H.A.R.S. Journal

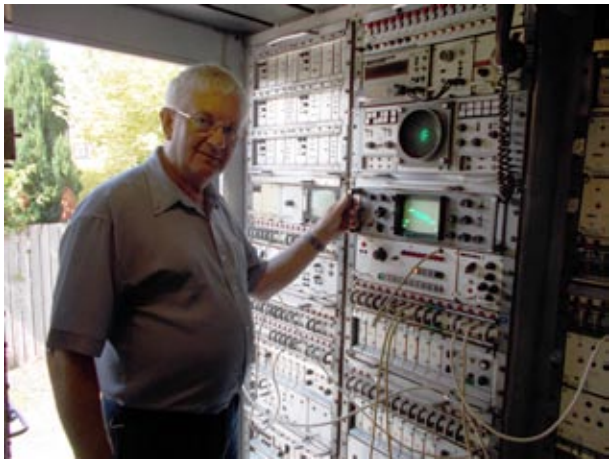
Journal of the Hereford Amateur Radio Society

Issue No 18 • February 2019

Editorial

We all have to applaud the major successes of our magnificent Contesters. It seems that HARS has quietly given notice that they intend to be at the top of every band pinnacle and are on course to achieve top results everywhere. It is suspected that secret contest information is passed around on a developed form of "dark-web". The *Journal* is not privy to its membership and cannot verify this for certain. All that we could say is many thanks to Matt (G8XYJ) our first Contest Captain, and best wishes to David (G4ASR) our new Captain, and the team, going forward into 2019.

Amateur Television. The *Journal* has long felt that modern ATV really is something to get into. A few of our members already know of the fun to be had building equipment and sending pictures of high quality. Much of the ATV technology is now available in modules. Couple these to a Sky dish and you are on the air!



Well, it is not quite like this but so that everyone can experience live transmissions and get a good look at the "kit", Ray Hill (G0IMV), will be demonstrating everything very soon. This is surely something to look forward to.

At the last club night members used the Bodenham Parish Hall as our venue, for the first time. The reasons for the migration are several. The membership continues to grow and there is now a parking deficiency at HH. By the same token, accommodation pressures inside are obvious.

Many prefer the Hill House venue nevertheless, because it has that less formal "shack-I-like" appeal and anyway, as a ritual, this is where the members have always met.

On the other hand the Parish Hall benefits and facilities are numerous and all of the Club's needs are fully met…including sympathetic facilities for disabled members.

It is just that the first impression suggests that the Hall seems overly large. This is likely to be something that members might need to get used to and is just a discomfort that will surely fade away.

…Ed

Do check out the M0JCQ Blog

www.hamblog.co.uk/top-10-amateur-radio-uses-for-raspberry-pi/

Suggested uses for the Raspberry Pi!

The Coherer

Well previous to the invention of the "valve" (1904) a very insensitive communication device was being used. This was the Coherer and it was the first detector of wide-band radio waves emitted from an electrical spark/aerial combination, keyed with Morse type code.

It consisted of a small glass tube containing soft iron filings held loosely between two contact plates. With the application of radio signals the iron filings would stand up and create contact between the two plates so that an electrical current could pass. This current operated a relay device which inked dots and dashes onto a clockwork-driven ribbon of paper. An automatic tapper connected to the glass tube, would shake down the iron filings prior to the arrival of each expected digit.

The Coherer was sluggish and insensitive, and required much attention. But it was the forerunner of much mightier things to come.

...Ed.

Museum of Science Oxford

Don't forget to send in your best DX successes!

journaleditor@herefordradioclub.uk

Marconi's Coherer Receiver at Oxford Museum History of Science

The Coherer is the glass tube on the right.

The HARS Technical Library

This is the new lending library thanks to Bob G3IXZ, who is the "owner". The library is of course at Hill House - thanks to Geoff G8BPN. Great stuff here…, do take a look.

Subjects covered include: Antennas, Technical, Reference, Historical, Equipment and QRP.

New 2m Beacon

by Dave Porter G4OYX

There is a new 2m beacon recently been activated in the Bewdley area GB3SEV is the call sign and the operating frequency is 144.432 (a bit close to the Kent beacon on 144.429), the keeper is Tristram, M0VXX. GB3SEV is running on a random test mode at 1w with FSK and PI4 beacon modes.

PI4 mode sounds like the bugle call from a US Cavalry charge in the cowboy movies – it is distinctive! More details can be found here https://rudius.net/oz2m/ngnb/pi4.htm as can the software to decode the signals (PI-RX). Equipment setup is the same as for any of the WSJT modes i.e. audio from the rig to the computer so if you can receive any of the WSJT modes with the PI-RX software.

GB3SEV is currently the only 2m beacon running PI4 from the available lists, other beacons running PI4 are EI0SIX, GB3MCB and OX6M on 6m with GB3CFG (NI) and OX4M on 4m - more are no doubt planned.

Thanks, Dave ...Ed

HARS Curry Night

Members and visitors enjoying the "curry social" at the Bodenham Parish Hall.

Food prepared by the Jalallabad. Note, David , G4OYX giving "the finger" !

The "must have" photo of Geoff, (G8BPN). Master caterer and quiz broker.

Two important visitors from the Telford & District Amateur Radio Society. Heather (M0HMO) and Paul Nickalls. On the right is Ray Hill, (G0IMV).

When not looking at the camera, the conversation centres upon ATV.

Radio Meets Fiber Optics: RF Over Fiber

by Marie Christiano

Two technologies with tremendous impact have been wireless and fiber-optic communications. Using radio frequency (RF) signals, wireless has given us military radar, avionics, cellular and satellite communications; our world is safer and more interesting thanks to all the benefits provided by wireless breakthroughs. We no longer need to be 'homebased' for an expected call or to catch a podcast; our banking, fitness routines, transportation, communications and home security can all be scheduled and controlled from our mobiles.

With strands of cladded glass as their backbone, fiber-optic networks provide the capacity to carry lots of data thanks to their huge bandwidth. In landline telecommunications and cable television (CATV) distribution, fiber-optic networks have taken over from copper wire, carrying telephone conversations and specialized content more efficiently and with better reliability. They enable our varied entertainment selections and allow our devices to be part of the internet.

Linking these two technologies is RF Over Fiber (RFOF), also referred to as Radio Over Fiber (ROF).

ROF is an analog transmission that uses RF signals to modulate light which is transmitted over a fiber-optic cable. At the receiving end, the RF energy is recovered. The optical link provides a high bandwidth, low-loss communications link to transport RF energy at optical frequencies, then the RF signal is recovered for use at the load point.

Traditional RF Transmission Line

The traditional transmission line for RF signals is coaxial cables (coax). The history of coax has familiar names: Oliver Heaviside (credited with reformatting Maxwell's Equations), Nikola Tesla and the Bell Laboratories of AT&T. The physical construction of coax allows RF energy to be transported within its shields. That we still use cables with origins in the late 1880s attests to their usefulness.

Still, with its copper centers and dielectrics, there is some rigidity and weight to coax. Its bandwidth is limited, it has losses, and is susceptible to noise, radio frequency interference (RFI) and electromagnetic interference (EMI). Coax has always had limitations due to its physical components; if it is bent too much, the shielding is interrupted; moisture degrades it over time.

While light has been used in communications going back to Alexander Graham Bell's photophone, to carry signals more than a few feet required the development of low-loss glass cables and the semiconductor laser. By the 1980s, fiber-optic networks were being used for cable television (CATV), replacing coax and microwave links.

