G3XBM

Project

Scrapbook

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SUBJECTS (by page numbers)

Introduction

This is a scrapbook mainly about the projects that I have designed and built over the years. It is a scrapbook of ideas and a bit of a brain dump. These circuits worked for me, but I hope they are springboards to your *own* ideas: I would be most surprised if many cannot be improved.

Please treat these circuits as starting points. Do not be afraid to try changes. They may make things worse or they might make them better. Often these circuits are very simple, so if it all goes wrong just start again! Warm up that soldering iron and get experimenting.

In most cases, these circuits were built in the back of the garage without fancy test gear. Useful things would be a multimeter, an oscilloscope, a signal source and an effective capacitance/inductance meter. These days some very sophisticated test equipment can be bought quite inexpensively.

The circuits span a period of nearly 50 years. The early circuits predated decent schematic drawing packages, so the schematics were hand drawn. This is an ideas scrapbook after all!

In some cases, these only reached the ideas stage. Then, in 2013, I had a stroke and experimenting, and most building work, stopped. I hope some of these ideas inspire you too. It would be good to see some of these ideas completed by others amongst us. In a way it is my attempt at leaving a legacy. On the way, I have enjoyed lots of fun experimenting and want to share the fun with others.

The circuits are grouped together by subject.

Let's hope these circuits give you some inspiration. I enjoyed designing and building these and I hope you do too. Even if you don't replicate the circuits, perhaps they will give you a kick to start experimenting. My message is simple: remarkably effective circuits can be low cost and fun to design and build. Whatever you do, enjoy yourself. Ours is a hobby and whatever you do, enjoy yourself.

I have organised projects by types so you can quickly find what you are looking for. Some prefer a printed book and I can understand this. However, I had never intended to make money from this and a free PDF book better meets my wishes. Anyone can print off pages if they wish or read it as a computer document. I may correct or add to the projects more easily this way. My intention is to keep the same link, but there may be different editions when the link is clicked.

Also enclosed for completeness are the antennas and commercial rigs I have had down the years with a few personal comments. Your experience may be different. At present, my main rigs are the Yaesu FT817ND, the ICOM IC-705 and my W5OLF 10m WSPR transmit beacon.

Also, I have included some of the “got away” projects that I never managed to do. Ours is a vast hobby and there are not enough hours in the day to do everything. Inevitably we have to choose some things and forgo others. Maybe you will choose other avenues to follow. These are your choices.

As this is a brain dump, I have also included some other things of interest.

Please excuse any errors in spelling and grammar!

As a brain dump, different sections may have different formats. This is why it is a totally free scrapbook and not a printed book! If it was a paid for, printed book, I would have a much harder job with grammar and formatting. I am hoping that I am forgiven. Much of this stuff is also on my main website. At least here it is all in one place.

If the schematics could be clearer (I think these are the best I have), please check my website www.g3xbm.co.uk. Many of these circuits were done many years ago! If need be be try zooming in further as this may help reading values.

Feedback should be emailed to me at

Any comments, good or bad, will be read.

A note about copyright and errors

Over the years my circuits have appeared in many magazines around the world in many languages. I hope copyright has not been infringed. If it has, please let me know, so I can correct this.

As I make no money at all from this PDF book, I hope you will not mind. My intention is to share my fun with others, simply that. This is just me sharing my ideas and thoughts. If I get any money donated, my intention is to gift aid it to our local foodbank.

If I need to add acknowledgements or assign copyright anywhere, please let me know at my email address. I have shown it in a way that cannot be harvested so you will have to put this in manually. My apologies for the inconvenience, but I am sure that you will understand.

Also, if you spot any mistakes please let me know so these may be quickly corrected.

My shack

The photo shows my shack. When we moved here in 2013, I had a dedicated shack for the first time. Previously, I had to share a bedroom with my grandson. Most radio building was at the back of the garage.

On the left is a bench for building projects and, overlooking the garden, the operating position.

Then came my stroke and an end to experimenting and building, so the left hand bench is hardly used these days. I had every intention of using it to design and build all sorts of things! Never mind. Instead I concentrate on what I *can* do. Thankfully, in our hobby there are lots of ways to have fun, and I still enjoy it.

The photo makes the shack look big. It is not. This is a trick of the camera.

There is a video walkthrough on my G3XBM video channel.
See https://www.youtube.com/watch?v=lHPtQiNlxgI .

MePads and MeSquares

In the “old” days I used to use an etching pen to make PCBs. For “one offs”, I have found making PCBs is totally a waste of time. Instead, I start with a piece of copper laminate (single sided is fine) and glue down MePads or MeSquares as needed. I used “super glue” to stick the pads down. The pads form copper islands so that components or ICs may be attached. Anything going to ground is soldered directly to the copper laminate that makes an excellent RF ground plane. It is good with RF circuits to always ensure a good RF ground. Although less critical at LF, it is worth getting into good habits. As you go up in frequency, long wire can have significant unwanted inductance.

Clearly, if you are doing a club project then a PCB may be sensible. However, with careful use, MePads or MeSquares can make very neat assemblies for “one offs”. As an example, see https://aa7ee.wordpress.com/tag/mepads If you are really tight for money you can always make your own islands by cutting up thin PCB material or cutting round islands in the copper laminate with a specially adapted drill bit. I have never tried the latter. The GQRP club sales used to sell these special drill bits. They may still do so.

Google to find out the best places to buy MePads and MeSquares. At one time, the GQRP club sold these, but I don’t think they still do. They are definitely available from QRPme in the USA. See https://www.qrpme.com/ .

There are pads available for ICs as well. These are shown in the second photo. I have not used these.

Dipole and Inverted V Calculator

These can be very simple yet effective antennas. You may find this online calculator of use. Inverted V antennas only need a single support and are a little shorter.

It is also possible to make multi band dipoles by having a common centre and fanning out the wires. You may need to optimise wire lengths in this case.

For insulators, I just used PVC pieces used to join wooden shelves together. I have found these inexpensive and effective. I have used these at the ends of dipoles and as the centre piece. There is no need to buy special insulators!

https://www.wireantennas.co.uk/dipole-calculator

10m Dipole

This is probably the simplest 10m antenna anyone can make for the band. Purists will suggest you wind a few turns of coax up near the feed point to avoid RF on the cable. This is probably a “good idea”.

Using wire and low cost RG58 50 ohm coax these antennas work well. In the past I have used these only a few metres over the ground and as a sloper with the far end quite close to the ground. My best DX one morning was a ZL when I was using just 10W pep of SSB on 10m.

Close to the ground, like mine, the radiation pattern is probably quite omni-directional. If you mount it higher, it probably has a more conventional dipole “figure of eight” pattern. Ordinary PVC covered wire is fine. I have never made antennas from special wire. If the SWR is less than 1.5:1, it is very unlikely anyone would notice any difference from 1:1. Basically, don’t aim for perfection as it is not worth it. Go and make a cup of tea instead!

End fed antennas

For many years I used my end fed Par antenna. This covered 10m, 20m, and 40m. Mine was not that high. Purists will tell you end-fed antennas need counterpoises, but I have never found these necessary. As I only ever used 10m (in the main) it is currently erected as a single band 10m antenna.

I cannot recall where it was bought, probably directly from Par. I don't think these are still made, but there are alternatives from other sources I think.

One problem to watch with end fed antennas is RF in the shack that can make rigs behave erratically. With QRP, this has never been a problem, although with high power it might be. If rigs or PSUs switch off for no good reason, suspect RF feedback. Choking leads (power and antennas) may cure this.

Homebase-10 10m Antenna

Some years ago I needed a simple but effective antenna for my favourite 10m band . The Homebase-10 was the result. This is nearly omni-directional and works almost as well as a horizontal dipole. It has worked Europeans with just 50mW. It was published in Practical Wireless some years ago. It is essentially a wire halo for 10m. Most of the parts were bought at a local Homebase hardware store. Other stores are available!

In practice, it worked well and was sufficiently inexpensive that if it looked weather beaten after a few years, a replacement could easily be made and erected within a few hours.

It can be erected by one person. If you have no 10m antenna up, this could be your answer.

On my www.g3xbm.co.uk webpage, there are links to the original Practical Wireless article with construction details. Essentially it is a wire halo with a folded dipole section.

Mine has worked the world with QRP SSB. On CW or digital modes it will be even more effective. By scaling the wire lengths, versions can be made for other bands. Although multi-band versions could be made (I made one for 10m and 6m), this distracts from the simplicity. See below for a photo of this.

See https://sites.google.com/view/g3xbm4/home/antennas/homebase10-10m-halo.

A dual band 10m/6m version is shown here.

70cm Moxon Antenna

If you have not come across Moxon antennas you are in for a nice surprise. These are simple 2 element antennas which are an easy match to 50 ohms, have a good front to back ratio and useful forward gain. They have quite a broad forward lobe. They are easy to make.

This online Moxon calculator may prove useful.

http://w4.vp9kf.com/moxon_design.htm

Some years ago I wanted to go portable in a 70cm contest, then realised I had no suitable antenna. My wife's wardrobe was raided for metal coathangers and about 30 minutes later the antenna was built. From a local East Anglian "hill" plenty of stations were worked, including a French station, from the car in the rain. I just used a PVC tube as the mast wedged in by the car door.

Versions have been made by other people from HF to UHF although I have only made a 70cm version.

70cm 4 element yagi

Again, I needed this for a portable contest. It was simple to make and, once again, I used a length of PVC tube wedged in the car door window as the mast. I got the dimensions from an online calculator.

I am pretty sure the calculator below was not the one used, but there are several. For small yagis, an old wire coat-hanger may be used, although aluminium rod is probably needed for longer antennas. For the centre support I used a piece of wood, although you could just as easily use a piece of plastic.

This antenna is still in the garage. As you can see, it is not pretty, but it worked and had a decent 50 ohm match!

An example of an online calculator is

https://www.changpuak.ch/electronics/yagi_uda_antenna_DL6WU.php

HB9CV Antenna

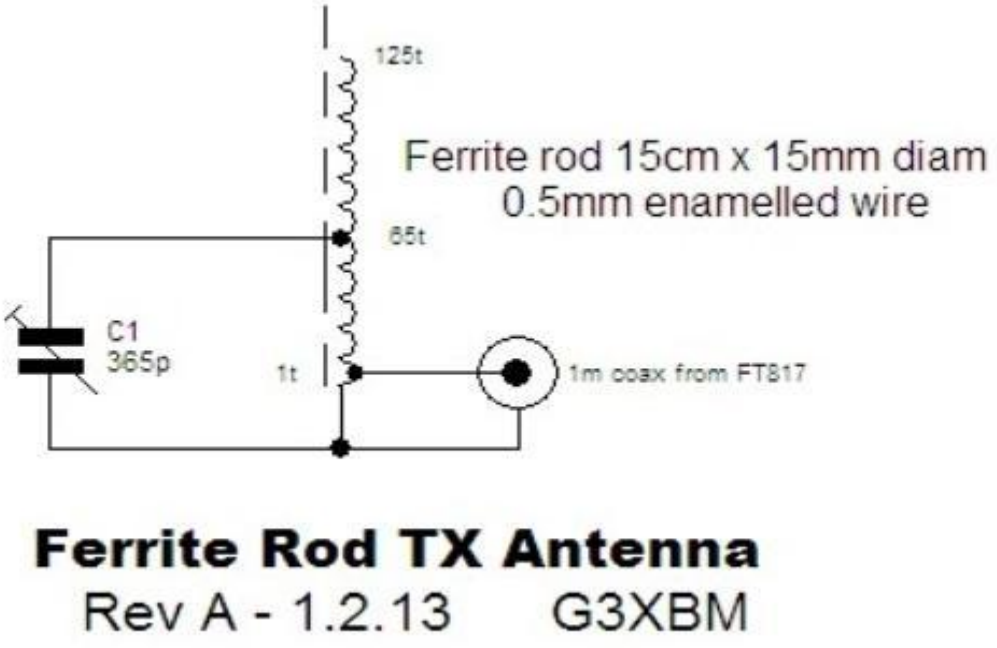
These are small 2 element antennas that were very popular some years ago. Mine was cut for 2m and was made from old copper studding. I trust yours will be made with “proper” material! Once again, there are online calculators to help with dimensions. If you Google “HB9CV”, you should find several calculators.

Both elements are driven with the coax attached at the front element

There are commercial versions available if you prefer not to make your own. The one shown in the photo is a commercial 2m one, but I cannot remember where it came from.

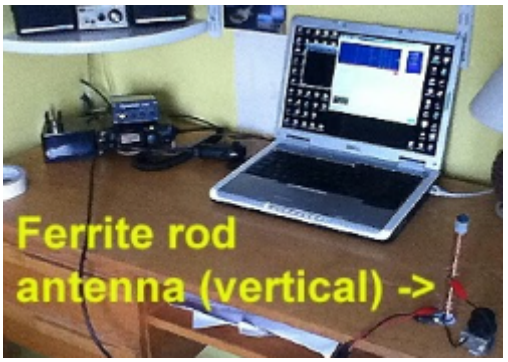
An example of an HB9CV calculator is at
https://www.changpuak.ch/electronics/HB9CV.php

Ferrite Rod Transmitting Antennas



Ferrite rods work by “magnifying” space within the rod. In my view, there is nothing to stop them working on transmit as long as the material does not saturate and they are suitable for the band intended. This means running at low or very low power only and probably on the lower bands.

Nonetheless, with modes like WSPR or FT8 signals will be well down on a “big” antenna, but worth playing with even so. The ferrite rod I used some years ago had unknown properties. However, I can think of no good reason why such antennas would not work on bands like 160m or 80m.



In my case the rod worked to 40m and 30m TX, but I had no success on 20m. You wonder how they might work on 630m TX. I might try this. Often antennas on LF and MF are quite inefficient anyway, so a bit more loss might not matter too much. Also, the directionality might be a bonus.

Some think they only work by coupling into larger antennas. I disagree. Mine seemed to work in various locations. If efficient, they will be sharply tuned. In my configuration I think it was working as a loaded whip and mounting it

vertically seemed to be best. Do not be afraid to experiment! Try thicker wire and try different arrangements.

See what works for you and do not believe “accepted wisdom”. Experts are often wrong!

