a slurry. The solvent is removed by evaporation, then the core is pressed in a die and heated to cure the polymer.

Soft option

The manufacturers of carbonyl iron powder also produce a “soft grade” by annealing hard grade material at 400°C under an atmosphere of hydrogen. This destroys the onion skin structure and also reduces the content of impurities carbon, nitrogen and oxygen.

These “**hydrogen reduced**” soft grades can be pressed to high densities with low amounts of binder. This allows higher permeability — μ , up to 100 — with low loss at low frequencies. However, above ~100 kHz the losses increase. Iron powder cores using these materials find use in chokes and filters for switch mode power supplies. The particles are coated with inorganic phosphate for insulation, then compacted into the desired shape under high pressure, followed by heat treatment to relieve stress. Finally a coat of moisture-resistant paint increases physical strength of the core.



SEM picture of BASF's 'hydrogen reduced' carbonyl iron powder showing loss of the onion-skin structure.

Pressing appointment

Magnetic cores can be molded into a variety of shapes. Examples include the central, threaded core for adjustable HF/VHF inductors, circular toroids — which are self-shielding as the magnetic field stays inside the core — and pot cores which have a central magnetic

post for the coil, surrounded by additional magnetic material. A modern version of the pot core is the flat-wound ER/I cores for SMDs (surface mount devices) as used in notebooks and smartphones.

Iron powder in practice

Iron powder cores are manufactured from carbonyl iron powder by companies such as Micrometals Inc. Their products for RF applications have core materials with permeabilities from 4 to 35, covering frequency ranges from 10 kHz to 500 MHz. Their hydrogen-reduced products have a permeability of 40. A table of frequency ranges, permeabilities, and toroid color coding for different material mixes is available on the Micrometals web site at:

http://www.micrometals.com/materials_index.html .

For an iron powder **toroid**, instead of quoting permeabilities, manufacturers provide an “inductance rating” or inductance index A_L , which indicates the inductance per squared turn. Different manufacturers may provide the index in units of nanohenries (10^{-9} H) per single turn or microhenries (10^{-6} H) per 100 turns. Inductance increases as the square of the number of turns, so the actual inductance for any number of turns (N) through the toroid in question can be calculated as:

$$L \text{ (nH)} = A_L \times N^2 \quad (\text{Where } A_L \text{ is in nanohenries per turn})$$

or

$$L \text{ (}\mu\text{H)} = \frac{A_L \times N^2}{10000} \quad (A_L \text{ is in millihenries per 100 turns).}$$

As an example, let's select a T80-2 toroid core from the Micrometals catalog. This is a 0.8" OD core with A_L of 5.5 nH/N² (or 55 mH per 100 turns). Micrometals' type -2 material is identified by a red/clear coating and is good for high-Q use from 250 kHz to 10 MHz. The inductance of a 25-turn coil wound on this particular toroid would be:

$$L = 5.5 \times 25^2 = 3437.5 \text{ nanohenries (or 3.43 millihenries).}$$



Iron powder cores manufactured by Micrometals Inc., showing various size toroids and threaded cores.



Micrometals' T80-2 iron powder toroids.

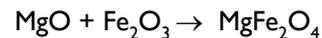
The (fer)rite stuff

As we saw earlier, the main problem with using bulk iron for magnetic cores is that metallic iron is a good electrical conductor, so special techniques are required to suppress eddy currents that cause losses. Instead of stacked laminations or use of insulated iron powders, what we need is “the right stuff” — a homogeneous material with **very low** electrical conductance and suitable magnetic properties. Such a material was discovered in 1930 by Dr. Takeshi Takei of the Tokyo Institute of Technology, who found that mixed oxides of **iron** and **zinc** have useful magnetic properties and poor electrical conductance. Tokyo Denki Kagaku Kogyo (now TDK Corporation) was founded to commercialize this newly invented material. Subsequent collaboration with TDK led to an **iron-copper-**



zinc oxide with useful properties up to medium frequencies. TDK employed this material to manufacture magnetic cores for military radios during World War II.