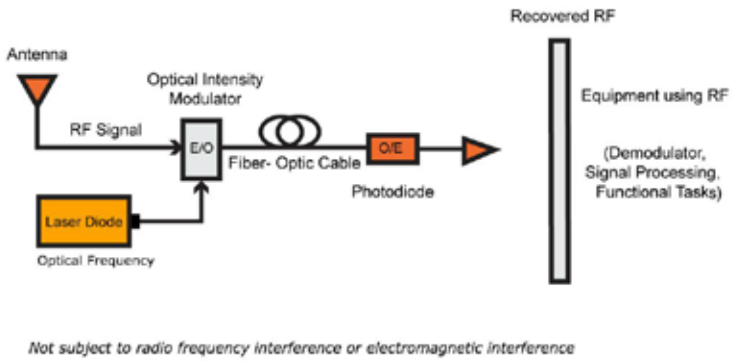


Figure 1. The ROF optical link

As shown in Figure 1, ROF takes an RF signal and processes it through an optical link. The optical link consists of:

- A light source to act as an optical carrier, usually provided by a laser diode. This semiconductor laser is controlled by forward-biasing the semiconductor junction. Due to the physical properties of fiber-optic cable, certain frequencies have less attenuation. The optical frequencies used most often are:

  LED: 780nm, 850nm, 1300nm
  Laser: 1310, 1550nm, 1625nm

- An electrical-optical modulator (E/O), to convert/modulate the light beam using the RF signal. Intensity modulation is used; these transducers have a signal controlled element that modulates the beam of light. The RF signal can be used to directly modulate the light source, or

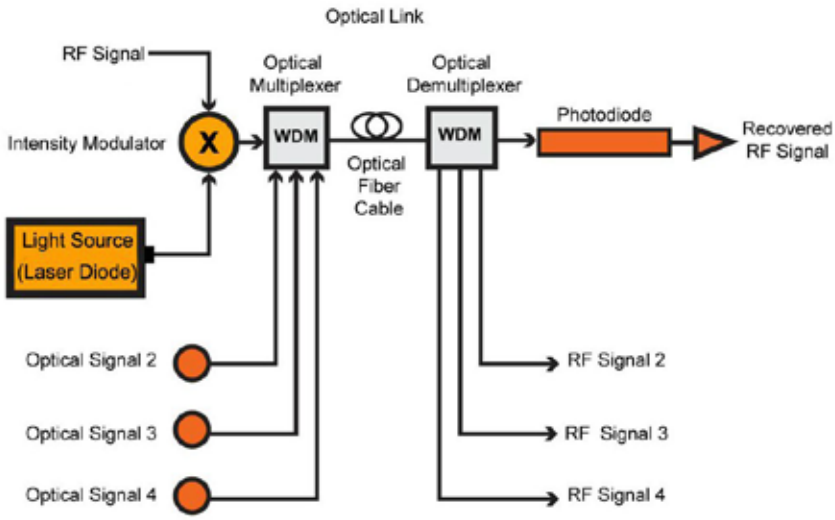


Figure 2. An example of an ROF link

an intermediate frequency can be used. Modulation bandwidths can approach the gigahertz range.

- The optical transmission medium: a single-mode fiber-optic cable. Single-mode has a lower number of light reflections, which lowers attenuation and allows the signal to go further than multimode. Doped optical fibers, like erbium doped cables, provide amplification by pumping the core of the fiber to produce gain.
- An optical-electrical modulator (O/E) to recover the RF signal at the receiver side, usually a photodiode or avalanche photodiode (APD). These components produce a current as a result of the absorption of photons that is proportional to the intensity of the received light.

At this point, the original RF signal is recovered.

Wavelength Division Multiplexing (WDM) and Dense Wavelength Division Multiplexing (DWDM) are used to maximize capacity. These multiplexing techniques combine separate optical signals on different wavelengths for transmission via a single light. The combined signal is then split to recover the separate optical signals after transmission, as shown in Figure 2.

The Benefits of Radio Over Fiber

ROF reduces RFI/EMI. Avionics requires control and communication equipment to reside in localized areas. Replacing coax in aircraft not only prevents RFI/EMI but its lightweight construction removes the weight of the coax.

ROF eases spectrum constraints. Additional RF spectrum can't be manufactured like fiber-optic cables. Using ROF in buildings and stadiums relieves congestion and uses available spectrum effectively. Emerging technologies, such as self-driving cars, are considering ROF for control and communications.

ROF replaces multiple coax cables. With advanced mobile offerings, multiple antennas may be required to provide service and coverage at each cell tower. ROF replaces multiple coax cables with a single fiber-optic cable. Fiber to the antenna (FTTA) systems, shown in Figure 3, incorporate the required control at the antenna.

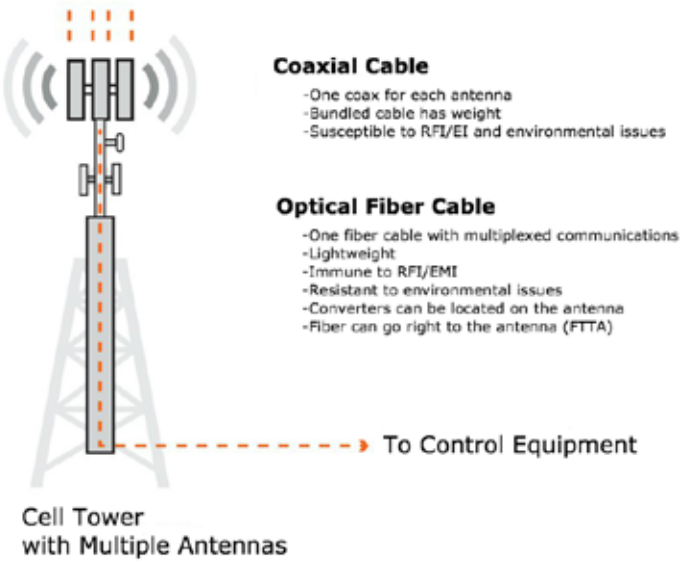


Figure 3. ROF FTTA

ROF transports RF efficiently. Satellite systems physically position receivers where the best reception is possible then transport the signals to their control hubs. ROF replaces long coax runs, efficiently carrying RF signals over long distances without the use of additional amplifiers. The low attenuation of

fiber-optic cable removes the need for multiple connections needed with coax.

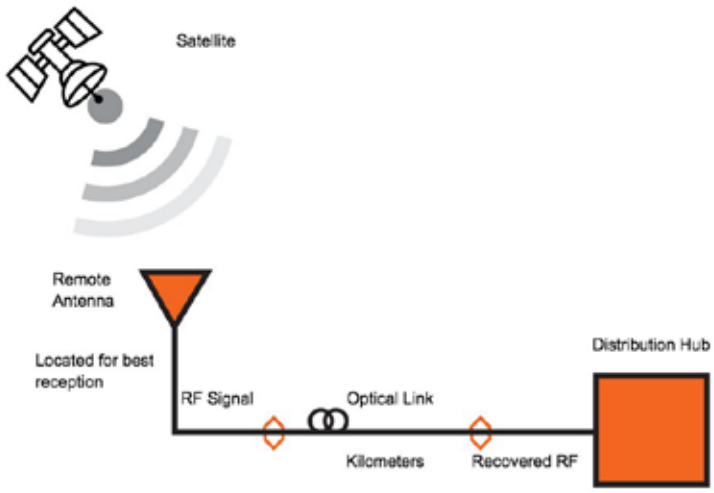


Figure 4. ROF distribution

ROF enhances cell coverage. It extends cell coverage where RF signals aren't possible due to geography and reach. Figure 5 shows ROF continuing cell coverage when a tunnel would normally result in a dead zone. The ROF link enables network access within the tunnel, much like networks within buildings.

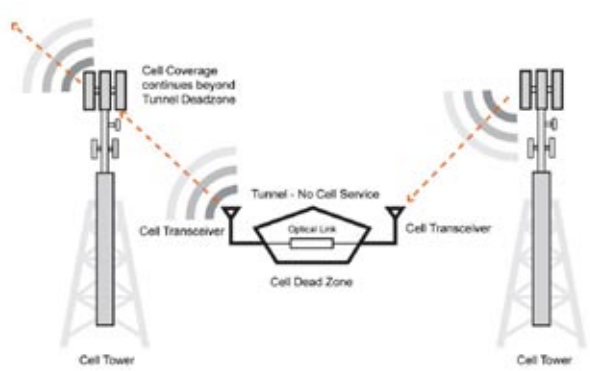


Figure 5. Enhanced cell coverage via ROF

Technical Issues and Future Challenges of ROF

The characteristics of a communication link still have to be considered.

The gain, noise figure (NF), and dynamic range (DR) of the fiber-optic link is as important as in electrical communications. The source of the noise is different: the laser's phase noise, the photodiode's shot noise. There's also thermal noise. The length of cable may be limited due to chromatic dispersion and phase decorrelation. As in all analog transmissions, impedance matching is required at the transmitter and receiver to attain maximum power transfer.