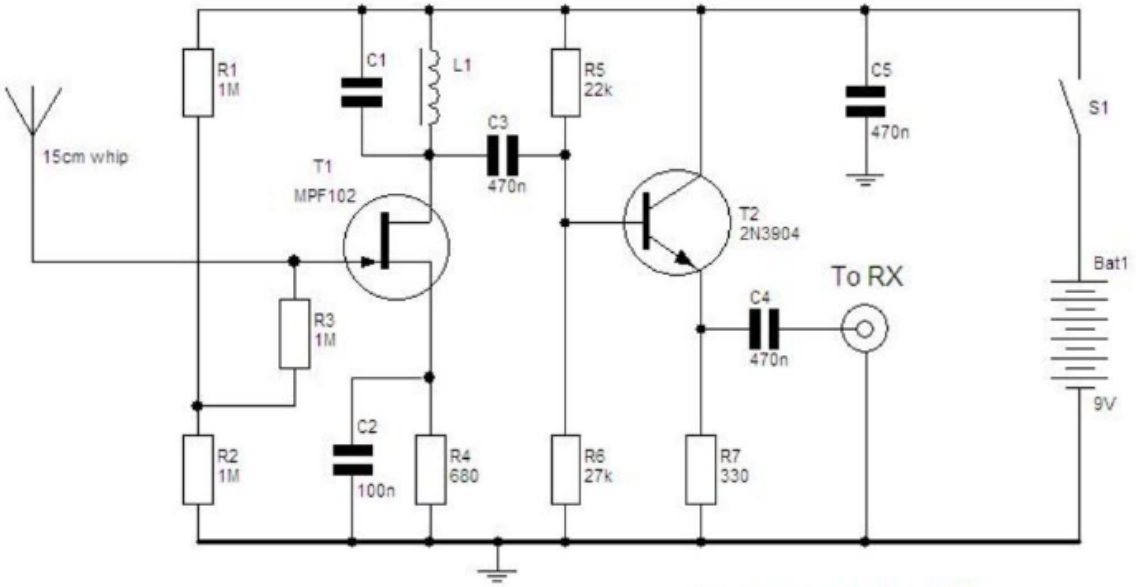
These were some of my 40m WSPR spots with just 50mW!

Timestamp	Call	MHz	SNR	Drift	Grid	Pwr	Reporter	RGrid	km	az
2013-02-01 11:34	G3XBM	7.040162	-21	0	JO02dg	0.05	OZ7IT	JO65df	853	63
2013-02-01 11:34	G3XBM	7.040156	-19	0	JO02dg	0.05	G7JSC	IO92ac	154	264
2013-02-01 11:22	G3XBM	7.040156	-15	0	JO02dg	0.05	G7JSC	IO92ac	154	264
2013-02-01 11:22	G3XBM	7.040161	-25	-1	JO02dg	0.05	ON7KO	JO21oe	295	113
2013-02-01 11:08	G3XBM	7.040160	-16	0	JO02dg	0.05	OZ7IT	JO65df	853	63
2013-02-01 11:08	G3XBM	7.040157	-18	0	JO02dg	0.05	G7JSC	IO92ac	154	264
2013-02-01 11:08	G3XBM	7.040164	-25	0	JO02dg	0.05	G4AXL	IO95ga	327	340
2013-02-01 10:56	G3XBM	7.040158	-12	0	JO02dg	0.05	G7JSC	IO92ac	154	264
2013-02-01 10:56	G3XBM	7.040192	-24	0	JO02dg	0.05	G4PMB	IO71	376	259
2013-02-01 10:56	G3XBM	7.040145	-31	0	JO02dg	0.05	GJ7RWT	IN85ve	385	288
2013-02-01 10:56	G3XBM	7.040164	-22	0	JO02dg	0.05	G4AXL	IO95ga	327	340
2013-02-01 10:48	G3XBM	7.040164	-28	0	JO02dg	0.05	G4AXL	IO95ga	327	340
2013-02-01 10:48	G3XBM	7.040157	-22	0	JO02dg	0.05	G7JSC	IO92ac	154	264
2013-02-01 10:42	G3XBM	7.040164	-26	0	JO02dg	0.05	G4AXL	IO95ga	327	340
2013-02-01 10:42	G3XBM	7.040166	-17	0	JO02dg	0.05	G3UYN	IO70ib	445	239
2013-02-01 10:42	G3XBM	7.040157	-19	0	JO02dg	0.05	G7JSC	IO92ac	154	264
2013-02-01 10:34	G3XBM	7.040164	-26	0	JO02dg	0.05	G4AXL	IO95ga	327	340
2013-02-01 10:28	G3XBM	7.040166	-13	0	JO02dg	0.05	G3UYN	IO70ib	445	239
2013-02-01 10:28	G3XBM	7.040164	-24	0	JO02dg	0.05	G4AXL	IO95ga	327	340
2013-02-01 10:12	G3XBM	7.040164	-23	0	JO02dg	0.05	G4AXL	IO95ga	327	340
2013-02-01 10:08	G3XBM	7.040167	-11	0	JO02dg	0.05	G3UYN	IO70ib	445	239
2013-02-01 10:08	G3XBM	7.040166	-21	0	JO02dg	0.05	G4AXL	IO95ga	327	340
2013-02-01 10:08	G3XBM	7.040162	-26	0	JO02dg	0.05	ON7KO	JO21oe	295	113
2013-02-01 09:52	G3XBM	7.040165	-22	0	JO02dg	0.05	G4AXL	IO95ga	327	340
2013-02-01 09:52	G3XBM	7.040167	-11	0	JO02dg	0.05	G3UYN	IO70ib	445	239
2013-02-01 09:46	G3XBM	7.040165	-21	0	JO02dg	0.05	G4AXL	IO95ga	327	340
2013-02-01 09:46	G3XBM	7.040192	-19	1	JO02dg	0.05	G4PMB	IO71	376	259
2013-02-01 09:38	G3XBM	7.040164	-23	0	JO02dg	0.05	PI4THT	JO32bf	448	88
2013-02-01 09:38	G3XBM	7.040164	-18	0	JO02dg	0.05	M0SBS	IO81vg	295	238
2013-02-01 09:38	G3XBM	7.040165	-21	0	JO02dg	0.05	G4AXL	IO95ga	327	340
2013-02-01 09:34	G3XBM	7.040960	-18	0	JO02dg	0.05	G4AXL	IO95ga	327	340
2013-02-01 09:34	G3XBM	7.040959	-20	0	JO02dg	0.05	PI4THT	JO32bf	448	88
2013-02-01 09:34	G3XBM	7.040977	-24	0	JO02dg	0.05	ON7KO	JO21oe	295	113
2013-02-01 09:24	G3XBM	7.040974	-19	0	JO02dg	0.05	ON7KO	JO21oe	295	113
2013-02-01 09:24	G3XBM	7.040959	-17	0	JO02dg	0.05	G4AXL	IO95ga	327	340
2013-02-01 09:24	G3XBM	7.040958	-21	0	JO02dg	0.05	PI4THT	JO32bf	448	88
2013-02-01 09:20	G3XBM	7.040949	-26	0	JO02dg	0.05	LA9JO	JP99gb	2096	20
2013-02-01 09:20	G3XBM	7.040974	-22	0	JO02dg	0.05	ON7KO	JO21oe	295	113
2013-02-01 09:20	G3XBM	7.040958	-17	0	JO02dg	0.05	G4AXL	IO95ga	327	340
2013-02-01 09:20	G3XBM	7.040984	-27	0	JO02dg	0.05	G4PMB	IO71	376	259
2013-02-01 09:20	G3XBM	7.040957	-17	0	JO02dg	0.05	PI4THT	JO32bf	448	88

A 137 kHz E-field probe receiving antenna

Some years ago, I needed a simple mag-mounted antenna for the car so that I could find out how far away my 137 kHz beacon could be detected. This circuit was developed. It worked very well with my FT817, which is a bit deaf on 137 kHz.

To my surprise, my low power uW ERP beacon driving my earth-electrode “antenna” in the ground could be copied well on the far side of Cambridge about 20km away. It was so good that I just stopped! As I recall, we had thick snow at the time!



137kHz E-field probe

G3XBM 6.2.13 Rev B

L1/C1 resonate at 137kHz
L1 approx 40t on ~16mm diam 3C90 core toroid
Output fed via mag-mount coax to RX
C2 may be omitted if gain sufficient without

2m half-wave antenna

The “gain” from a quarter wave whip or a helical antenna is frequently poor. Often, people use ⅝ wave verticals to improve matters.

Many years ago, I made a half-wave whip that seemed to be a lot better than a ¼ wave or helical. I used it on my 2m MX2 SSB handheld and AM Fredbox. It consisted of a steel whip with a matching coil tapped at the 50 ohm point. I have no idea how it compares with a ⅝ wave whip, but it worked.

One photo shows the full whip and the other the matching tuned circuit.

Loop Antennas

Loop antennas can be very effective. They can be made with copper pipe for the inductor and, if low power, ordinary capacitors. If running high power, special high voltage capacitors will be needed.

Coupling to 50 ohms is via a smaller loop which is connected to the feed coax. The photo shows my 10m loop. The loop itself may have a very high impedance and high voltages if fed with high power. This is why special capacitors are used with higher power. Low voltage capacitors can break down with high power. At QRP levels, I have never found special capacitors necessary.

Their main disadvantage is they are narrowband, if efficient. This is OK if the frequency is infrequently changed such as for WSPR or FT8, but less ideal if you use CW or SSB. They are also directional, which may help with noise nulling. For things like 10m WSPR or FT8 they can be made fixed tuned by using a length of coax as a capacitor cut to resonance.

There are commercial versions available. These are usually made for high power with special capacitors. A single band QRP one can be made very inexpensively.

Don't forget that the efficiency is directly proportional to the inductor, so use as thick a conductor as you can. In my case, I used copper central heating pipe. Coax cable could be used for the inductor. If in doubt, double up on the coax inductor! Increasing the thickness will add to efficiency. If you use coax cable any old stuff may be used. It is only used as a piece of wire so if it is no good any longer as coax, use it for a loop! Remember that if using thinner wire it will be easier to tune and still work, but it will be less efficient. You may be seeking a compromise between ease of tuning and efficiency.

The commercial Whizz loop uses thinner wire, but is easier to tune. These work well even indoors, but they are a compromise.

For an example of a loop calculator see
https://www.66pacific.com/calculators/small-transmitting-loop-antenna-calculator.aspx

Miracle Whips and Similar

From the outset, do not expect miracles! A small whip can only be as good as a small whip.

On higher HF bands with a good earth or counterpoise, these antennas may only be a few S-points down on a full sized dipole. My best DX was working a station in Argentina when I was using just 5W SSB when indoors using a radiator as my ground in an upstairs bedroom!

The main advantage is they can be very easy to tune. Compromise antennas, yes, but they can be effective. Don't dismiss these. I even managed an 80m QRP SSB QSO using the IC-703 and its internal auto-ATU.

These were originally made by a Canadian company and an article appeared in QST magazine some years ago. Similar antennas are available from other sources.

I still have mine.

Big Wheel Omni

This is an omni directional horizontally polarised antenna. Mine is for 2m, but versions are available for other VHF bands. It has an almost 360 degree coverage with a few dB horizontal gain. It is ideal for nets and modes like FT8. I got mine commercially made from Wimo in Germany, but many people make their own. It is sometimes known as a cloverleaf as the shape resembles one.

It beats turning a beam. If you are like me and not a fanatical VHF operator, this may suit your operating style. As a bonus, it was quite a respectable match on 70cm too, although I do not know the radiation pattern.

With 2m FT8, unimaginable DX seems to be always possible, possibly using some form of troposcatter. These antennas are unobtrusive and just work.

Don’t do like I did: just before erection it was propped against the house without any supports. A gust of wind got it and it crashed to the ground bending many of the elements. Thankfully they all straightened out and it has been up for many years with no issues. It is my main antenna for 2m and 70cm SSB and FT8.

For some more data on the big-wheel see https://www.dolstra.nl/Antennes/VHF-UHF-SHF/Stationairy%20antennes/Big%20Wheel/Big-wheel.htm

V2000 vertical

This covers 6m, 2m and 70cm. It works well as a vertical antenna and is ideal for FM nets. On 6m QRP SSB it has enabled me to work all over Europe and even the USA on QRP 6m CW.

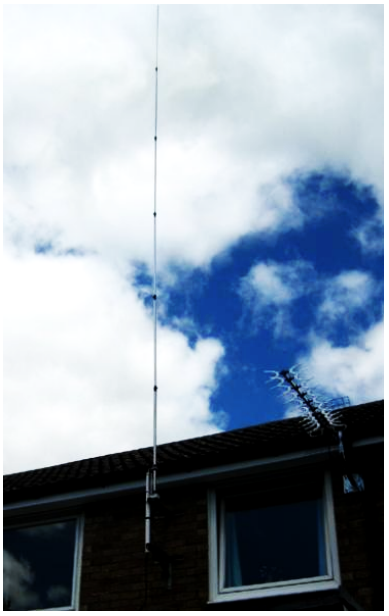
Mine was an original, but there are several clones. I do not know how these clones perform or last.

Overall, it is a useful antenna. Mine is not that high on the side of a bungalow, but serves me well.

For more details see
https://www.nevadaradio.co.uk/product/diamond-v-2000/

Rybakov Verticals

Introduction



The X80 was a commercial version of a so-called Rybakov vertical antenna that was manufactured in the UK by the Snowdonia Radio Company. Sadly, this company ceased trading in late 2012 I believe.

The antenna is 5.8m long and covers 3.5-29MHz via an ATU. The antenna resembles a base loaded CB vertical in appearance, although the design is quite different. The SRC X80 base contained a 9:1 UNUN transformer rated at 150W which converted the relatively high antenna impedance at the base of the vertical section to an impedance more easily matched by auto-ATUs found in modern radios. As with all such antennas, this is a compromise one, so do not expect remarkable results. However, when mounted in the clear it is capable of quite decent performance, even when running QRP. The SRC X80 was very reasonably priced and represented quite a bargain for a commercial HF antenna.

Packing and Delivery

The unit arrived within 3 days of ordering by Royal Mail and came in a strong cardboard carton. What surprised me was how small the package was considering the size of the erected unit. The secret was packing the 6 vertical sections of the antenna within each other to save space. All the necessary jubilee clips and brackets were supplied and nothing was missing.