These mixed oxides of iron and another metal are known as **ferrites**. They are derivatives of the naturally occurring magnetic material **ferrous ferrite**, $\text{Fe}(\text{Fe}_2\text{O}_4)$ or $\text{FeO} \cdot \text{Fe}_2\text{O}_3$. This material is also known as magnetite, Fe_3O_4 — and as lodestone when naturally magnetized. In a metal ferrite, the ferrous oxide ($\text{Fe}^{\text{II}}\text{O}$) component of ferrous ferrite is replaced by the oxide of another divalent metal M, having roughly the same ionic size. The chemical formula for such a ferrite is then: $\text{MO} \cdot \text{Fe}_2\text{O}_3$ or MFe_2O_4 . The divalent metal M could be: manganese (Mn), copper (Cu), cobalt (Co), zinc (Zn), nickel (Ni), or magnesium (Mg). These simple ferrites can be prepared by intimately mixing the appropriate metal oxides or carbonates, for example MgO and Fe_2O_3 , then sintering at temperatures above 800°C.



Ferrite development was also underway at Philips Research Laboratories in the Netherlands. Over the period 1935-1945, physics researcher Dr. Jacob L. Snoek was experimenting with combined ferrites. He developed nickel-zinc and manganese-zinc ferrites. These materials had useful magnetic properties at higher frequencies than Dr. Takei's copper-zinc ferrite. After receiving details of the Japanese work, Dr. Snoek improved the procedure for preparing low-loss ceramic ferrites by heating a very finely divided mixture of the solid metal oxides, then treating the product with oxygen at lower temperature until sufficient oxygen had been absorbed. This method was used to prepare a copper-zinc ferrite, which was given the



commercial name of Ferroxcube I. The manganese-zinc ferrite was named Ferroxcube III, while nickel-zinc ferrite was known as Ferroxcube IV.

Nowadays, the two most popular materials for preparing “soft ferrites” (which do not become permanently magnetized) are the last two, manganese-zinc ferrite and nickel-zinc ferrite. Compared with the carbonyl iron powders, they have much higher permeabilities, μ_r of 1000 or more. This allows **higher inductance** coils to be wound in a smaller space than with powder cores.

Ferrite manufacture

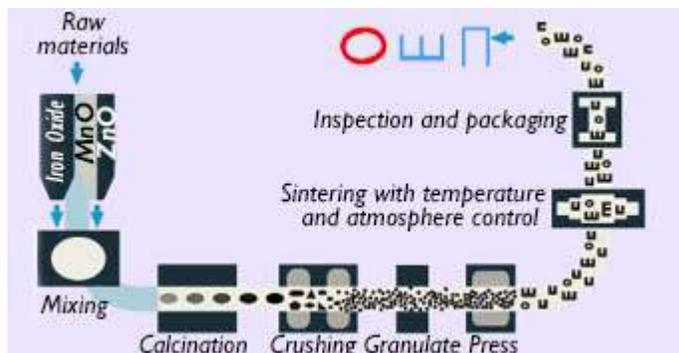
The manufacturing process for ferrites begins with the oxides or carbonates of the constituent metals, for example iron oxide (Fe_2O_3), zinc oxide (ZnO) and manganese carbonate (MnCO_3). The three powders are carefully weighed, then thoroughly mixed together using a dry or wet ball mill process followed by drying.

The next step is calcining, where the mixed powders are heated in a furnace to 1000°C under air, driving off carbon dioxide from the metal carbonate. This produces coarse pellets which must be ground down to a fine powder (~ 1 micron) in a wet ball mill with steel balls. Binder and lubricant are added to the wet slurry, which is then spray dried by forcing into a heated chamber.

The resulting powder now has to be formed into the desired shape for the intended application. This is usually carried out by dry pressing in a die cavity, where the two halves of the die are filled with powder then subjected to high pressure.