The initial installation of the ROF links is more involved than when using coax. If the fiber optic link is severed, repairs typically take longer.

Handling these technical issues means additional circuits and control within the system and add to the expense of installing ROF links. The benefits of ROF ensure that research will continue to address any limiting factors.

Summary

As the RF spectrum becomes constrained, engineers are searching for alternatives to deliver content. ROF provides coverage in dead zones and provides an alternative to acquiring spectrum for emerging technologies. ROF is immune to RFI/EMI and can replace long coax runs to effectively transport RF energy.

When a pl socket is not a pl socket

by Richard Fox 2E0FDA

I recently bought a colinear four band aerial 6/4/2/70cm, upon Dave Porter's recommendation, from Mirfield Electronics.

Upon arrival the pl socket would not accept a standard plug. I examined the thread and found it to be undamaged. I determined using thread pitch gauges and a micrometer that the standard plug is ⅝ x 24tpi, which is American UNEF according to Machinerys handbook. However the thread on the socket was M16 x 1, a very close metric equivalent.

I rang Martin at Mirfield and he told me that sometimes this happened and he had some plugs that fitted the antenna. Two duly arrived foc.

I thought this should be mentioned in the *Journal* in case anyone else has a problem and to say that I have a plug that can be used to check.

Thanks, Richard ...Ed.

Hereford Morse Bootcamp

by Richard G4FAD

Hereford Morse Bootcamp to be held on the 4th of May 2019 held by kind permission at Geoff's (G8BPN) qth. Please ask anyone interested to email me, my details are correct on my QRZ.com page.

I enclose a copy of the Essex CW Clubs recent bootcamp but we will use different instructors, the idea is to have a day dedicated to Morse code, we will demonstrate the different keys available and how to use them properly and methods of learning Morse code and I think it will be a big help to anyone who wishes to learn or improve on their sending and receiving skills.

We will alter the speed of training depending on the skill and needs of the candidates.

We are lucky to have Andy G0IBN joining us as he has done several of these sessions,

Thanks, Richard ...Ed

Time	Event (Essex CW Club Bootcamp)				
08:30	**Registration on Entry**				
09:00	**Safety Briefing and Welcome**				
09:15	Low Speed Sending Practice and Critique (up to 10 wpm max) with G4ZUL and M0WAG	Mid-range Sending Practice and Critique (up to 24 wpm) with G4WQI and M0KCP	High Speed Sending Practice and Critique (25 wpm and above) with G0IBN and G4AJY		↑ STATION ON AIR ↓
10:00	Low Speed Receiving Practice and Critique (up to 10 wpm max) with G4ZUL and M0WAG	Mid-range Receiving Practice and Critique (up to 24 wpm) with G4WQI and M0KCP	High Speed Receiving Practice and Critique (25 wpm and above) with G0IBN and G4AJY		
10:45	**Coffee Break**				
11:00	Morse Keys: * Introduction to straight, bug, sideswiper, single-lever paddle, dual-lever paddle and touch paddle keys. * Explanation of differences between types, setting up and demonstrations. By G0IBN, G4WQI and G4AJY				
12:00	↑ RSGB Morse Tests as required, leading to certification if passed.	Low Speed Sending Practice and Critique (up to 10 wpm max) with G4ZUL and M0WAG	Mid-range Sending Practice and Critique (up to 24 wpm) with G4WQI and M0KCP	High Speed Sending Practice and Critique (25 wpm and above) with G4AJY	
12:30	Speed: your choice (5wpm, 10 wpm, etc). Official RSGB Examiner: G0IBN ↓	Low Speed Receiving Practice and Critique (up to 10 wpm max) with G4ZUL and M0WAG	Mid-range Receiving Practice and Critique (up to 24 wpm) with G4WQI and M0KCP	High Speed Receiving Practice and Critique (25 wpm and above) with G4AJY	
13:00	**Lunch Break**				
13:30	Short Talks: * Design and build of a touch paddle key * Design and build of a paddle key speedometer * Mobile Apps * G4FON * CW Player * Contesting and Morse Runner				
14:40	Grab a coffee to drink during the next session				
14:45	Varaible Speed Receiving Exercise by G0IBN and G4WQI				
15:30	Final Questions, Handouts and Wrap-Up by G4AJY				
15:45	Pack up and leave the building.				

Amateur radio (illegally) aiding yacht racers

By Dan Romanchik, KB6NU

The Golden Globe Race (https://goldengloberace.com), a 30,000 mile, non-stop solo yacht race to celebrate Sir Robin Knox-Johnston's historic 1968/9 world first solo non-stop circumnavigation. There are 18 sailors in the race, which started on July 1, 2018 from Les Sables-D'Olonne, France.

Amateur radio is at the heart of the latest controversy surrounding the race. *Scuttlebutt Sailing News* reported (https://www.sailingscuttlebutt.com/2019/01/21/maintaining-information-barrier/) on January 21, 2019 (day 205 of the race):

> "Sailors have been making use of the Amateur Radio net (ham radio) for decades, and while National telecommunication authorities have often turned a deaf ear to unlicensed operators using made-up call signs while at sea, warnings from a National regulator to Golden Globe Race skippers has created intrigue into an exciting finale for race leaders.
>
> "Modern navigation and routing tools are restricted from use in the 2018-19 contest, limiting GGR skippers to the type of equipment available for the inaugural Sunday Times Golden Globe solo non-stop round the world race in 1968-69. That includes Amateur Radio.
>
> "The skippers have been using this free communication system to gain weather forecasts and maintain contact with their teams, which is allowed under the Race Rules. However, it is the responsibility of each skipper to ensure that they abide by National and International regulations which Jean-Luc Van Den Heede and Mark Slats, in first and second in the race, have not been doing. [Neither Van den Heede or Slats have valid amateur radio licenses…Dan]]
>
> "Said the warning, 'You use an amateur callsign and are making connections with amateur radio operators. The call sign letters are not registered, and thus illegal. I ask you to stop. If you have a legal amateur callsign then I urge you to present it.'"

As a result of this warning, Slats is considering dropping out of the race, even though the race is nearly complete. *Yachting Monthy* reports (https://www.yachtingmonthly.com/boat-events/golden-globe-race/golden-globe-race-slats-considers-quitting-comms-row-68574):

> "Mark Slats, who is less than 50 miles from Golden Globe Race leader Jean-Luc Van Den Heede, has announced he is thinking about retiring from the race after being banned from broadcasting on the Ham Radio Net.
>
> "Race organisers said the Dutch skipper does not have the required licence, and has been warned by the Dutch authorities to stop broadcasting, which has left him unable to communicate with his shore team.
>
> "Under the rules of the race, all of the entrants are able to use this free communication system to gain weather forecasts and maintain contact with their teams, but, it is the responsibility of each skipper to ensure that they abide by national and international regulations."

It's not only the yachters that are flouting the rules, it's the amateur radio operators who are communicating with them. According to *Yachting Monthly*, OFCOM, the UK regulator issued the following warning:

> "Fair warning both to unregistered GGR skippers and to legitimate Ham radio operators communicating with them. In Britain, the Ham Radio net is controlled by OFCOM, which recently revoked more than 500 licences for non-compliance. This includes communicating with unregistered Ham radio operators. The maximum penalty is 6 months in prison, a £5,000 fine and loss of their licence."

This is a fascinating story, and I wish that I'd found out about this sooner. It would be interesting to listen in on some of these communications. One question I have is why these guys failed to obtain a valid amateur radio license? The Golden Globe Radio website notes, "[The race]

Continued opposite

One Christmas Long Ago.....