Erection

This took about 30 minutes, with some of this time removing the previous antenna on the side of the house. There were no issues at all in assembly or erection. SRC recommended waterproofing the antenna joints with self-amalgamating or PVC tape if erecting permanently. When up on the back

of the house, the antenna does sway about in the wind, but it looked strong enough and likely to survive.

Testing

This consisted of connecting 10m of coax back to the operating shack in the front upstairs of the house (the antenna is at the back) to my Elecraft T1 auto-ATU and connecting this to the output of my FT817 QRP radio. Then I set the middle of each band on the FT817 and set the match using the auto-ATU. On all bands from 80-10m I was able to match the antenna without problem. As I have the Elecraft T1's FT817 interface lead, the ATU automatically remembered band settings when changing bands on the FT817. This means you can switch to the same part of a new band without having to reset the ATU - ideal for flicking between QRP calling frequencies, FT8 frequencies, PSK31 frequencies or WSPR frequencies.

Results

Within a couple of minutes of connecting up the antenna and matching it on all bands I had a couple of QRP CW QSOs in the log on 12m and 10m. I then tried WSPR beaconing on 7, 10, 14 and 28MHz to see what reports were given and received. On all bands tested I received several reports within a few minutes. I received a -27dB S/N WSPR report on 18MHz with my 5W from **W8LIW** some 6105km away, so it definitely worked. A little later I had a QSO on QRP CW with **EI5DR** on 12m.

Conclusions

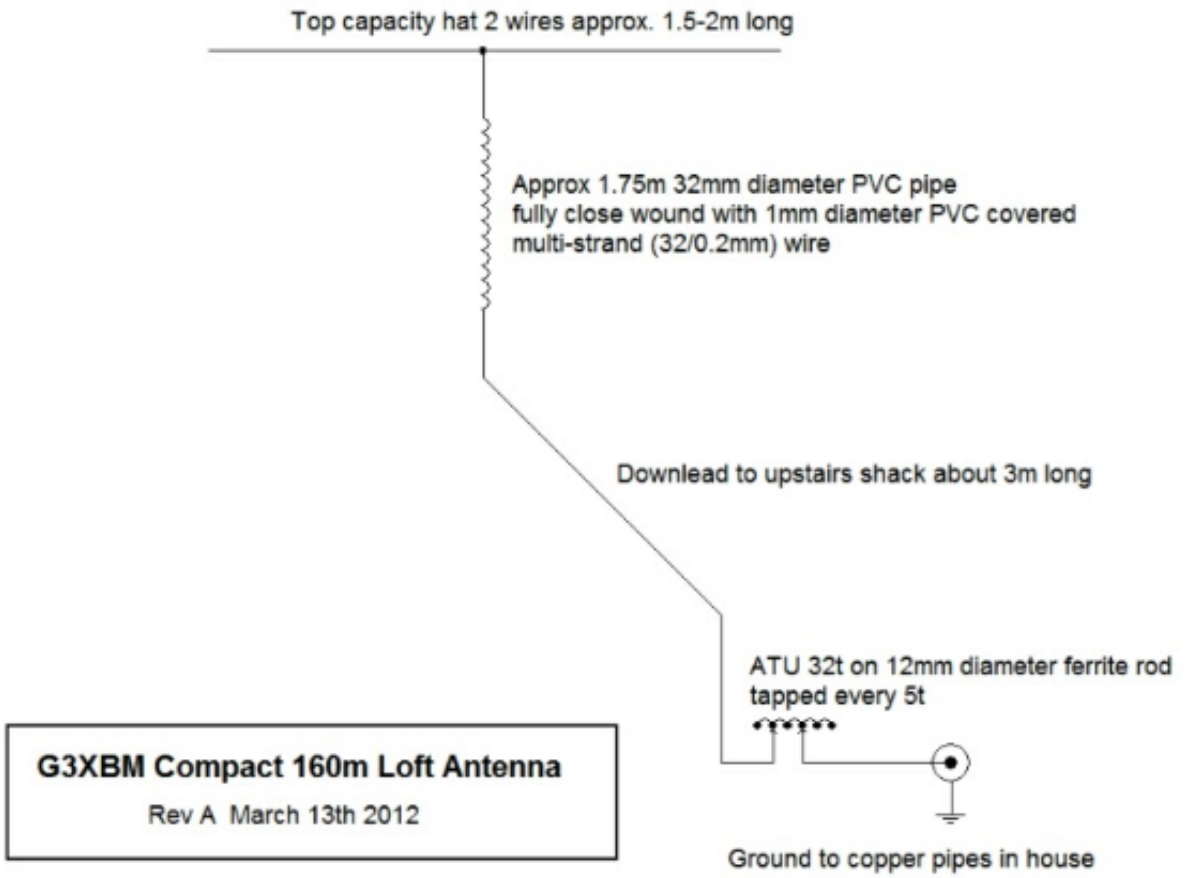
It certainly put a decent signal out on several bands and it allowed me multi-band operation without adjustment with the FT817 and the T1 auto-ATU. My only concern was it was rather high and thin and it did blow around a bit in the wind.

Final Remarks

The X80 was in a box in the garage unused for several years. Eventually, it was swapped for an active RX antenna with Jason M0NYW which sits on my windowsill and performs well.

Although the X80 is unavailable, similar antennas are available from other sources. I think the modern versions are available in fibre glass.

160m loft antenna



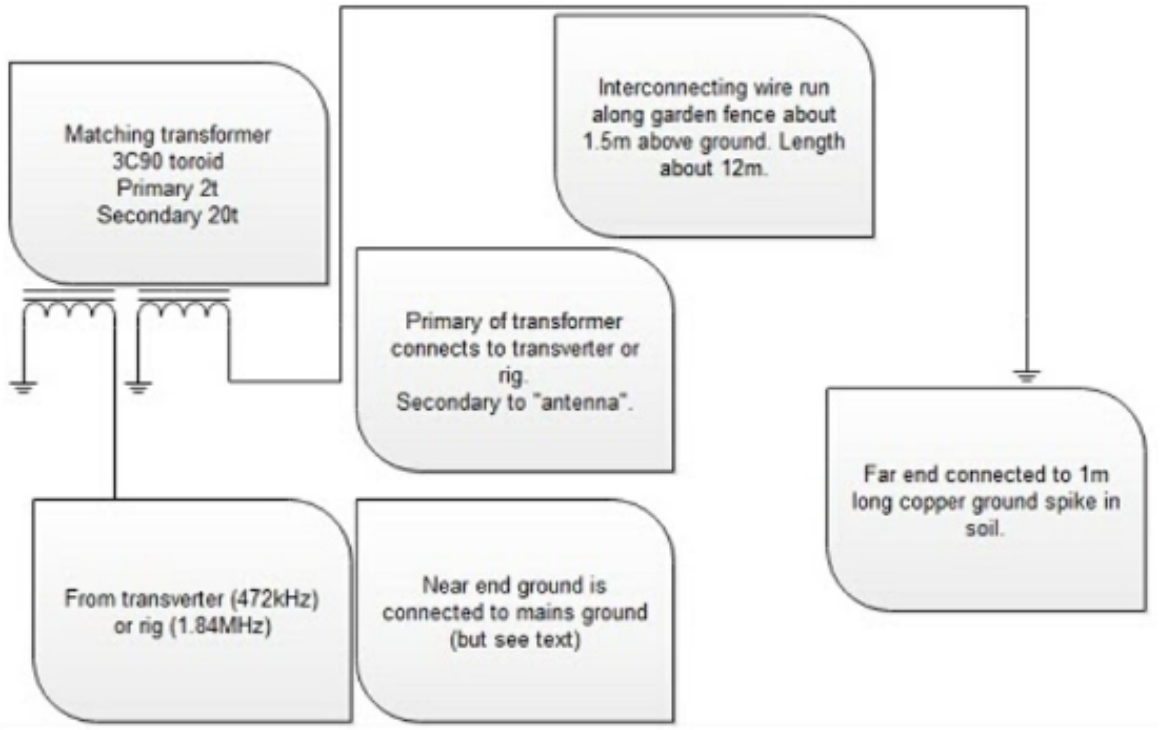
This is a very small vertical 160m antenna that fits in the loft of even my small house. It was built as a way of getting a signal out on 160m for local AM contacts, but the local noise level was far too high to allow it to be used at night for this purpose. However, on WSPR it did a pretty good job with WSPR spots from a very long way across Europe being received when running 2.5W out.

The idea was to wind a length of PVC piping with as much wire as I could find (a bit like a helical, but on 160m), attach some top capacitance in the form of a couple of horizontal wires, bring the whole thing to resonance, tuned against my central heating system as ground. The design is not critical. If you use a different ground you

may not get away with just a series tuned circuit as in my case and you may have to use a “proper” ATU.

Results were good: WSPR spots from Sweden (over 1000km) and Poland on JT65. All with 2.5W RF from the TX.

Earth-electrode “antenna” in the ground



For some years I have used an earth-electrode antenna to TX my earth-mode signal on VLF. The earth-electrode antenna consists of two earth rods, or one earth rod and a connection to a copper water pipe separated by 15-20m of cable running along the ground. Using this system on 8.97kHz I can detect my 5W VLF beacon to at least 6km.

I have been experimenting with the very same antenna at 472kHz and getting some quite remarkable results with reports from over 1000km on WSPR using 10mW EIRP levels. Another local MF station G4HJW has also carried out experiments with a very similar antenna, in Bernie's case he was using 30m spacing between the earth rods, and getting results from over 900km away when running about 6dB more than me. Some of the German amateurs have been achieving remarkable far-field results at SLF frequencies.

Where the bedrock is chalk, I am getting results only 2-14dB below those I was getting with a 6m top loaded Marconi antenna on 472 kHz. There is some evidence from the signal strengths in various directions that the earth-electrode antenna behaves like a virtual loop within the ground, radiating a signal much like that from an elevated wire loop i.e. with directivity. Signals

in the line of the antenna are strongest and those orthogonal to the wire weakest.

Testing the same 15-20m baseline earth-electrode antenna on 137kHz gave similarly encouraging results.

At my newer QTH I have a shorter baseline earth-electrode antenna with one end (the shack end) connected to a mains earth. The spacing from the far electrode is about 12m with a short wire about 1.5m off the ground running along the garden fence to the far electrode. Best DX on 472 kHz with a measured ERP of under 10mW is just over 1300km. Unlike at the old QTH, a matching transformer was needed here to get a good 50 ohm match (see photo) .

The diagram on the previous page may make the arrangement clearer. So far, at this QTH it has given decent results on 630m, 160m, 80m and 60m. At higher frequencies I would not expect it to work at all well.

23cm 4 element yagi

This probably dates from the 1970s. One night, a friend loaned me his 23cm receive converter to try. As I had no 23cm antennas I hastily made a 4 element yagi from a design (I think) from VHF Communications magazine.

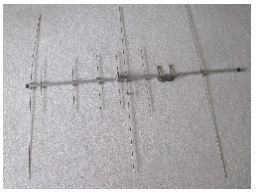
It was made from 2.5mm diameter silver plate wire (almost certainly overkill) with a piston capacitor as part of the matching circuit.

As I recall, it was tiny, about the size of a hand, and attached to the converter. It was enough to hear a local station directly and indirectly off a nearby water tower.

Sadly, I no longer have the design and actual antenna. I never went on 23cm transmit at that time.

Small yagis for 23cm can probably be made on a piece of PCB material. I have not tried this.

Dual 2m/70cm yagi

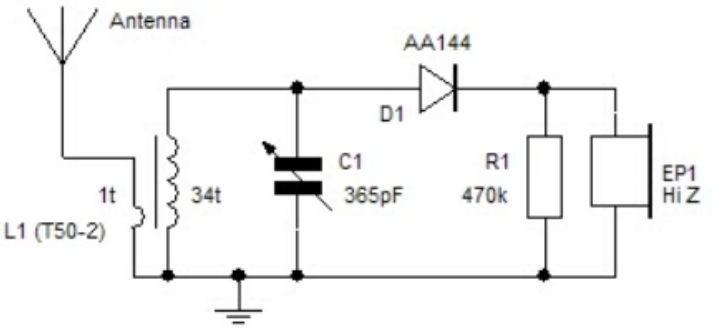


Some years ago, I bought this yagi, mainly for use in the RSGB organised 2m and 70cm activity contests (UKAC). It was mounted on a pole outside the shack and was hand-rotated. It had a bit of gain. An advantage was it only needed a single coax feed. However, it had to be turned.

In the end it was replaced with a big-wheel horizontal omni antenna. I figured I was trading a little bit of gain for an omni-directional antenna that did not need turning. For the activity contests, the big-wheel antenna was better for me.

I cannot recall where I bought it. It is still in the garage.

Shortwave Crystal Set



If you have never dabbled with crystal sets, you don't know what you are missing! All the power comes from the transmitter, so they need no source of power like batteries. They only pick up strong signals and most of the signals you will hear will be broadcast signals and there are far fewer now that broadcast in English.

Amateur signals *can* be received. AM signals have been copied over several miles on 160m and on 80m some SSB has been copied by slope detection. In the USA there are regular AM nets on 80m that have been received with crystal sets.

Often utility signals can be detected by cross modulation enabling CW signals to be copied.

What crystal sets need is patience. I remember copying Radio Australia (actually from Australia and not a closer relay) when another station faded. So, it is possible to hear stations on the far side of the planet with a crystal set! One of my hobbies was collecting QSL cards from broadcast stations when using just a crystal set.

One of the best sites to explore is
http://www.hobbytech.com/crystalradio/crystalradio.htm

The following table gives you an idea of what you can expect from a very simple crystal set such as that above. There is little doubt that with a full wave receiver and optimisation, these figures can be beaten.