The final, critical step is sintering of the formed component to fuse all the parts together. This is similar to firing of ceramic pottery in a kiln. Temperature and atmosphere must be carefully controlled with time. The cycle starts with a gradual ramp-up to 800°C under air to burn out impurities, moisture, binder and lubricant. The temperature is further raised to 1100°C to 1400°C under a reduced-oxygen atmosphere. This is followed by a slow cool-down under oxygen-free conditions.

The sintering process shrinks the pressed component's size by $\sim 10\%$ to 20% . Obviously this has to be



Industrial process for the manufacture of magnetic cores containing manganese zinc ferrite.

taken into account in the design of the die for pressing the powder. Careful control of the sintering process is essential in order to obtain the desired magnetic and physical properties.



Tunnel kiln for sintering of soft ferrite pressings.

There may be some final processing depending on the application. Mating surfaces need to be polished, toroids are tumbled to reduce surface imperfections and the product may need a coat of paint or plastic for identification and to prevent scratches when wound with insulated wire.

Ferriteful experience

I had my own brush with ferrite manufacturing several decades ago. Just before leaving grammar school in Southport, there was a class visit to Mullard Magnetic Components' factory in Crossens. This establish-



Mullard Magnetic Components factory at Crossens in Southport, NW England.

ment was located at the north end of town, near the old Crossens station on the rail line to Preston.

Mullard was part of the Philips group

and at one time their Crossens factory was the largest magnetic materials plant in Europe, employing 750 people. The site produced Ferroxcube soft ferrites, widely used at the time for the deflection yokes of TV picture tubes, TV flyback transformers (LOPTs) and in ferrite

rod/loopstick antennas. They also manufactured Magnadur hard ferrites, based on barium ferrite, for use as permanent magnets in CRTs, loudspeakers and DC motors.

The company name was changed to Philips Components and the soft ferrites business was subsequently divested to Yageo Corporation of Taiwan in 2000. The Crossens site closed and was later demolished in 2014.



Measurement of ferrite core losses using frequencies up to 1.5 MHz at Mullard's magnetic materials plant in Crossens during the 1970s.



Trade advertisement for Mullard Ferroxcube magnetic materials and their use in television components (1951).

The (fer)rite choice

The **type** of ferrite used for a particular application needs careful selection. **Fair-Rite Corporation** produces many

of the ferrite cores used in amateur radio, and they have tables showing the properties of their different magnesium-zinc and nickel-zinc materials. See: <http://www.fair-rite.com/design-tools/materials/>. Fair-Rite Type 43 and Type 77 materials are described as follows:



Ferrite components manufactured by Fair-Rite Corporation.

Type 43: “This NiZn is our most popular ferrite for suppression of conducted EMI from 20 MHz to 250 MHz. This material is also used for inductive applications such as high frequency common-mode chokes. EMI suppression beads, beads on leads, SM beads, multi-

aperture cores, round cable EMI suppression cores, round cable snap-its, flat cable EMI suppression cores, flat cable snap-its, miscellaneous suppression cores, bobbins, and toroids are all available in 43 material.”

Type 77: “A MnZn ferrite for use in a wide range of high and low flux density inductive designs for frequencies up to 100 kHz. Pot cores, E & I cores, U cores, rods, toroids, and bobbins are all available in 77 material.”



Ferrite cores based on these popular materials are marketed to the amateur radio community by **Amidon Inc.**



Amidon Inc. location in Costa Mesa, CA.

in various shapes and sizes, including toroids, pot cores and binocular cores. See <http://www.amidoncorp.com/> for further details. As well as the ferrite cores, Amidon also markets iron powder cores manufactured by Fair-Rite. - NM9J

Basic Electronics Class

Larry, W2LGB has provided information on the upcoming Basic Electronics Class organized by Orange County Amateur Radio Club.

BASIC ELECTRONICS – III March 2016

Instructors: Saul Rozinsky WA2KOT, Mike McGinn KD2CNU, Stan Labinsky K2STN. Sponsored by Orange County Amateur Radio Club. No charge.

When: March 5, 12, 19, 26; April 2, 9:00 am – 12 noon.