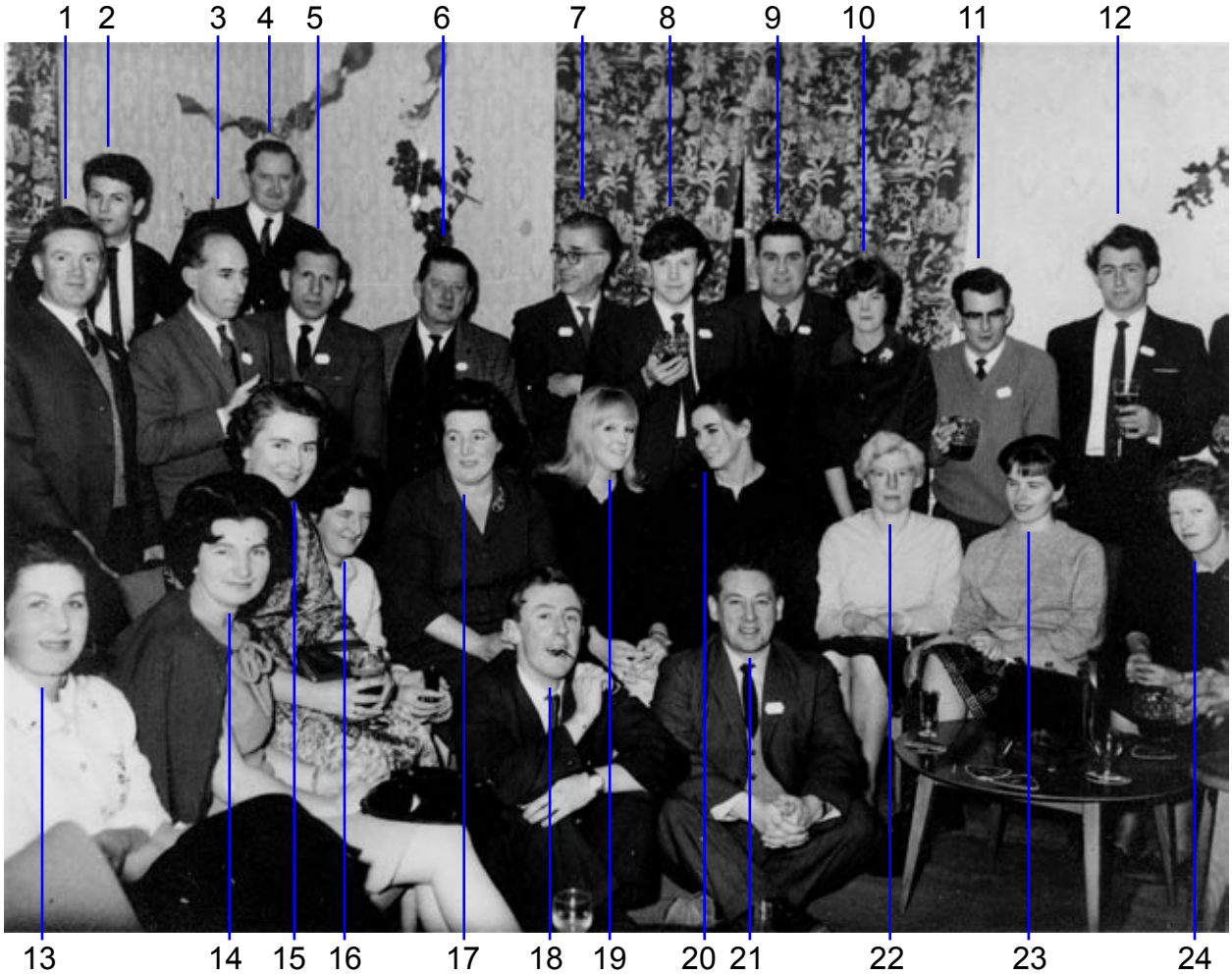
This is a Hereford Times photo of most of the members of the Hereford Amateur Radio Society taken at the Salmon Inn. All of the gents are wearing neckties!!

The Journal noted Harold Coates G3NA (7), Brian Edwards G3RJB (9), Peter Jones G3ESY (21), Roy Smith G3MPB (4), Reg Kendall (1), and Stuart Jesson (12).

Can anyone recall this meeting and name everyone in the photo? And fix the date? The landlord at the "Salmon" was John Jackson. The Inn is now a very smart Crèche.

11, 23: Mike and Angela (G3LZM)

...Ed



will be sailed under the auspices of the Royal Nomuka Yacht Club in the Kingdom of Tonga. His Royal Highness, Crown Prince Tupouto'a Ulukalala is Patron of the Race." They probably could have issued valid amateur radio licenses to all the racers.

If any of you have heard the communications or know any more about the technical details, I'd love to hear from you.

Thanks, Dan ...Ed.

Dan Romanchik, KB6NU, is the author of the KB6NU amateur radio blog (KB6NU.com), the "No Nonsense" amateur radio license study guides (KB6NU.com/study-guides/), and one of the hosts of the No Nonsense Amateur Radio Podcast (NoNonsenseAmateurRadio.com). When he's not think about operating maritime mobile, you'll find him on 30m, 40m, and 80m.

Fairy Droppings or SMD ?

By Nigel G4XTF

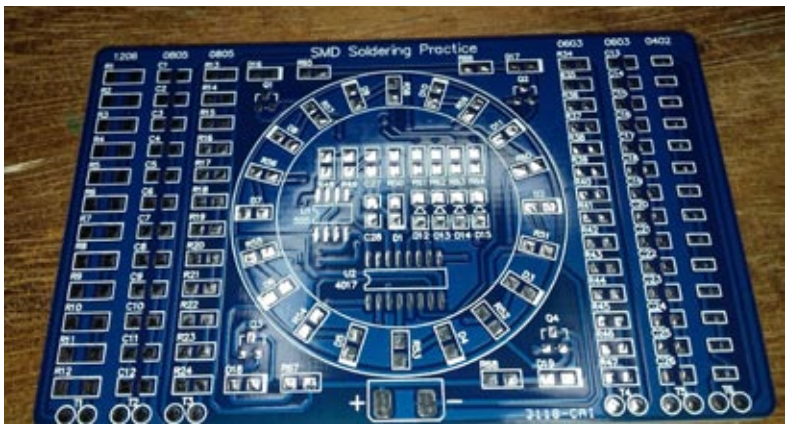
Have you ever considered building electronic equipment with SMD components?

I have a number of times. I have even watched Geoff G8BPN soldering in components and marvelled at the way in which he soldered in multi legged chips by dragging the solder across the legs. However I have never really attempted to do it myself.

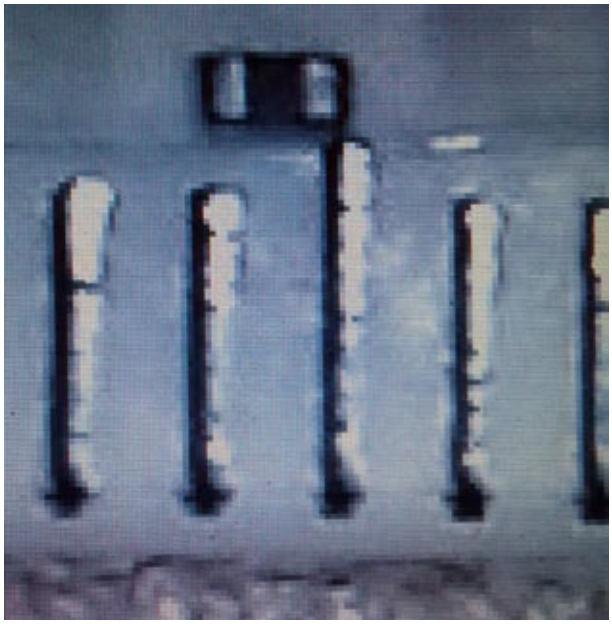
I was listening to a couple of chaps on 70Mhz FM one day talking about SMD construction and became very interested in their conversation when one mentioned he had bought a SMD practice board with components. I followed up my interest by going onto the web and put "SMD practice boards" into the search. Good old eBay surfaced with a host of sellers offering various smd boards for sale. One particular board interested me in that it appeared to have a circuit that would produce a visual result and had test points to confirm a successful completion of the job. As the board and components only cost £1.67 and there was a discount for four or more purchased I ordered five boards thinking it was odds on for me mess one or two up in the process of soldering in the bits.

A few days passed and Royal Mail delivered a grey polythene bag. The contents were well wrapped in bubble wrap and the individual boards, components and short instructions were in separate bags.