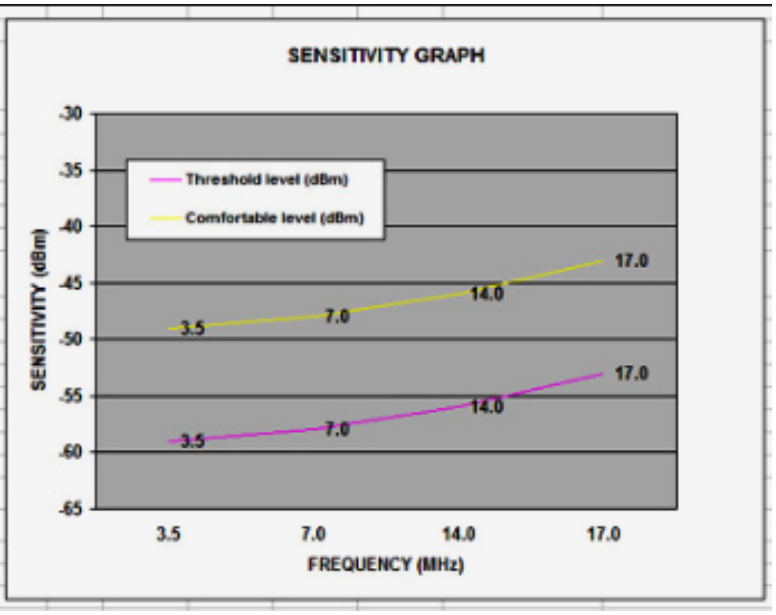
Frequency (MHz)	Threshold level (dBm)	Comfortable level (dBm)
3.5	-59	-49
7.0	-58	-48
14.0	-56	-46
17.0	-53	-43

Single tuned T50-2 toroid circuit
34t primary with 1t antenna winding

AA144 germanium diode
Measured with HP8640B signal generator
100% AM modulation

NB -59dBm is 255uV, -53dBm is 505uV

SENSITIVITY GRAPH
AA144 CRYSTAL SET



Designs have appeared using full wave circuits and zero bias MOSFETs, although I have not tried these. See the ARRL website. Also, some designs have extracted energy from nearby broadcasters to bias the diode on more. Again, I have not tried this. The important thing is to be prepared to try things!

As you are trying to extract the most power from the signal, resonant antennas will help, if these are cut for the band you want. Depending on the type of antenna, a good ground may be helpful.

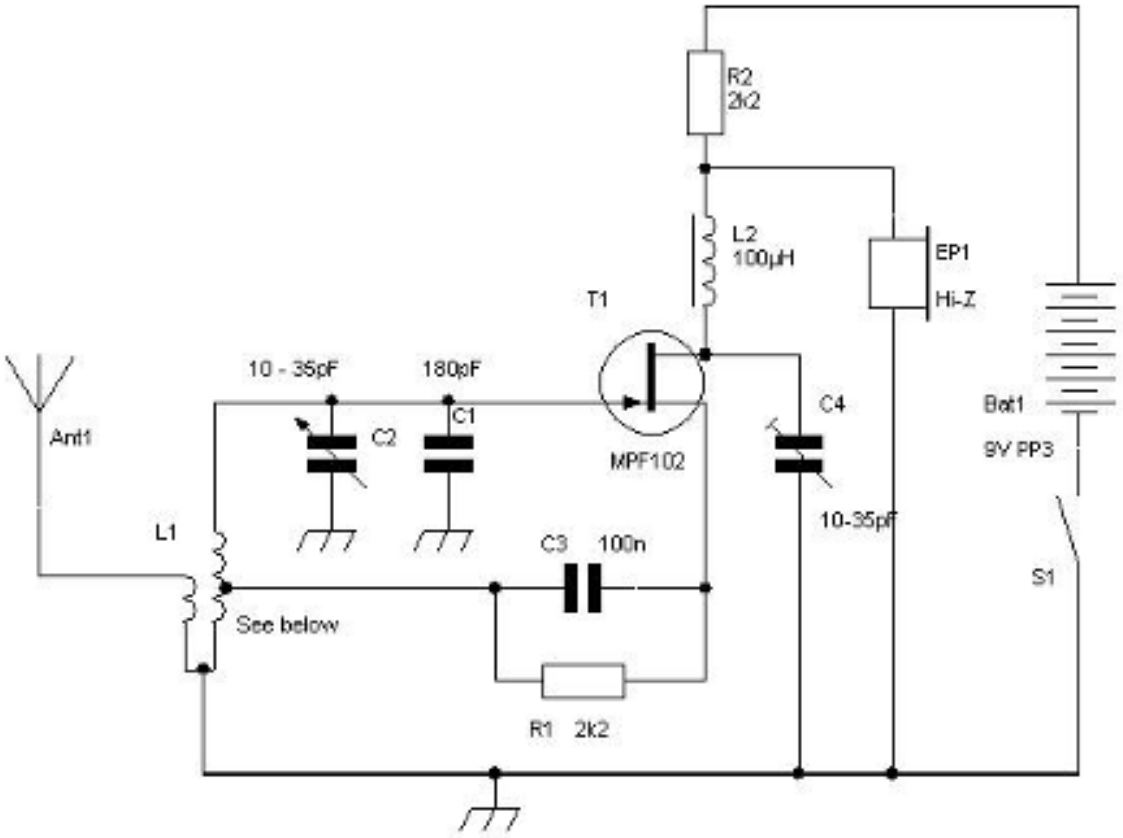
I have little doubt that a 10m crystal set will slope detect DX amateur SSB signals in a good sporadic-E (Es) opening, as signals can be very strong.

Some have even made crystal sets to pick up Band 2 wideband FM by slope detection! Very high Q tuned circuits are needed.

One of my aims was to build a crystal set covering multiple bands from VLF to VHF. I guess this has to be done by someone else now.

I suppose some would argue that solar cells are extracting electromagnetic energy from the sun for free. Whilst I agree with this, I don't think they are in the "spirit" of crystal sets.

80m or 40m Regenerative Receiver



The regen receiver is an amazing piece of electronics.

If you have never tried to build anything ever this is something you have to try!

Various circuits are available on the Internet, but I offer you my own humble version based heavily on similar circuits that have been published over the last 30 years or more. I can claim no originality.

The circuit described may not be the answer to the purist: it may radiate a little RF on the frequency to which it is tuned so avoid using one when you have nearby hams trying to work DX. Having said that it works well, is sensitive and produces decent level signals on SSB and CW into a small crystal earpiece.

With the circuit shown the receiver can pull in SSB/CW stations well from all over Europe on 40m (or 80m) with ease in the UK. It will be overloaded if there are strong AM stations nearby e.g. in the 41m broadcast band at night. If run from a 12-14V supply and R2 is increased to 5k6 or 6k8 the output will be louder and sensitivity close to -100dBm (about 2uV).

L1 is a small T50-2 (red) toroid with around 18-20 turns (40m) or 35-40t (80m) on the main winding connected to the FET with a single turn coupling loop for the antenna connection. The tap is about 20% up the main winding. C1 is adjusted to set the radio into the 40m band and C2 then acts as a fine tune within the band.

You can check the frequency by listening to the frequency radiated when the stage is in oscillation. By changing L1 and C1/2 other HF bands like 80, 30 or 20m can be covered. Experiment! C4 is adjusted to get the circuit to just regenerate. There are no decouplers: these did not seem to matter, so were left out for simplicity. Sensitivity is such that signals of about 2uV may be copied.

Later, I went on to make a full transceiver version called the FETer based on a circuit by W2UW (SK). This is described elsewhere.

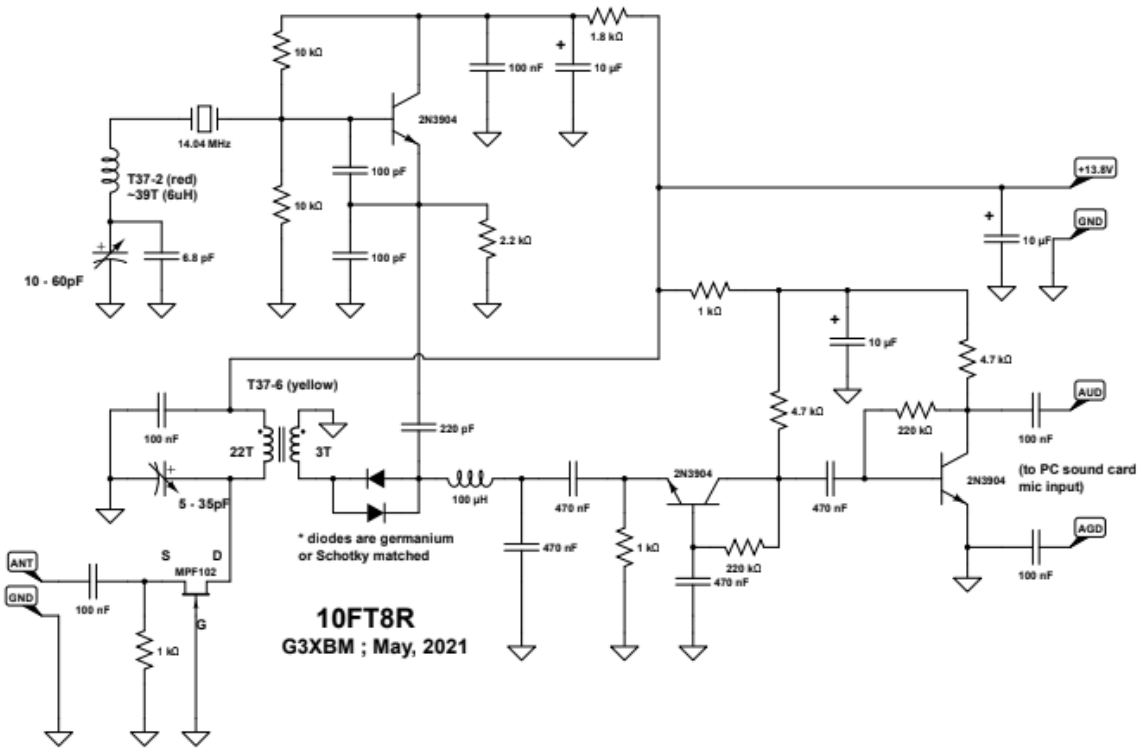
10m WISPY Receiver

This was produced as I needed a simple way to monitor 10m WSPR. The idea of using low cost 14.060 MHz crystals obtained from the GQRP club sales and a Polyakov mixer was born.

I had plans to make a full 10m WSPR transceiver. Although the circuit was created and both the transmitter and receiver built separately, I never managed to complete the full transceiver because of my stroke.

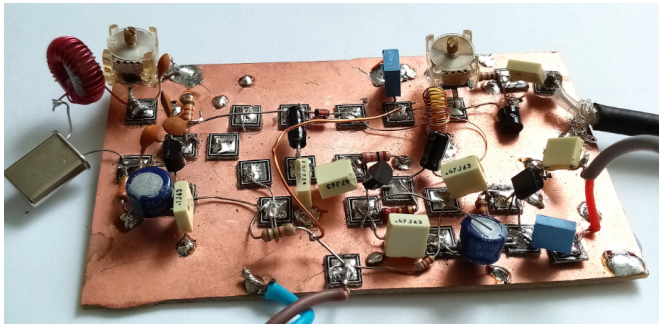
The circuit is essentially the same as the 10FT8R (see below), but with a different crystal. As the crystal has to be pulled *up* a little, some changes around the crystal may be needed. Do not be afraid to experiment!

10FT8R 10m FT8 Receiver



This was a derivative of the 10m WISPY receiver for WSPR, but with different low cost crystals. Initially I found a low cost source of 14.040 MHz crystals which pulled down to 14.037 MHz. When doubled these provide the correct frequency in a Polyakov mixer for 28.074 MHz, which is the 10m FT8 frequency.

Despite being a DSB design, it pulled in lots of stations from across the world. Later I found some 14.037 MHz crystals at low cost and this meant I could do away with the toroid to pull the crystal.



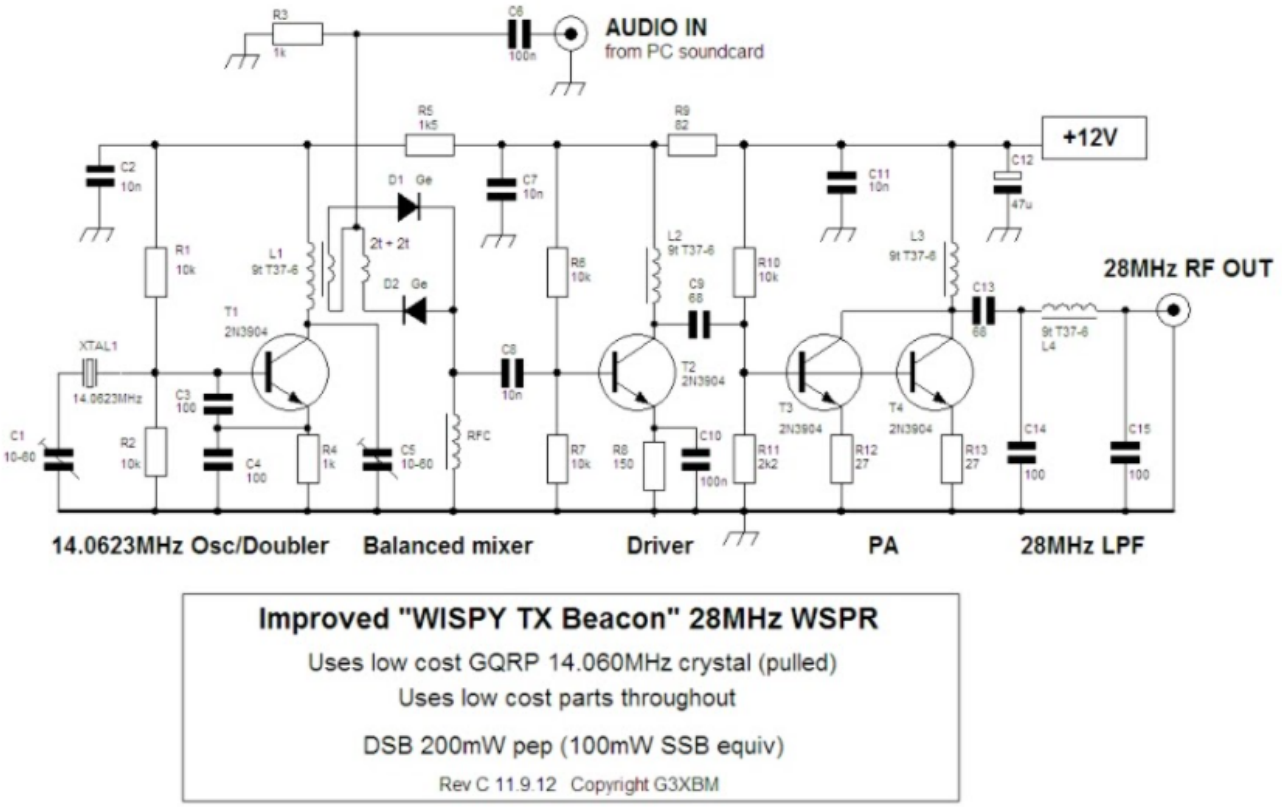
The whole receiver is very simple. It means you can monitor 10m FT8 without tying up the “big” rig. On a suitable PCB it would make a great, low cost, club project. I am sure a single sided PCB could be made with plenty of ground plane. I’d be surprised if the whole cost (with case) was more than £10.