Where: Moulton Memorial Baptist Church Community Room, 54 Old Little Britain Road, Newburgh, NY 12550. From Union Ave (Rt 300) intersection with Old Little Britain Road (immediately south of Home Depot) go East ½ mile to church entrance.

Purpose: Learn, investigate and test the functions of **oscillator** and **mixer** circuits, and **direct conversion** concepts, by means of constructing a low-power 2-transistor transceiver kit.

What to bring: Fine-tip soldering iron (not more than 20-30 watts), Radio Shack 6402055

Rosin-core solder

Multi-meter (CEN-TECH 7-function #69096 or equivalent) (Harbor Freight, Amazon)

Needle-nose pliers

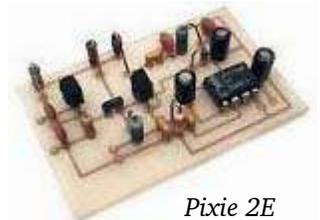
Diagonal cutter (“side-cutter”)

Wire stripper

Safety glasses

X-Acto knife (optional)

Magnifying glass (optional)



Pixie 2E

What to order: Pixie-2E QRP CW Transceiver Kit* \$14.95 + shipping, <https://www.halted.com/ccp13844-enhanced-pixie2e-qrp-cw-transceiver-kit-pixie2e-kit240.htm> .

Register for the class: email gshacklett@earthlink.net or call (845) 649-9402.

*Transceiver for on-air use by licensed radio amateurs only.

Peekskill / Cortlandt Amateur Radio Association

Mail: PCARA, PO Box 146, Crompond, NY 10517

E-Mail: mail 'at' pcara.org

Web site: <http://www.pcara.org>

PCARA Update Editor: Malcolm Pritchard, NM9J

E-mail: NM9J 'at' arrl.net

Newsletter contributions are always very welcome!

Archive: <http://home.lanline.com/~pcara/newslett.htm>

PCARA Information

PCARA is a **Non-Profit Community Service**

Organization. PCARA meetings take place the first Sunday of each month* at 3:00 p.m. in Dining Room B of NewYork-Presbyterian/Hudson Valley Hospital, Rt. 202, Cortlandt Manor, NY 10567. Drive round behind the main hospital building and enter from the rear (look for the oxygen tanks). Talk-in is available on the 146.67 repeater. *Apart from holidays and July/August break.

PCARA Repeaters

W2NYW: 146.67 MHz -0.6, PL 156.7Hz

KB2CQE: 449.925MHz -5.0, PL 179.9Hz

N2CBH: 448.725MHz -5.0, PL 107.2Hz

PCARA Calendar

Sun Mar 6: PCARA Meeting, Hudson Valley Hospital Center, 3:00 p.m.

Hamfests

Sun Mar 6: Bergen ARA *Auction*, Westwood Regional HS, 701 Ridgewood Rd., Township of Washington, NJ. 12:00 noon.

Sat Mar 12: Cherryville RA Hamfest, North Hunterdon Regional HS, 1445 State Rt. 31S, Annandale, NJ. 8:00 a.m.

Sun Mar 20: Southington ARA Flea Market, Southington HS, 720 Pleasant St., Southington CT. 8:00 a.m.

VE Test Sessions

Mar 5, 12, 19, 26: Westchester ARC Radio Barn, 4 Ledge-wood Pl, Armonk, NY. 12 noon. Pre-register with M. Rapp, (914) 907-6482.

Mar 10: WECA, Westchester Co Fire Trg Cen, 4 Dana Rd., Val-halla, NY. 7:00 p.m. S. Rothman, (914) 831-3258.

Mar 13: Yonkers ARC, Will Library, 1500 Central Park Ave, Yonkers NY, 1:00 p.m. Pre-register with John Costa, WB2AUL (914) 969-6548.

Mar 18: Orange County ARC, Munger Cottage, 183 Main Street, Cornwall NY. 6:00 p.m. Joseph DeLorenzo (845) 534-3146.

Mar 21: Columbia Univ VE Team ARC, 531 Studebaker Bldg, 622 W 132nd St, New York. 6:30 p.m. Alan Crosswell (212) 854-3754.



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