Having looked at the contents in the bag I became some what concerned about the size of some of the components and wondered how I was going to bring three individual items together with my shaky hands to guide them. I decided to have a chat with Geoff G8BPN and he agreed to have a look at the practice boards with the result I left one with him. I was pleasantly surprised, more so as Geoff was packing to leave to go on holiday, to receive the completed working board in the post a couple of days later with him saying there were no hidden nasties. To see the completed board spurred me on to have a go.

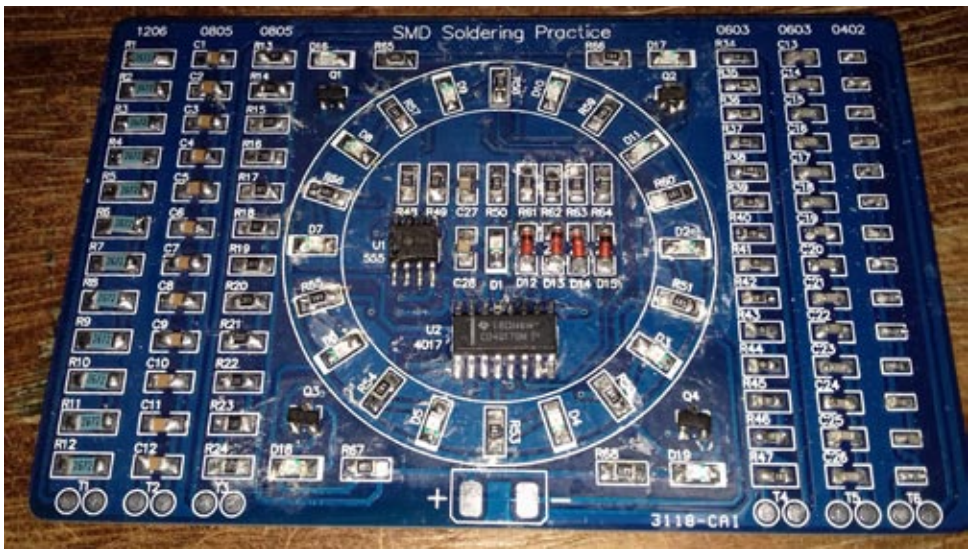


When one looks at the PCB there are six vertical practice columns for various size components 1206, 0805, 0603 and 0402 the smallest. The photograph shows a 0402 placed on a millimetre ruler. The columns are spaced three either side of a central circuit consisting of a circle of red leds and resistors placed alternately. At what appears to be the four "corners" of the central space are four very bright green leds and transistors. All the leds are controlled by two chips placed in the centre of the circle. Each column when completed has either resistors or capacitors in series and ends in two test points. These made it possible to test for continuity on finishing a row. Completing the practice board means that



most of the soldering techniques used in smd work will have been attempted.

Well how did I get on? As I had no intention of spending any more money I used my old Maplin soldering iron and some reasonably thin fluxed soldering wire, a pair of tweezers and my Maplin illuminated magnifying glass.

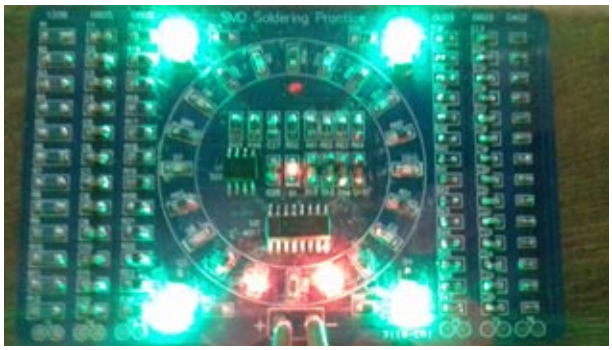


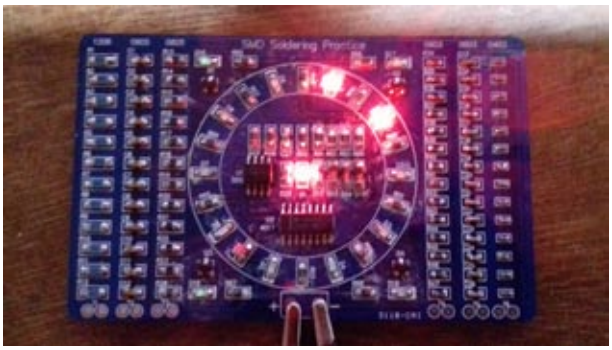
The 1206 and 0805 sized components were reasonably easy to see and manoeuvre. My problem was trying to control my shaky hands. I finally decided to rest my arms on the work bench and having taken the weight off my muscles I was more relaxed.

Using the fluxed solder I found that taking the solder and iron to the pads left too much solder. This I removed using a solder sucker. I then tried just quickly touching the tip of the iron with the solder and immediately put the tip on the pad. This appeared to leave sufficient solder. I then would use the tweezers to place the component down next to the pad. Remelting the solder and at the same time moving the "resistor" into position completed the process. It was most important to wipe the tip of the iron before every step of the process to remove any oxides. I found this method quite successful. However, having watched a YouTube video on soldering smd components a few times where they used liquid flux I went and ordered TOPNIK TK83 flux. This made remelting process easier and a better joint was formed but the residue left was rather sticky and made the board unpleasant to handle.

I completed the board over a few days as I found looking through the magnifying glass rather tiring for my eyes. To remove the sticky residue having completed the board I sprayed it with electronic cleaner. It removed the sticky material but left the board very dull in appearance.

The Smoke test. Geoff G8BPN had previously informed me as to the required voltage as the instructions were not clear. I applied the required 5v and the board lit up as intended.





Conclusion

Having completed a working smd board using the basic equipment I felt quite pleased with my achievements. However, its appearance when compared with a professionally finished article it was quite scruffy. I am not convinced that the liquid flux I purchased was the correct one as there were a number of similar liquids on offer. It left a sticky residue and the method I used to clean it was not very effective.

As to working with the 0603 and 0402 components they have a certain challenge about them. They have a tendency to fly out of the tweezers if one is not careful. If one of the smaller components manages to escape to the floor it becomes one hell of a problem to find. I did have two escapees, one resistor and a led, that I did not find. However the kit does have one or two extras in most cases but where it is listed as one of an item in the component list then extra care is need. Hence the name ***Fairy Dust/Droppings***. All I can say is have a go.

p.s. by G8BPN

Nigel's observations are pretty accurate. The smaller parts, 0603 & 0402 can be quite challenging for old eyes and shaky hands. Incidentally, the numbers refer to the actual size in inches, 0402 being 0.04" x 0.02" or 40 thou by 20 thou. This would be 1005 in metric, 1.0mm x 0.5mm. Components can be specified in either measurement at the manufacturers whim.

I built one of these kits and everything fitted quite nicely, even the 0402 components.

In the past I always used to employ someone to fit these smaller parts when hand build was required, so it was quite a challenge for me too.

This kit is well worth a try, especially considering the modest cost. Buy a few and get loads of practice. Just do it.

Thanks Nigel and Geoff ...Ed

Notes for Constructors

Do you wish to gain experience soldering tiny SMT components of all sorts? SMT (surface mount technology) offers traditional components of all sorts but, in tiny physical packages such as type 0402.

Experience comes with careful use of the soldering iron and the use of thin multi-core solder. It is possible to glue the component into position, apply solder paste and then heat with a high temperature heat-gun. This gives the best finish but perhaps is not practical for one operation at a time. Glueing of course, will help anyway.

Geoff G8BPN and Mike G3LZM have pooled their resources and can now offer unwanted pcbs with SMT component footprints and a selection of new SMT components for you to practice with.

Do let Geoff or Mike know if this appeals to you.

Go to "*Meet the Committee*" on the website for contact details.
www.herefordradioclub.uk/committee

The History of Rugby Radio Station

By Malcolm Hancock

Reviewed by Dave Porter G4OYX

It's probably best to start this review with the actual words on the back page of this book

For over 80 years, twelve iconic radio masts graced the skyline of Rugby and Hillmorton – towering symbols of Rugby Radio Station's global reach.

The pace of technological advancement never slackens though. Time moves on, demands change… and today Rugby Radio Station is no more. Fortunately this extensive history meticulously compiled by Malcolm Hancock (a former Rugby Radio Station manager) is here to ensure that to ensure that all of its incredible stories and glories are preserved for future generations.