It would make a great project for winter evenings, especially as 10m will be excellent for many years to come. It is good every year in the Es season. By monitoring 10m all the time, then many more short openings might be spotted.

Attached is a photo showing the spots one day on the 10FT8R receiver. Mine never got past the breadboard stage. so it is not very pretty! Even in this state it works really well.

10m WISPY Transmitter

This transmitter was designed as a simple transmitter for 10m WSPR. It used low cost GQRP crystals and a very low cost RF PA solution. It got spots from all over the world. It is a DSB transmitter, so half the TX power is wasted. By putting more 2N3904 devices in parallel as shown in the schematic, power may be increased further.



10m WSPR-AXE beacon

This was a small TX beacon by W5OLF. It has been copied all over the world despite the 500mW RF output.

Apart from initially synchronising the time, no PC is needed. It is totally self-contained and needs no audio from the PC. It is only about the size of a pack of cards.

Whenever the 10m antenna is available and not in use, I use it. Of course a PC is not needed to do the synchronisation. I have a clock that syncs to an atomic standard and this is perfectly acceptable.

Sadly, I do not have the schematic.

137 kHz transmit beacon

This was built to allow me to see how far I could get locally. I do not have the schematic sadly.

There is a short video on my YouTube G3XBM channel. See https://www.youtube.com/shorts/QXeXG6nPY1E .

The Pixie and Micro 80 transceivers

The original idea came from RA3GM as an attempt to make a very simple transceiver for 80m CW. The basic idea is to use the PA transistor as the receiver mixer. Years later, the Pixie was designed using an IC for the receiver audio instead of discrete transistors.

Even though both the Pixie and Micro 80 produce only some hundreds of milliwatts of RF, this can go a long way! The main limitation is the receiver that can easily be overloaded by strong broadcast stations.

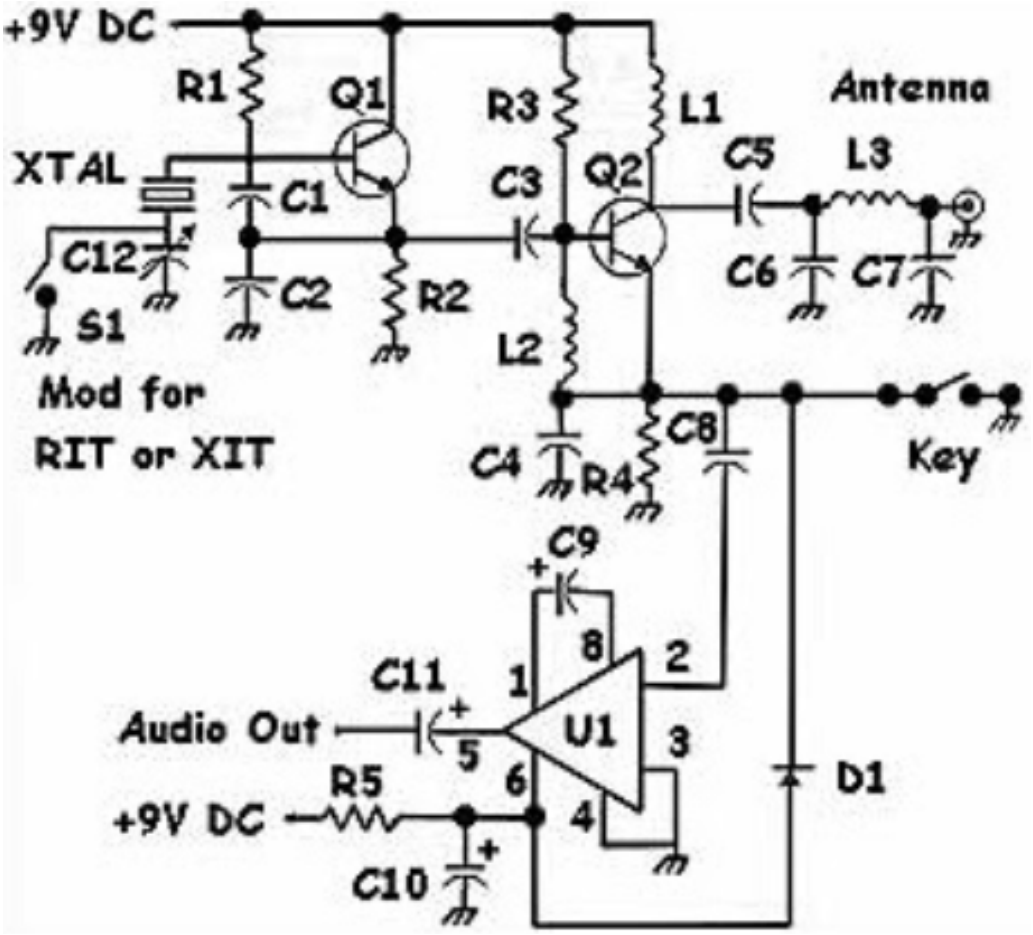
Derivatives have been made to provide offset between the receiver and transmitter frequencies. In my view, the receiver is the real limitation rather than the transmitter.

When I first built mine I was so keen that my Morse key was bare wires on to the copper laminate. This resulted in a contact of around 200km, so it really does work.

As there is no real audio filtering, one has to use the “ear-brain” filter to separate signals close together.

In more recent times, the Chinese have been selling very low cost kits of the Pixies for 40m. The cost of these kits with free airmail from China and a 7.023 MHz crystal is very low. I built one of these and it worked first time. However, as with all things from China *caveat emptor* (let the buyer beware) as some kits can be a bit “dodgy”. The cost of these Pixie kits is so low that the whole transceiver can be made for less than the cost of one component in the UK or USA. Personally I suspect the Chinese will soon lead the way with low cost, high quality, amateur gear. I give them 5 years.

If you are after a low cost way of building a simple CW transceiver, the 40m Pixie kits from China may be a way. I recommend finding out which kits are good, perhaps by reading reviews or speaking with someone locally who has made one.



Typical Pixie schematic

28 MHz (10m) Tenner 500mW CW Transceiver

The Tenner uses the OXO circuit for the transmitter and an SBL1 (or similar) double balanced mixer based direct conversion receiver. TX-RX offset is around 600-800 Hz when the key is pressed, so no special RIT circuit is included. The receiver is a decent one with a respectable performance for something this simple. If the SBL1 or similar is not available it could be substituted with a single balanced mixer using a toroid and 2 matched diodes.

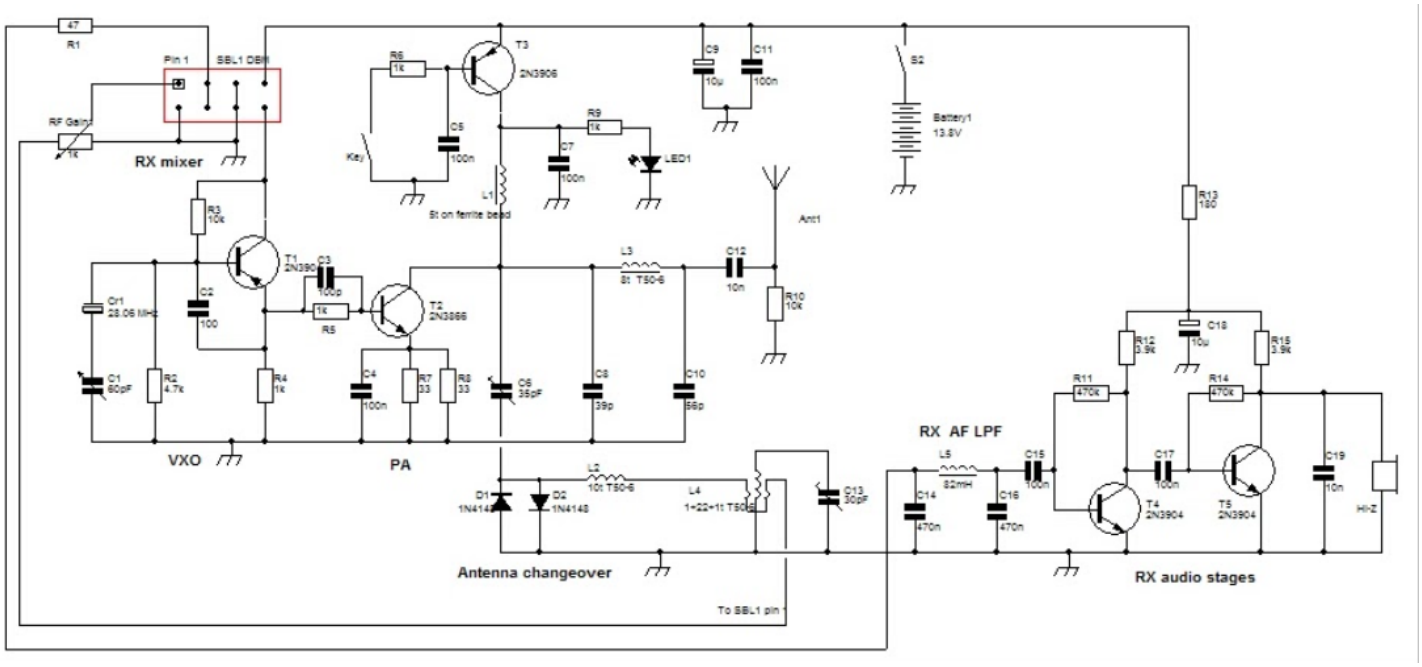
I have roughed out the schematic although I cannot guarantee all values are precise.

Note that the crystal uses a 28.060 MHz *fundamental* crystal - NOT 3rd overtone. These are a little harder to find, but this gives more pulling range. Even greater pulling range can be achieved with a small inductor in series with the crystal, or 2 crystals in parallel, but watch out as chirp may become excessive and the difference between TX and RX frequency less well defined.

This is a basis for experiments - don't take the values as optimised. Have a go yourself and adjust the circuit to improve it further.

The Tenner has worked lots of DX including many transatlantic QSOs.

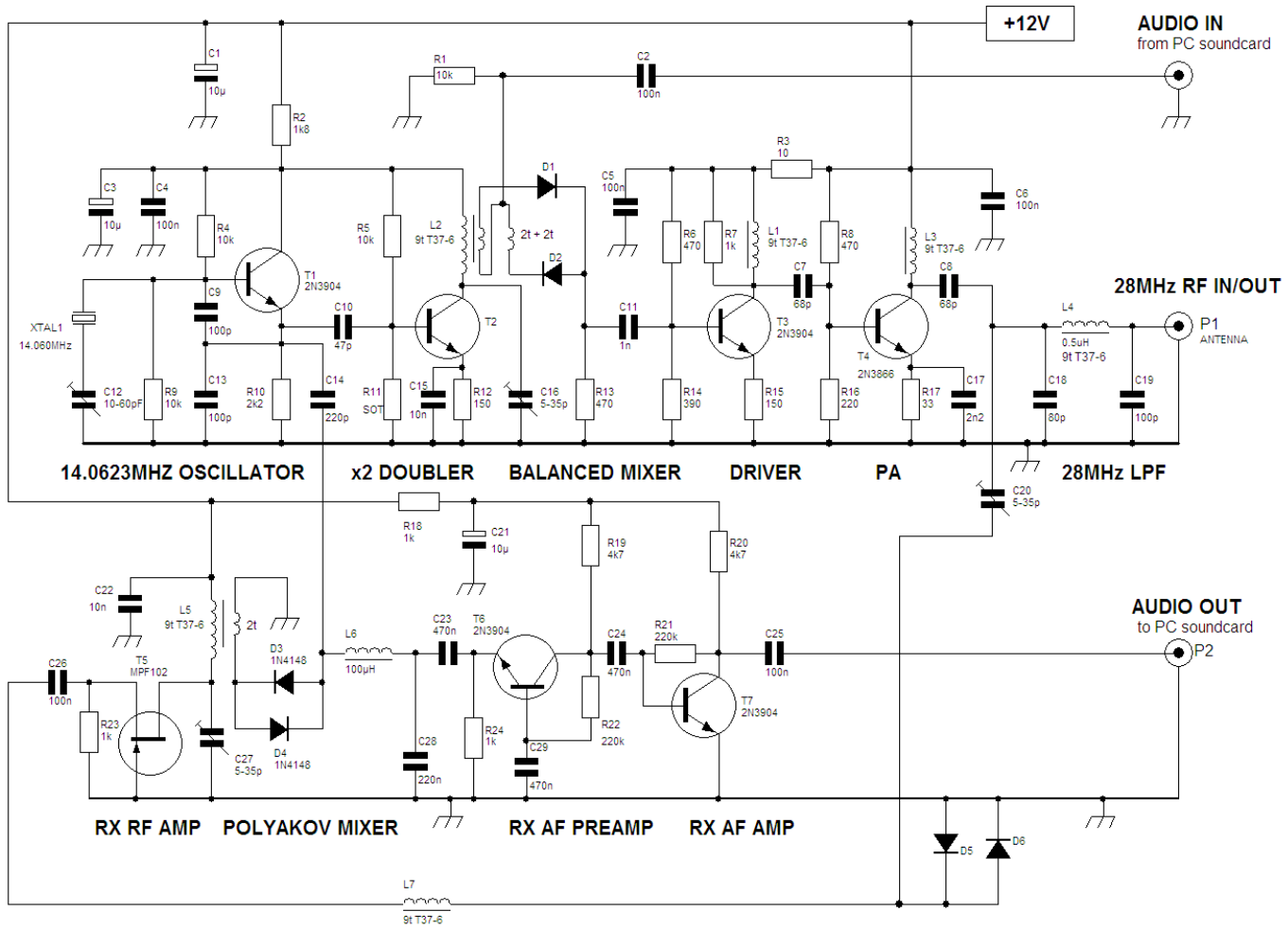
With cycle 25 really getting into gear, 10m should be good again for several years.



Tenner Schematic

10m WISPY Transceiver

Although both the receiver and transmitter have been breadboarded, the full WSPR transceiver is just a concept and has never been built as a transceiver. It should work, but you may have to experiment and optimise. The idea (interrupted by that darn stroke) should also be suitable for FT8.