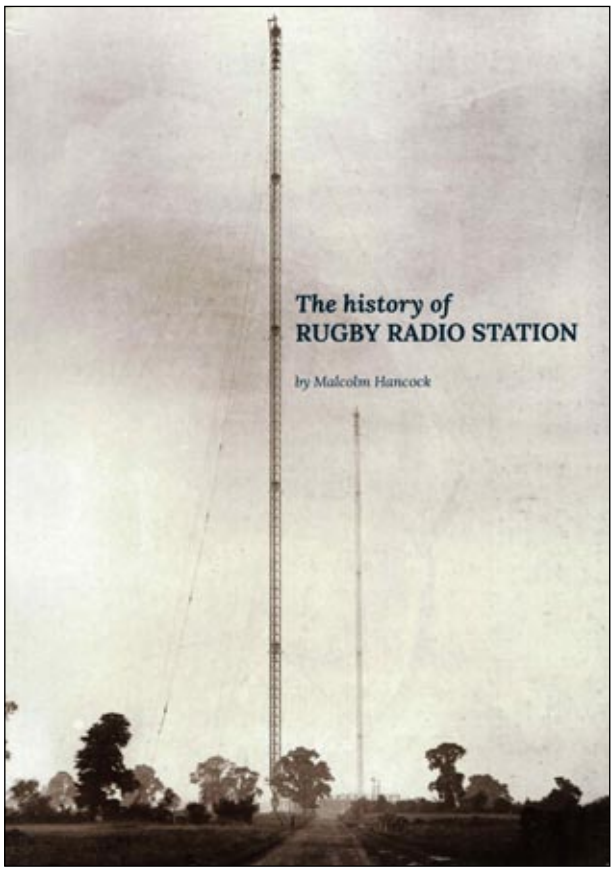
The first Public Telephone Service from Europe to the USA; top-secret operations during the dark days of World War II and The Cold War; personal anecdotes relaying the everyday lives of the people whose vision created it and whose passion brought the vision to life.

It's all here in The History of Rugby Radio Station.

Well that's the general punters info, but what technical information is between the covers?

Malcolm G8EYY is a former engineer at the site and progressed through the ranks to become the final station manager before its closure. The story he tells is chronologically in the correct order, often with a tale extending nearly a century it is easy to get way-laid and lose the reader but by having access to a good quality series of illustrations the time stamps are in the document. "Time stamps" is pertinent here as within the book is the engineering tale of the MSF LF and HF services as well as the GBR time transmissions prior to it becoming a top-secret MoD facility in the mid-1960s.

The developments are documented of the site on both sides of the A5 to include the 1950's HF SSB/ISB "B" facility with what appeared to be about 1000 Rhombic antennas!



What could be dry engineering reporting is enhanced by the steady stream of "Personal Memories" that help immensely in bringing the saga to life. Who could not resist reading about The Ode to a Pigeon, The Disconnected Admiral, Transmissions to the USSR from the CCCP or even The Inverness Railway Station Car Park Closure whilst G8EYY was away on a training course and how escape was effected by driving along a platform after having conducted, what we would say now, was a Risk Assessment!

Humour is very much in this book and it's best to close this review with another quote from G8EYY.

He writes "I do remember one time when we were building a Rhombic aerial on the ground at the "B" site. This involved a 400 foot length of 7/22 cadmium copper wire. This was long enough for quite a bit of RF pick-up from the GBR 16 kHz transmitter on the site opposite. Every time I touched the wire I got a small shock I was told "You don't want to tickle it like that. Grab hold of the f***er! And it worked!

The 237 page paperback book is available from the following on-line

Continued overleaf

source for the amazing price of £5-99 + postage. ISBN 978-1-5272-0540-6

http://rugbyradiostation.co.uk/the-history-of-rugby-radio-station/

All proceeds go the Warwickshire and Northamptonshire Air Ambulance service

Thanks, David ...Ed.

HARS radio equipment available for loan to Club members or for purchase

The following list of equipment is available for loan to Club members. The loan period is 3 months and members wishing to use the equipment will have to sign a simple agreement which covers the loan terms. If you wish to borrow then please contact Duncan (Hon Sec) M0OTG.

- Grid Dip Meter MFJ-201
- Buddipole 10-40M portable antenna with tripod and carrying case.
- Yaesu FT450 All bands to 50MHz. Needs a 12V PSU
- Pixie 7MHz QRP kit. Needs assembling.
- Baofeng UV-5R 70cms/144MHz hand-held complete with accessories.

Go portable with the Buddipole! Ed.

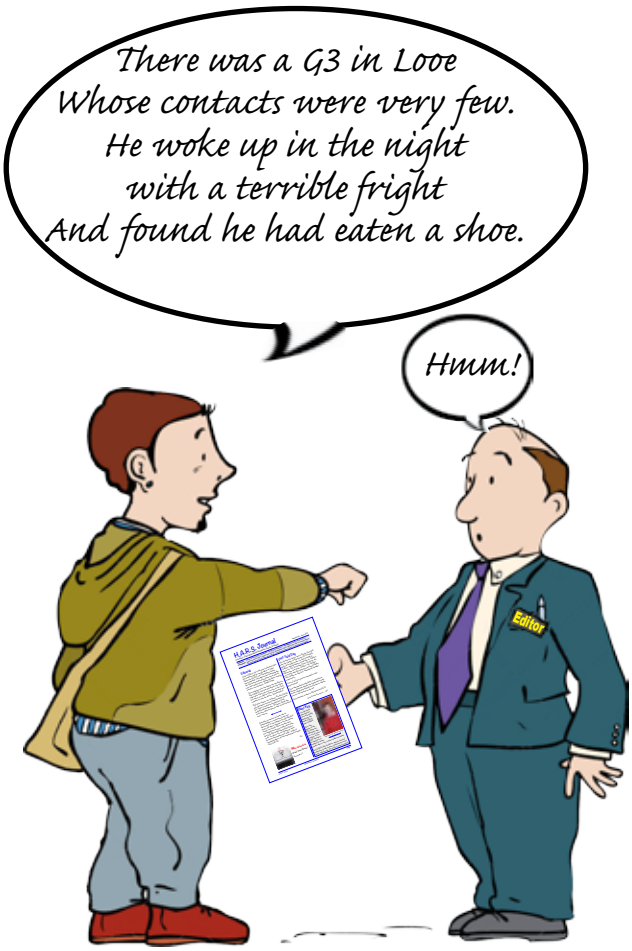
G3LZM Talk On Satellites

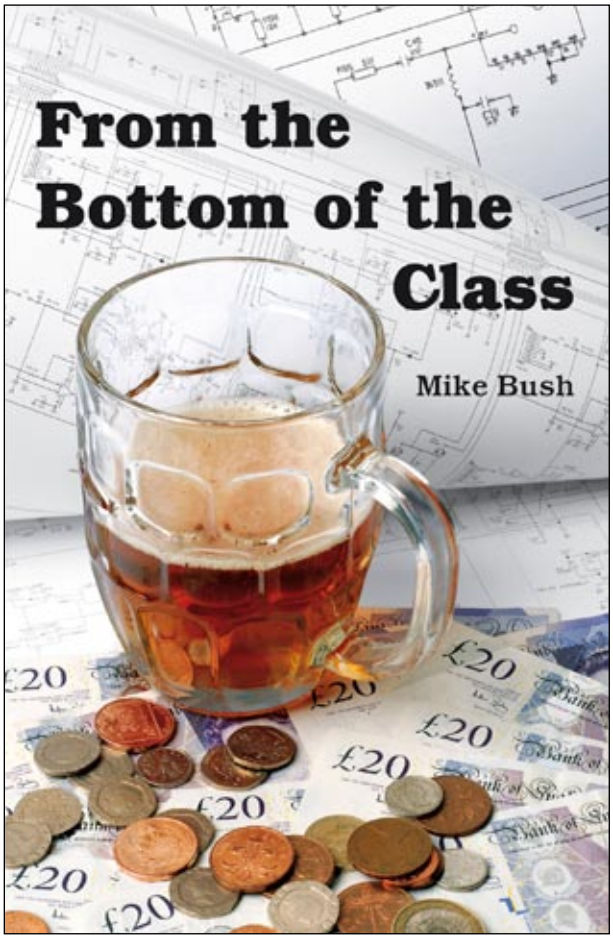
At the recent talk given by Mike G3LZM (Ed) mention was made of the business aspect of manufacturing matrices. For Mike, his experience of being "employed" was a severely rocky road and unhappy…until he went self employed. Being self employed meant developing a different mind-set. It opens up a new outlook on the world and life, leading to contentment and money. There is nothing sweeter than being your own boss.

If any one of you have a yearning to be self employed, do go for it. It may help if you have a read of Mike's book which chronicles such events.

If you would like a free copy call Mike on 01432 272987. Good Luck.

Sid & Charlie





An Introduction To openEMS, an Open Source FDTD Solver for Simulating Microwave Antennas and Components.

Paul Klasmann
paulklasmann@hotmail.com (2E0PMK)

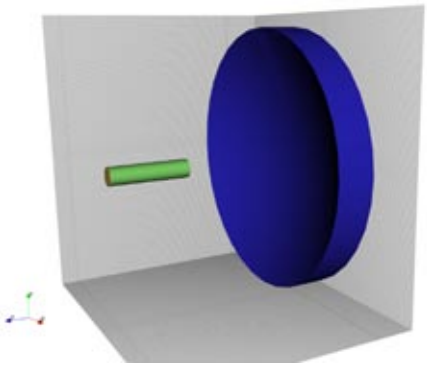
Introduction

Modern RF and microwave antenna/ component design makes extensive use of electromagnetic simulation software. However, the high cost of commercial packages put these tools out of the reach for the hobbyist or for radio amateurs. Most radio amateurs are familiar with codes such as NEC and MMANA which use Method of Moments (MoM) for simulating wire and beam antennas at RF frequencies. When we want to design microwave components and antennas we require numerical methods more suitable for simulating structures of arbitrary shape from RF through microwaves and mm-waves up to photonics frequencies. The most widely used methods are the Finite Element Method (FEM) or the Finite Difference Time Domain (FDTD). There are several others, but the aim of this article is to introduce the free and open source software called "openEMS" which is based on the FDTD method, more specifically, the EC-FDTD method where EC stands for "equivalent circuit".

This software is available for Linux or Windows. It does not have a fancy graphical user interface, but is controlled via a script written in Matlab or GUI Octave, which is very much like Matlab but is FREE and its functions are mostly compatible with Matlab. I use openEMS with GUI Octave to simulate microwave antennas and passive components. The software was written by Dr Thorsten Liebig and can be downloaded from openEMS.de. On the website there are tutorials to show how to setup and use the software, and there is a users forum where users may ask for help.

This software is suitable for simulating waveguide structures (rectangular, square and circular), this includes antennas, filters and polarisers, waveguide to coax adapters etc. It can also be used for simulating arbitrary planar structures like microstrip, stripline and coupled line passive components. Examples are patch antennas, patch arrays, filters, couplers, and other planar transmission line circuits with or without lumped elements such as resistors, capacitors and inductors.

I have started to write a series of tutorials, beginning with an example of how you would setup a parabolic reflector simulation using a simple open ended circular waveguide feed at Ku band to illuminate a 0.34 m diameter parabolic reflector. This can be downloaded from the forum or email me for a copy of the tutorial and simulation script file. Here is a picture of the model to be simulated. Note that I have not included feed support struts and mounting detail but this can easily be added for a more realistic simulation.



Physical model with mesh planes shown in the background.

I won't go into the details of simulation setup here because it's covered in the tutorials, but here is a very brief description and overview of what can be done with this software. For more details about the mathematical background of the FDTD method and the software, please search for the paper "openEMS – a free and open source equivalent-circuit (EC) FDTD simulation platform supporting cylindrical coordinates suitable for the analysis of travelling wave MRI applications" by Dr Thorsten Liebig on the internet.

When an antenna or non radiating structure is physically defined, we need to create a rectangular mesh to fill the whole of the simulation volume. This discretization includes the antenna, any materials used and the free space around the structure. When dealing with antennas we must truncate

the simulation domain because we can't fit infinite space into the computer memory! A rule of thumb is to allow a distance between the antenna and absorbing boundary of one quarter of a wavelength at the lowest frequency of interest. When simulating a microstrip or stripline circuit we can define the boundaries as perfect electrical conductors which represent a ground plane or metal box as would be used in practice.

Defining Physical Structures

We can define the physical model to simulate by using a number of the "primitive" definitions that openEMS provides. Primitives are simple 2D or 3D shapes that can be defined to construct a more complex shape. Examples of the basic primitives are the box, cylinder, cylinder shell, sphere, spherical shell, cone, wire, curve, polyhedron, polygon, extruded polygon and rotational polygon etc. The use of these basic shapes can generate a wide range of complex geometries.

Included in the package is a program called CSXCAD. This is a simple structure visualisation program used to examine the structure and mesh as shown above. It can also be used to check the location of ports and dump-boxes used to record results.

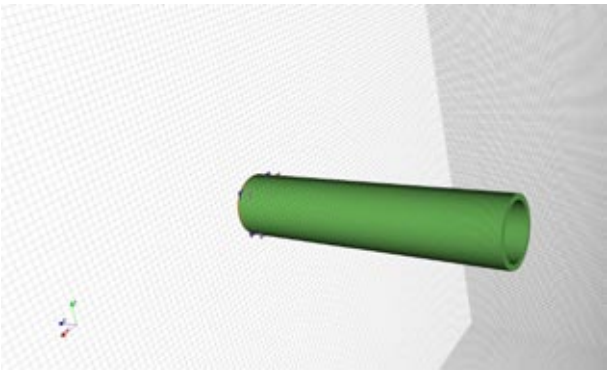
The "AddPolygon", "AddLinPoly" and "AddRotPoly" are particular powerful functions that can be used to generate complex shapes defined by coordinates that may be manually entered (into an array), or generated by a parametric equation. The example of the reflector was generated by plotting the equation of a parabola and adding some more points to create a closed profile which is rotated into body of revolution (BOR) to create the solid object. One of the benefits of using Matlab/GNU Octave is that it is very straight forward to create complex shapes defined by mathematical equations compared to using a stand-alone program written in another computer language.

If you prefer to design a complex shape in another CAD program, such as SolidWorks or FreeCAD, you can import STL files. However, by defining shapes in Matlab/GNU Octave allows more flexibility to easily change dimensions. You can also export STL files to take a basic shape and import it into a CAD program to add features for manufacture.

Mesh

The mesh is a 3D grid and the grid lines should generally coincide with the structure edges. It may be uniform or refined around areas where the electric field gradient is high. It is the grid lines where Maxwell's equations are solved in discrete space and time. The finer the grid, the more accurate the simulation results will be, but the simulation will take longer to complete and more computer memory will be used. In the image above you can see a fine mesh in the background. The mesh planes can be moved to examine the lines more closely around important features.

The mesh is based upon a unit cell called the "Yee cell", after Kane Yee who first proposed the method in 1966. The unit cell consists of two staggered hexahedra. For each time step of the simulation, the electric fields are computed at the center of every edge of a hexahedron, and the magnetic fields are calculated at the center of each facet of every hexahedron in a staggered fashion (think of two overlapping cubes). Details are provided in the publication by Thorsten.



Close-up of circular waveguide feed antenna showing excitation port and reference plane.

A unique feature of openEMS is that you can also define a cylindrical mesh which is better suited for body of revolution or curved antennas. There are tutorials that show how to do this, for example, an MRI ring antenna, or a curved patch antenna that is conformal to a cylindrical surface. This will create a more efficient mesh compared to the rectangular grid mesh and this mesh can be graded in multiple steps so that less mesh cells are defined closer to the center of the volume. However, the rectangular mesh is most commonly used for

most antennas and passive microwave devices. Experience will help you determine which mesh to use.

Materials

Both, metals and dielectrics can be defined. Metals can be perfect electrical conductors (PEC) or lossy metals with a given conductivity to represent real metals. Dielectrics can be defined to have a specific relative permittivity and permeability. Sophisticated models are available to take into account frequency dependant and dispersive materials. Perfect magnetic conductors (PMC) may be defined and although these don't occur in nature, they can be used to define symmetry planes to reduce the simulation size in symmetric structures.