"WISPY-10" 28MHz WSPR transceiver

DSB 200mW pep Uses low cost GQRP 14.060MHz crystal (pulled)

Rev B 10.9.12 Copyright G3XBM

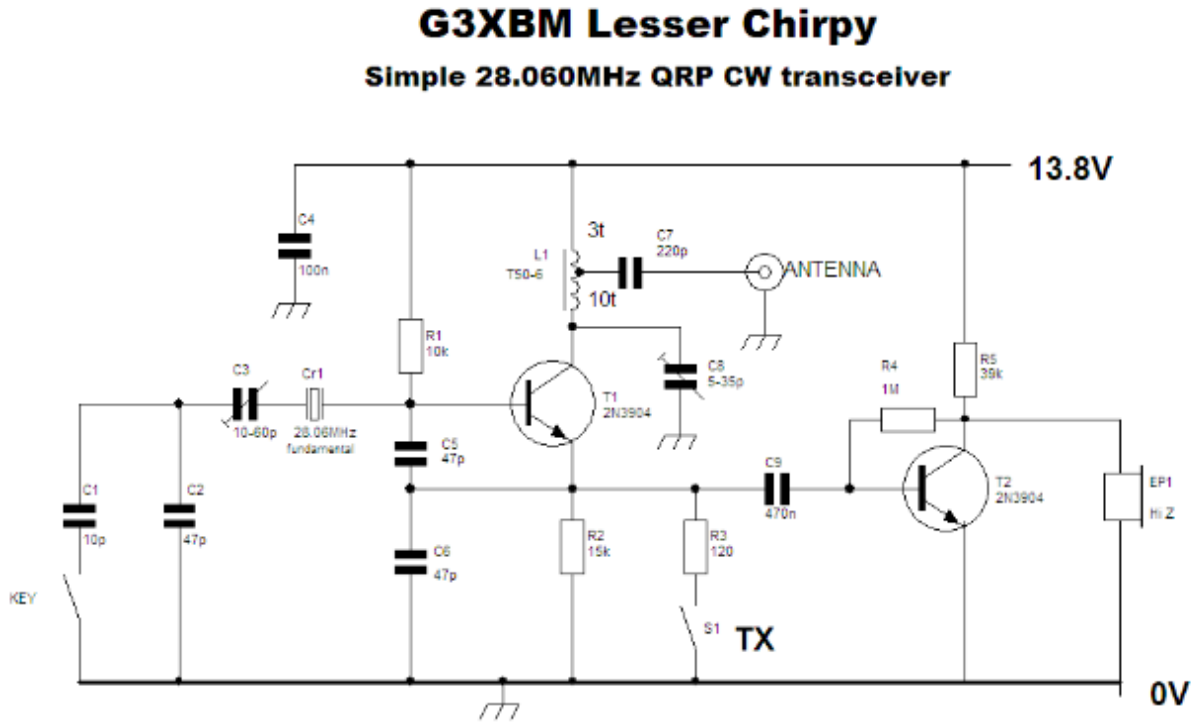
Notes:

C20 and L7 form BPF on RX
On TX D5/6 conduct shorting C20 to ground
D3/4 are part of a half freq injection polyakov mixer
Drive to PA to be adjusted to keep clean o/p signal
TX and RX have been separately breadboarded and tested
Adjust R11 for best 2nd harmonic output at L2

DRAFT - there may be further changes (and errors on schematic!)

10m Lesser Chirpy Transceiver

This circuit dates back to 2012 and is one of the simplest transceivers that you will ever see. The original circuit had too much chirp, so this circuit uses FSK to move the transmit frequency when the key is pressed. This means there is full power on a different frequency when the key is up. So, be aware of this and do not transmit if this risks clobbering other signals. As with all my ideas, do not be afraid to experiment and make it even simpler or better. If it all goes wrong, just start again!



Rev B - July 29th 2012

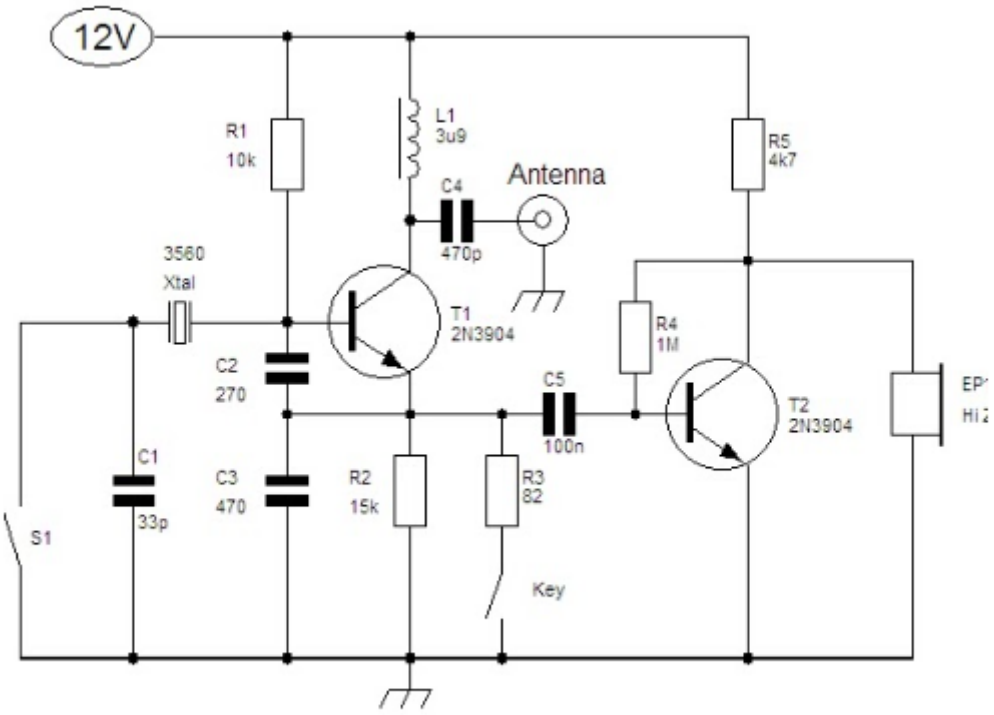
Circuit error corrected

~150mW RF out - negligible chirp!
-100dBm sensitivity
Correct RX/TX offset frequency

80m XBM-80-2 CW transceiver

This was another project to see how simple an 80m transceiver could be made. It is pretty basic! By experimentation you can probably make it better. As the receiver is in oscillation my advice is to avoid its use when others are in range. Ideally, use it on pre-arranged skeds. It would need a low pass filter on the TX output for serious use. This was left off in this case as I only intended to use it very briefly.

Note the homemade pads!



Experimental 80m CW Transceiver XBM80-2 (Rev E)

2m Fredbox AM Transceiver

This dates way back to the 1970s when there was still plenty of AM on 2m. What I really wanted was a simple rig to natter across Cambridge. Several were built. More recently, a version was made by others with a PCB, loudspeaker and audio amplifier, but I cannot recall which club it was!

Mine produced 10mW of AM which sounds very little, but it produced solid contacts across Cambridge as well as several around 100km from Devon clifftops. It was also used in Yorkshire where some very useful contacts were made. The best DX was a French station across the channel at 160km with just a half wave whip antenna on the rig.

The photo shows the Fredbox in use in 1974 I think. Well, it was a long time ago as I still had hair! Why was it called the Fredbox? Well, in those days there was a local disabled amateur named Fred, G8BWI. Oh, how he could talk! You could go away, have tea and come back and Fred would still be talkíng! So, it had to be called the Fredbox! I had quite a few nice chats with Fred on it.

I would not suggest you try to duplicate it, but it might give you some ideas. The super-regen receiver is very simple, but a bit broad. It works well on AM, but is not really suitable for FM. It is very sensitive for something this simple. The transmitter uses series modulation, which works very well and avoids the need for a modulation transformer.

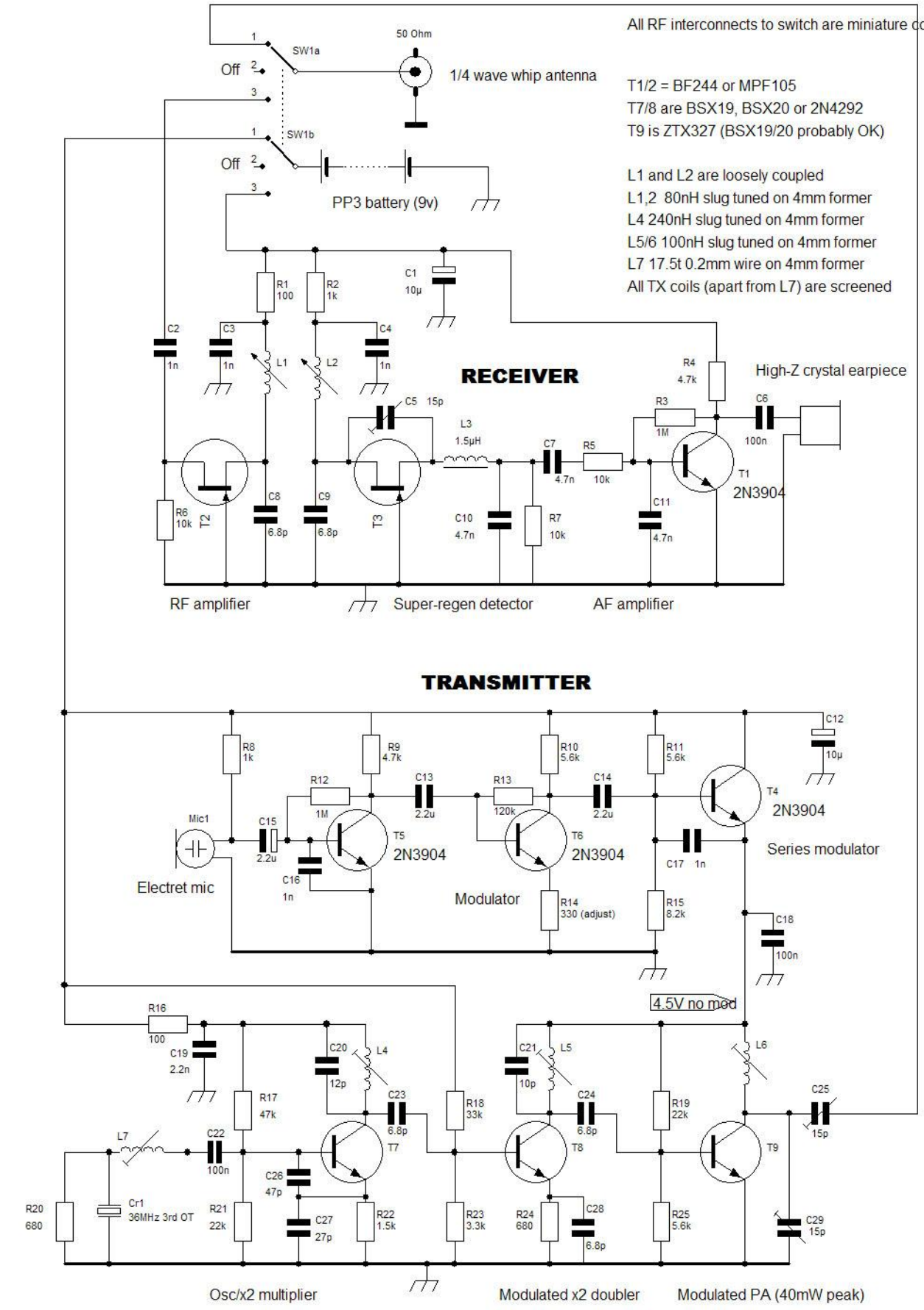
About 12 years ago I found the assembled PCB and case, so I rebuilt it. It still worked fine and was instrumental in a local QSO over 16km and was copied 76km away! It has been little used since.

At the time of its first build, it was a very tiny transceiver. There were no Japanese handhelds

and this was, I think, the smallest VHF transceiver I had ever seen. These days there are several similar sized, dual band, FM handhelds available from the major manufacturers.

Some years ago I noticed that 2m FM signals could be detected well if a carrier was injected. This was not pursued and is an area for more work. I have no idea what the mechanism is.

The schematic is on the next page.



Fredbox 10mW 2M AM Transceiver

 Roger Lapthorn G3XBM

6m Sixbox Transceiver

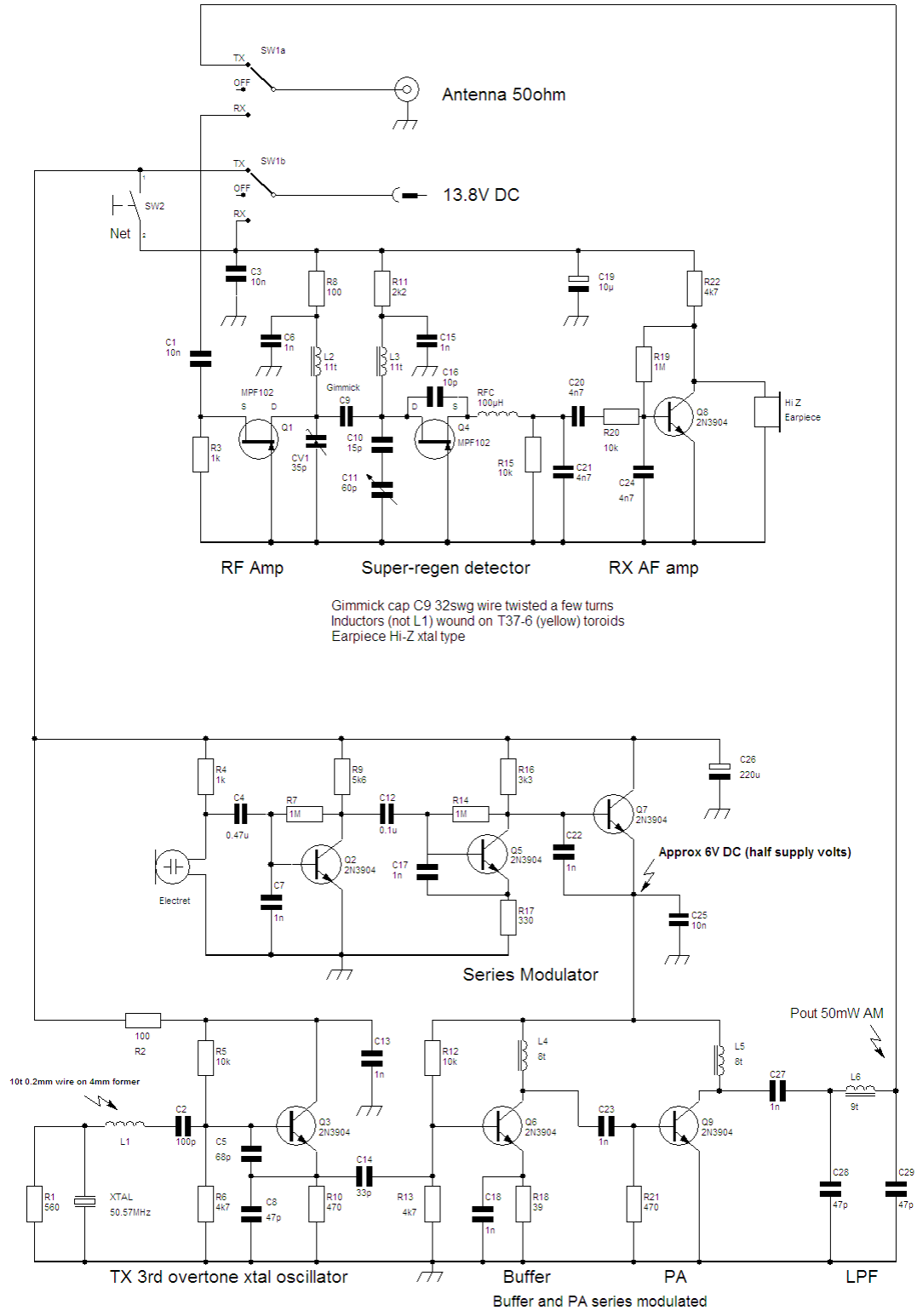
This was based on the 2m AM Fredbox, but was built without a PCB on a piece of copper laminate. It was built more like a small desktop unit than a handheld. It was designed for local contacts rather than DX. It has more power than the 2m Fredbox and has a tunable receiver. It had several local QSOs, but I suspect AM is far less popular these days. If you look at the schematic, you can see it is very much like the Fredbox.

Again, it is an AM rig with a super-regen receiver and a series modulated transmitter. With a 5 MHz tuning range, it makes a useful band monitor with SSB stations detectable, but not demodulatable, by slope detection.

Improvements would include a TX RF linear amplifier and an audio amplifier and loudspeaker.

There is a video about this on my video channel.
See https://www.youtube.com/watch?v=c4pyzm_LEzk

The schematic is on the next page.



The SixBox

A very simple 6m AM transceiver

G3XBM Rev E (July 30th 2009)

10m Tenbox Transceiver

Like the Fredbox and Sixbox, this was to have been made as a simple transceiver for cross-town chats on 10m AM.

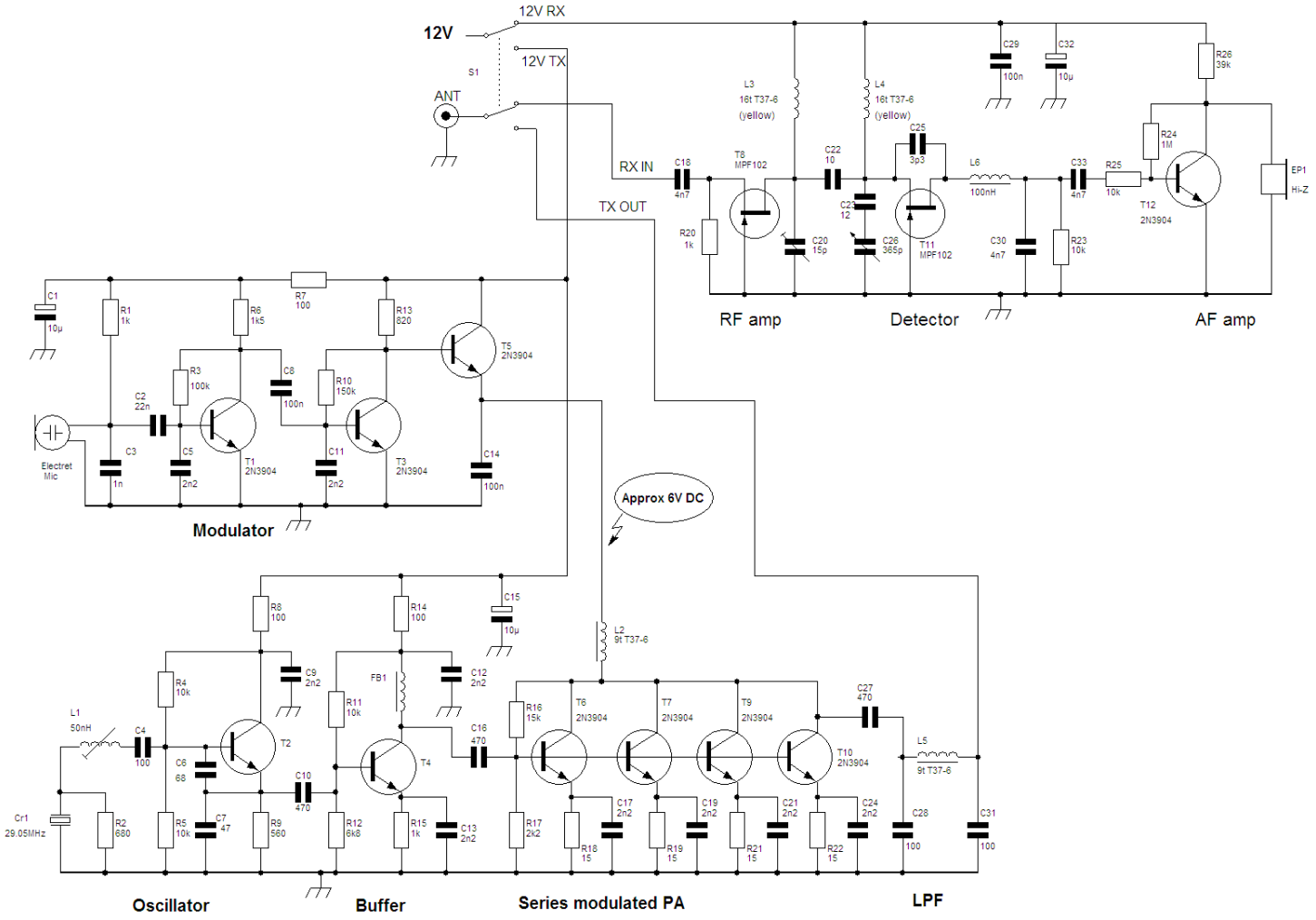
The intended circuit was based on the Sixbox, but with more power. Sadly, my stroke got in the way and this was never completed. It was *not* intended as a rig for DX, although I had no problems copying and separating USA amateur AM stations with the receiver breadboard with a base-loaded whip on the car.

It could do with an RF linear amplifier on the transmitter, and an audio amplifier and a loudspeaker on the receiver. In my mind I thought of a rig a bit like the old Heathkit Benton Harbour Lunchboxes, but far smaller and built on a simple PCB. This would have made a good club project for the times when 10m behaves more like a VHF band such as in the evenings or at sunspot minimum. 10m has lots of space, is very under-used at such times, and the antennas are small, certainly compared with 160m or 80m. CB verticals work fine.

Similar rigs could be built for 4m although I never got around to this. I suspect the toroids would “run out of steam” and some other form of inductors would be needed.

Nothing would give me more pleasure than if this was improved and completed.

The schematic proposal for the transceiver is on the next page. Again, you may like to consider more RF power and a receiver loudspeaker amplifier. I must emphasise that although everything was breadboarded, the full transceiver was never completed.



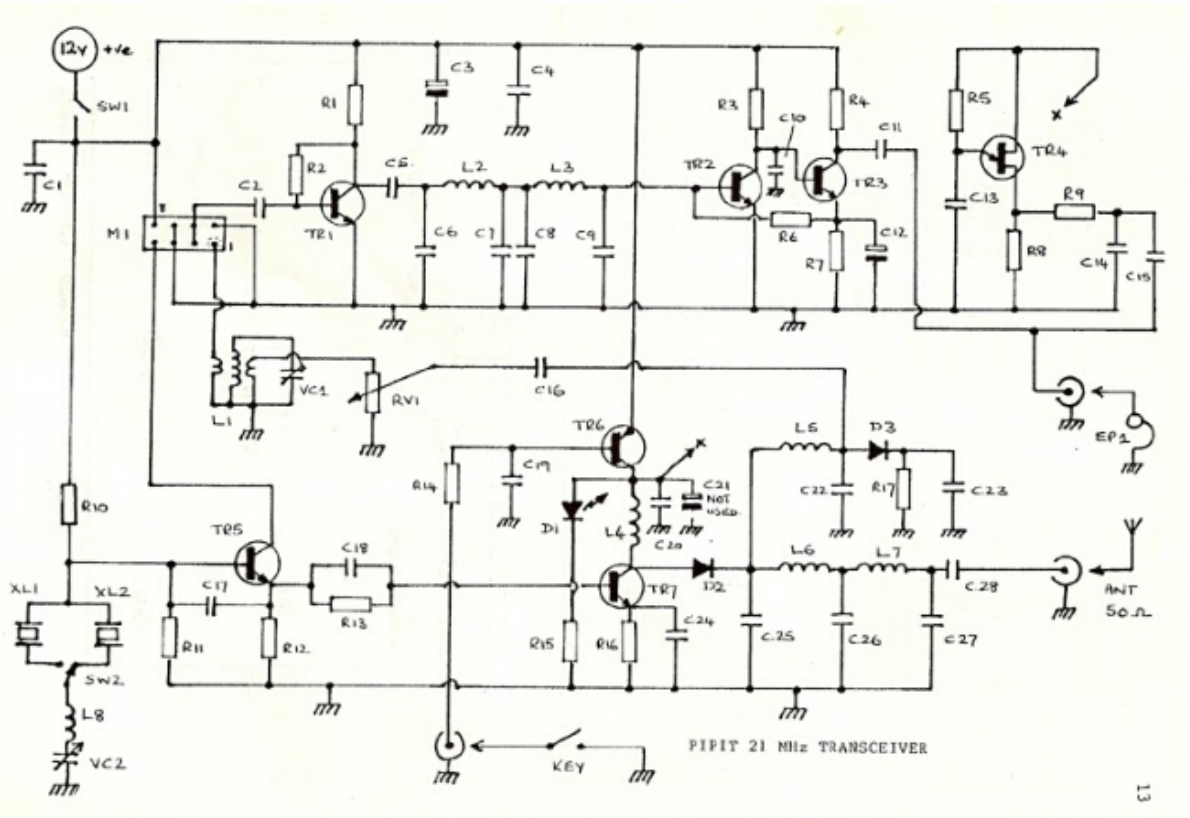
Tenbox 10m 250mW AM Transceiver

Rev A - Dec 1st 2012 **G3XBM**

Does not yet include audio power amp on RX

Provisional (may be some cct errors)

15m Pipit CW Transceiver



This dates back to the 1980s and was my main rig for many months. My very first contact was a station in Chicago some 5000km away and he was on SSB. At the time I only had a crystal in the SSB part of the band. I well recall my amazement when he said, “QRZ the station calling on CW”.

Later, I bought another crystal for the QRP CW frequency of 21.060 MHz. I had loads of fun even though it only put out just 800mW of RF. The design predated me having a schematic capture tool, so it was hand drawn. It appeared in GQRP SPRAT magazine, in 1987 I think. Years later I used the enclosure for the 10m Tenner. I should never have taken it apart! It was a very successful project.

Although there was no attempt at a receiver offset, this seemed to happen by accident as the offset between RX and TX seemed about right. The rig used VXO control to pull the frequency.

For the parts list, see the table. This also shows part of the SPRAT article.

The G3XBM 'Pipit' 21MHz Transceiver

Specification

Frequency Band	21MHz
RX Sensitivity	<0.5uV for 10dB S/N
TX Power Output	approx 0.8W
VXO Range	2 x 15kHz
Break-in	Instantaneous electronic (listen between dots).

Circuit Description

The circuit is loosely based on the OXO transmitter with an SBL1 based DC receiver. It has a full QSK keying system without relays or TX/RX switches being necessary. Only one component, the RX input tuned circuit, needs alignment.

The only gain control is the RF attenuator on the RX input. This is the best place since, whenever possible, it allows the receiver to be de-sensitised giving added protection from overload and breakthrough. In practice, most contacts with QRO stations occur with around 10-20dB input attenuation in line.

PIN diodes were used in the antenna change-over circuit because these were at hand. They could probably be replaced by 1N4148 diodes with only slightly degraded performance.

The toroids used were Neosid rather than the more common Cirkit ones, again because these were at hand but other types could be substituted, maybe with minor turns adjustment.

There is a slight frequency offset between TX and RX as the oscillator loading alters when the TX PA is keyed, the amount of shift being just about optimum for CW! Increasing the turns on L8 will allow further frequency shift with the VXO but the difference between RX and TX frequency can then become too great to be usable.

The TIS43 provides sidetone with R9 and C14 helping to make the note more agreeable to the ear. M1 and TR1 could probably be replaced by a MOSFET mixer with some conversion gain, but this hasn't been tried.

The whole rig is built into a 4" x 4" x 2" metal box using 'ugly' construction on a 3" x 2" copper laminate board for most of the components.

The rig has been in use for about two years and has allowed contacts with 6 USA states and all over Europe using just a wire dipole at a maximum height of 25'. With improving HF conditions 21MHz will be an excellent band over the next few years. The Pipit is easily adaptable to other bands up to 28MHz.

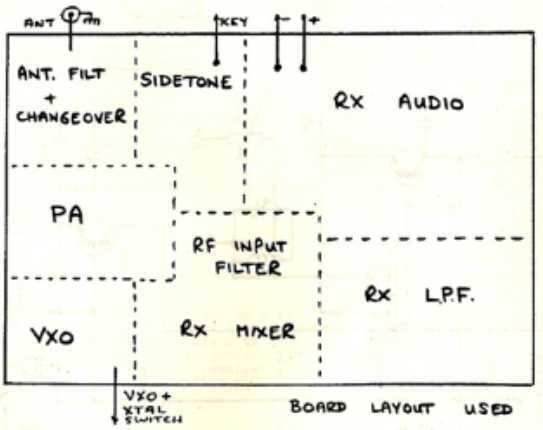
Isn't HF QRP just wonderful!