Absorbing Boundaries

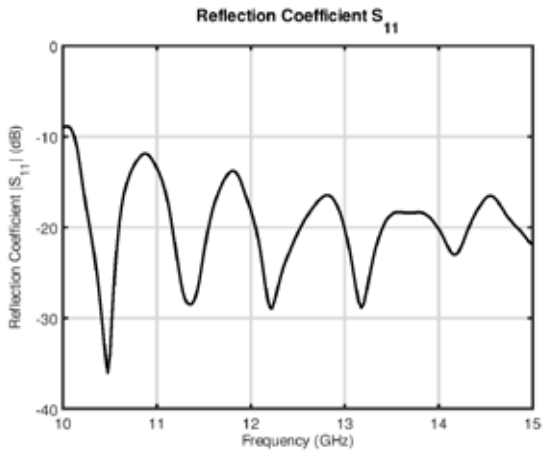
The absorbing boundary is an import concept in the simulation of antennas. If we did not absorb the propagating wave then it will reflect from the boundary of the simulation domain and not decay as is required. openEMS provides two types of absorbing boundary. The simple type is known as the "Mur" boundary condition, named after G.Mur who came up with the method. This requires one mesh cell of depth and is fine for general use, but is not very effective when the angle of incidence between the incident wave and the boundary is large. A more effective boundary is the Perfectly Matched Layer (PML), which requires around 8 mesh cells of depth. This is better at absorbing an incident wave over a wider angular range. The PML method was first developed by Jean-Pierre Berenger in 1993.

Ports

Energy is "injected" into a simulation by the use of a port, this can be a waveguide port, lumped port or a microstrip line port. A planewave may also be simulated to study the scattering from an object. One application of this is to study the radar cross section of an object such as an aircraft, ship or a missile. There are a variety of excitation methods available. These methods are widely used to determine the effectiveness of stealth materials or structures.

It's important to note that 1D, 2D and 3D ports must be defined to coincide with mesh lines.

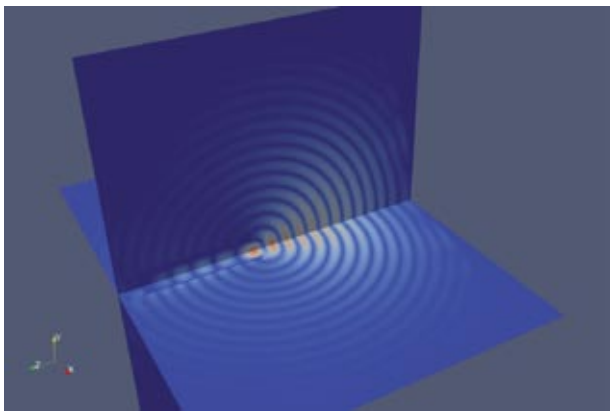
S-parameter data can be recorded and used to generate S-parameter plots. This data can also be displayed as a Return Loss or VSWR in the same way as is displayed on a Vector Network Analyzer. The S11 plot of the waveguide feed in the reflector example is shown.



S11 of the waveguide feed includes the coupling with the reflector.

Recording Results

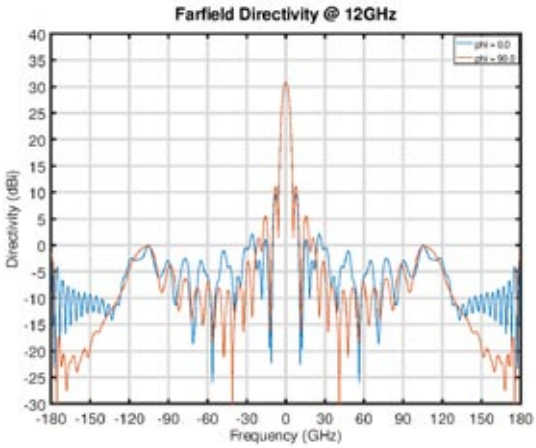
Results are recorded by defining "dump planes" or "dump boxes". For example, to record a 2D plane on which you want to observe the electric fields, you would define a dump box with zero thickness in the plane that you wish to monitor. Many field quantities may be monitored, including electric and magnetic fields in both time and frequency domains. Beware, 3D dump boxes can use up a lot of storage space on your hard drive. Sub-sampling can be used to reduce the size of data stored. An example of two E-field planes in the reflector example is shown.



Two orthogonal E-Field dump planes showing the electric field after most of the energy has left the feed.

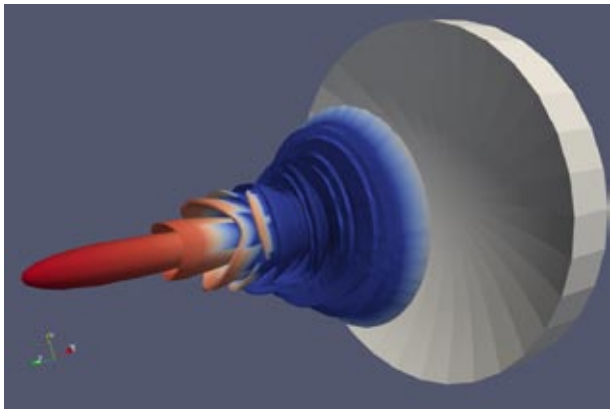
Another important antenna characteristic that you may want to plot is the far-field radiation patterns and gain. To do this we define a near-

field to far-field dump box. The dump-box for the near to far field must not be inside the PML absorbing boundary or intersect the structure. Each plane of the dump-box may be one mesh cell away from the absorbing boundary and at least one quarter of a wavelength away from the antenna, at the lowest frequency. The location of the dump planes can be viewed with CSXCAD before running a simulation. This captures the near fields and the "nf2ff" function is used to perform the mathematical transformation that will calculate the 2D or 3D far-field radiation patterns which is plotted.



Directivity plots for phi=0 and 90 degrees

Far-field data can be saved as HDF5 or VTK format. VTK data can be displayed using another free and open source software package called ParaView. This is typically used for plotting large datasets in a wide range of sciences. The image below shows the 3D far-field radiation pattern with the antenna geometry in the same image. Far-field radiation patterns may also be plot in Matlab/GNU Octave if you don't want to use ParaView, but I strongly recommend the use of ParaView due to the flexibility and quality of the images it can generate. ParaView can also be used to generate animations of the electric fields with respect to time to give a greater insight into how the fields propagate and the animation can be exported to an AVI video file.



Far-field radiation pattern @ 12 GHz shown with the reflector.

Final Remarks

I hope that this has been a useful introduction to a very flexible and powerful simulation tool for microwave and RF antennas. It is not limited to waveguide and planar structures but can also simulate wire antennas such as the "Bow Tie", Yagi and helix antennas and many other antenna that radio amateurs may be interested in. To get a more general overview of what can be done with openEMS, please have a look at the gallery page at openEMS.de.

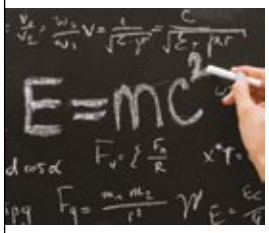
The FDTD method is a very complex and powerful numerical method but you don't have to understand the math to be able to use it for the design and optimisation of antennas and components. Once you know the basic rules of thumb and get used to the syntax it really is not as daunting as it may appear. I have compared the results from my reflector example to an equivalent simulation set-up in Ansys HFSS (very expensive!) and there is an excellent correlation of the results.

If you would like to know more or require any help getting started, please send me an email.

At the time of writing this article, the software's wiki site is to be transitioned to a new site where I will be contributing to help with the documentation of the available functions and with new examples.

Thanks, Paul ...Ed.

openEMS: http://openems.de/start/
GNU Octave: https://www.gnu.org/software/octave/
ParaView: https://www.paraview.org



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Items for sale	DX	Early radio
Hints and kinks	Militaria	Restoration...

... or anything else that you think might be of interest to HARS members. If you have an idea for a submission, but don't know how to present it, I will do it for you.

Please submit anything and everything to journaleditor@herefordradioclub.uk or talk with Mike at the Club meetings.

73s es GDX, G3LZM
Mike Bush (Editor)