Roger Lapthorn
G3XBM

L1	20t primary, 1t output, 1t input on 0.25" diam. Neosid 'pink' toroid.
L2,3	82mH TOKO inductor, part number 181LY-823 (Ambit)
L4	20t on 0.25" diam. Neosid 'turquoise' toroid.
L5	4t on 0.25" diam. Neosid 'turquoise' toroid.
L6,7	3t on 0.25" diam. Neosid 'turquoise' toroid.
L8	8t on 0.25" diam. Neosid 'pink' toroid.

Component List - Pipit

R1	6.8k	TR1,2,3,5	ZTX108, BC108 etc. NPN
R2	470k	TR4	TIS43 or similar
R3,10	10k	TR6	ZTX212,213 etc. PNP
R4	1.2k	TR7	2N4427, 2N3866 etc.
R5	100k		
R6,9	47k	D1	LED (red).
R7,12,17	470	D2,3	PIN diode e.g. UM9401
R8	5.6k		(see text).
R11	4.7k		
R13,14,15	1k		
R16	15 (10-39 select on test for 0.8W RF)		
RV1	1k lin.	M1	SBL1 Double Balanced Mixer
C1,2,5,11, 15,16,19, 20,24	0.1uF	XL1	21.050 MHz fundamental
C3	47uF	XL2	21.060 MHz fundamental
C4	1n	VC1	60p variable
C6,7,8,9	0.47uF	EP1	High Impedance Earpiece
C10,23,28	2.2n	SW1	On-off switch
C12	6.8uF	SW2	Single pole - two way
C13	0.068uF		
C14	4.7n		
C17	100p		
C18	27p	Enclosure	4" x 4" x 2" metal
C21	-		
C22	150p		
C25,27	180p		
C26	270p		



10m Simple Sideband Transceiver

Way back, I had a germ of an idea to build a very simple sideband rig for 10m that could be both compact and effective. On 10m, low power can work very long distances by sporadic-E (Es) or F2 propagation.

When I started, I had a low powered DSB rig with a direct conversion receiver in mind. There is certainly plenty of space on 10m so even if power is wasted in the unused sideband, the USB component would still be capable of covering a very long distance. Possibly a phasing SSB transmitter would be better as any suppression of the unwanted sideband would be useful, even if not perfect.

Likewise a direct conversion receiver would be effective.

In my mind the entire circuit could be on a small, single PCB. These days, a synthesizer IC and a small low cost micro-controller might be better than a VXO or mixer VFO. Such synthesized solutions could give full band coverage. Sadly, my stroke got in the way and this idea never progressed. It would be an ideal project for someone to take on board.

For the PA there are several possibilities. A lot of 2N3904 devices in parallel, with a small resistor in each emitter to ensure current sharing would be a low cost RF PA solution. Such an idea is shown in the Tenbox 10m AM transceiver proposal.

This circuit could be done for several different bands such as 15m or 20m. With the synthesizer, the main PCB could probably be very similar on most bands with perhaps just the PA low pass filter, RF phasing (if SSB), and the receiver filter changing.

These days, an SSB simple phasing transceiver might be a better solution, especially for a club project. With DSB, simple transceivers can talk to each other, but tuning is very critical. With SSB, working other locals and DX is certainly possible. As a single band transceiver, the RF phasing may be optimised for that band.

I think this could form the basis of a great club winter project. What it needs is a simple single PCB that is easily duplicated and low cost.

In my view, a simple QRP DSB or SSB 10m transceiver is easily capable of working DX by Es or F2 propagation. Imagine, a small QRP rig that you have built by yourself yet able to talk locally and across oceans, with a very simple and small antenna, not on FT8 or CW, but with speech!

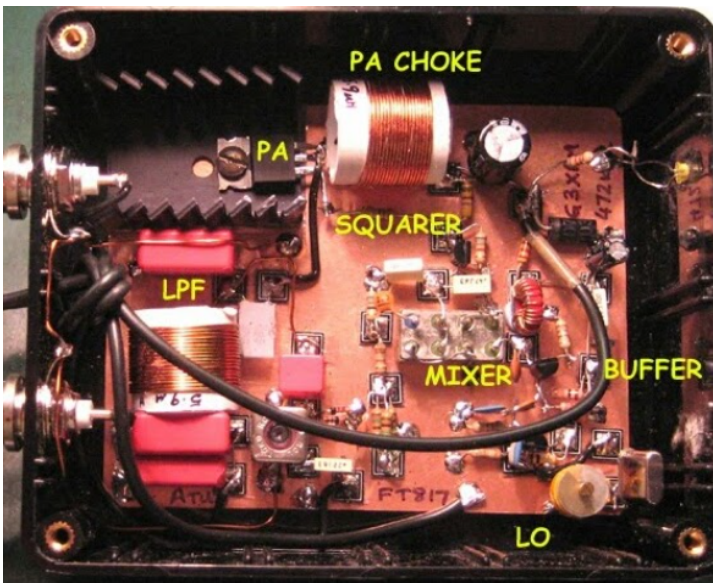
10m (28 MHz) transverter

This was designed and made many years ago. Sadly, I no longer have the circuit or actual unit, although it may be in the loft somewhere.

It went from 2m to 10m and allowed the world to be worked with my MX2 and IC202. It produced about 1W pep on 10m when driven with about 200mW on 2m. You may be surprised how effective 1W pep of SSB can be on 10m.

It was made in a small plastic box.

630m (472 kHz) Transverter



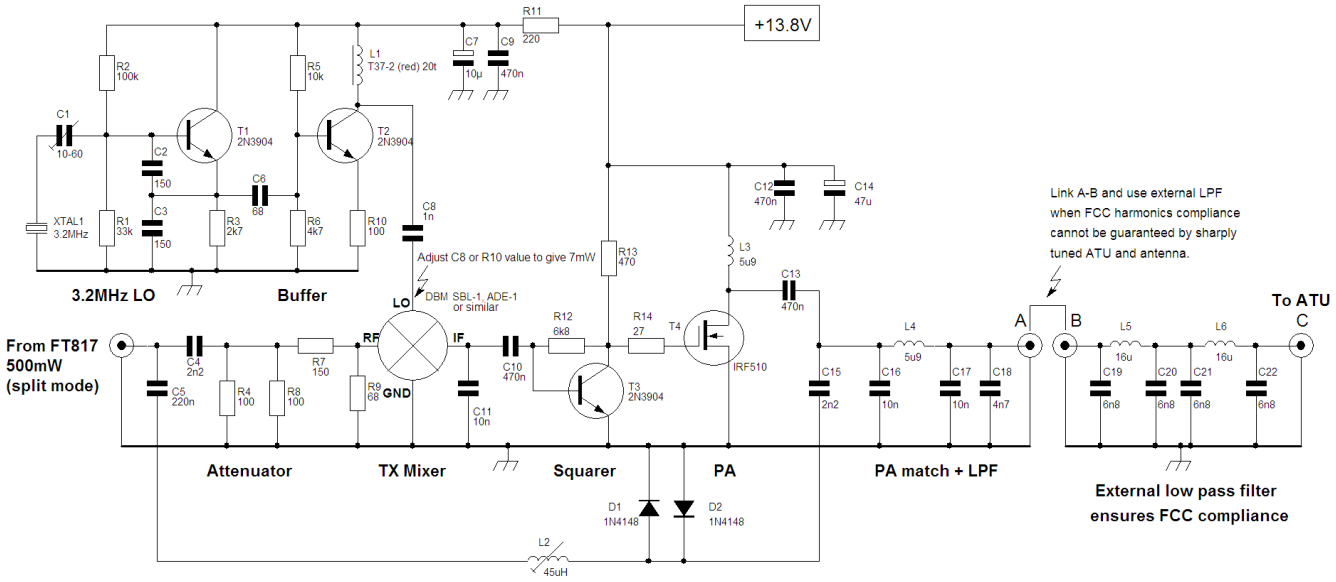
As I had no rigs for 630m (472 kHz) this transverter was designed.

Into a 50 ohm load it produces about 10W although the ERP is likely to be far lower with “real” antennas. I used mine mainly on WSPR and regularly got reports from Finland over 1700km away when using my earth-electrode “antenna” in the ground. The design appeared in QST some years ago and it has been in an RSGB book. Several people have built versions including at least one that used SMD devices. It provides a simple way of getting on this band.

I have used mine on WSPR and JT9, but it should be usable with any mode that uses a constant amplitude.

The SBL1 double balanced mixer was used as it was at hand. Other mixers would almost certainly be suitable. Mine used hand wound coils wound on PVC pipe in the main.

The schematic is on the next page.



472/500kHz TX/RX Transverter

G3XBM Rev L - Nov 15th 2012

Minor errors corrected

Notes:

FT817 Tx on 3.672-3.679MHz, RX on 472-479kHz (split mode)
10-15W RF @ 13.8V
L2/C15 series resonant at 475kHz
On TX D1/2 conduct and C15 forms part of LPF
L2 is TOKO KANK3333 or Spectrum Communications 45u0L

SBL1 Pin 1=RF, 3,4=IF, 8=LO, others ground
ADE-1 Pin 3=RF, 2=IF, 6=LO, others ground

For higher power transceivers scale input attenuator

4m (70 MHz) Transverter

Some years ago, I needed a way of getting on 4m. The last time I was on 4m was in a contest in 1971 and, before that, at university in 1969 when ZB2VHF was worked with 4W of AM on 70.26 MHz with some surplus gear from WW2.

This simple transverter from 28 MHz resulted. It produces a few watts. It was in GQRP SPRAT magazine. I am sure the circuit could be improved, possibly by using a different output device to give a bit more power. As with many of my designs, it is a compromise.

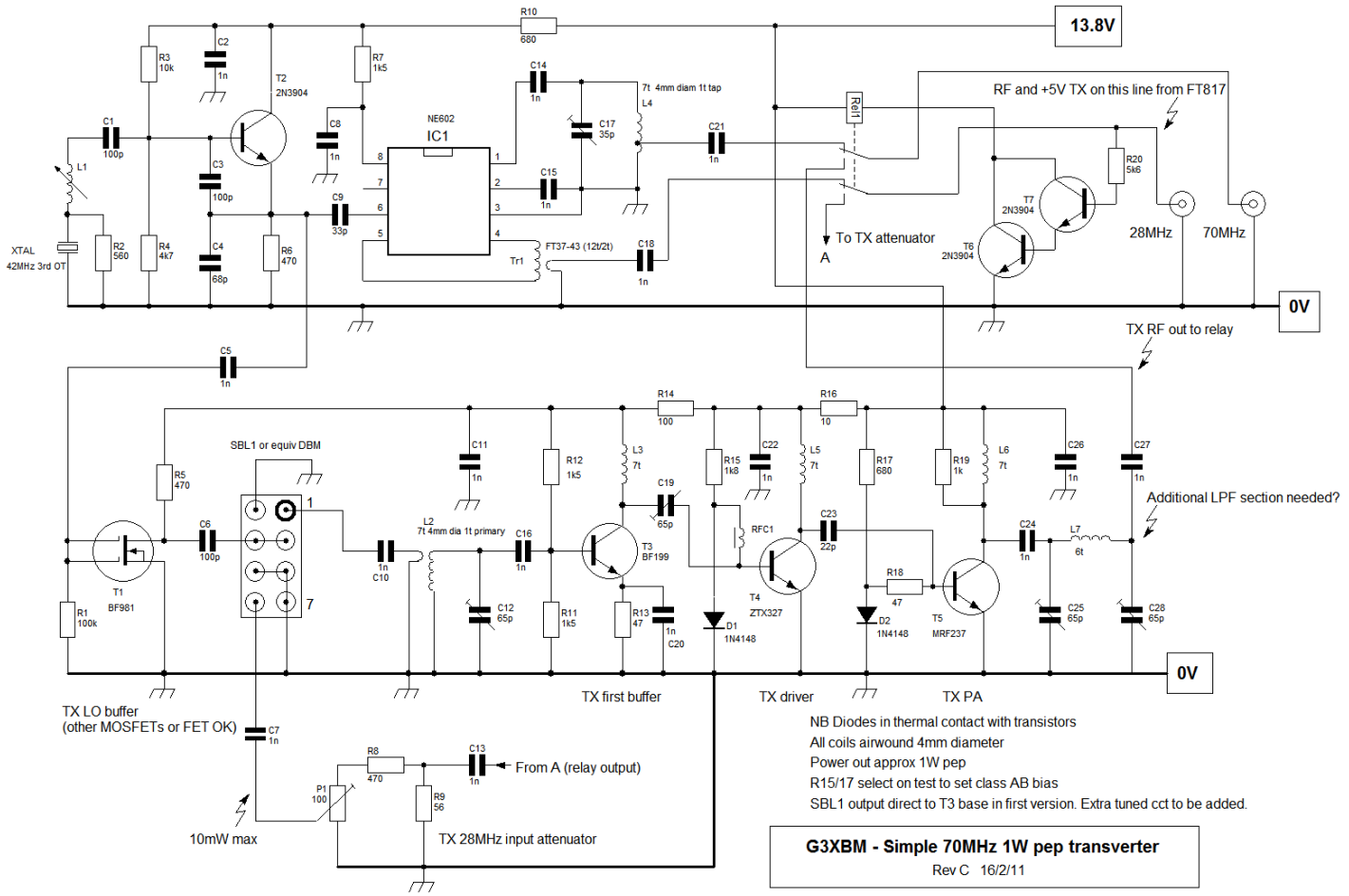
It has worked some decent DX with just a wire dipole. With far more Europeans now on the band, I am sure many of these would be within range by Es propagation, even with just a halo or dipole and a few watts.


SPRAT
THE JOURNAL OF THE G QRP CLUB
DEVOTED TO LOW POWER COMMUNICATION
ISSUE Nr. 174 | G-QRP-CLUB | SPRING 2018

May I use this opportunity to plug SPRAT and the GQRP club? In the past I have said many times that if I had to give up most magazines, then SPRAT would be the last to go. It comes out every quarter and is filled with ideas for future projects. It is produced entirely by volunteers and represents incredible value for money. Members may buy back issues of SPRAT on flash drives. It is almost worth joining for this alone.

http://www.gqrp.com/

The schematic is shown on the next page. You may have to zoom in to read the values.

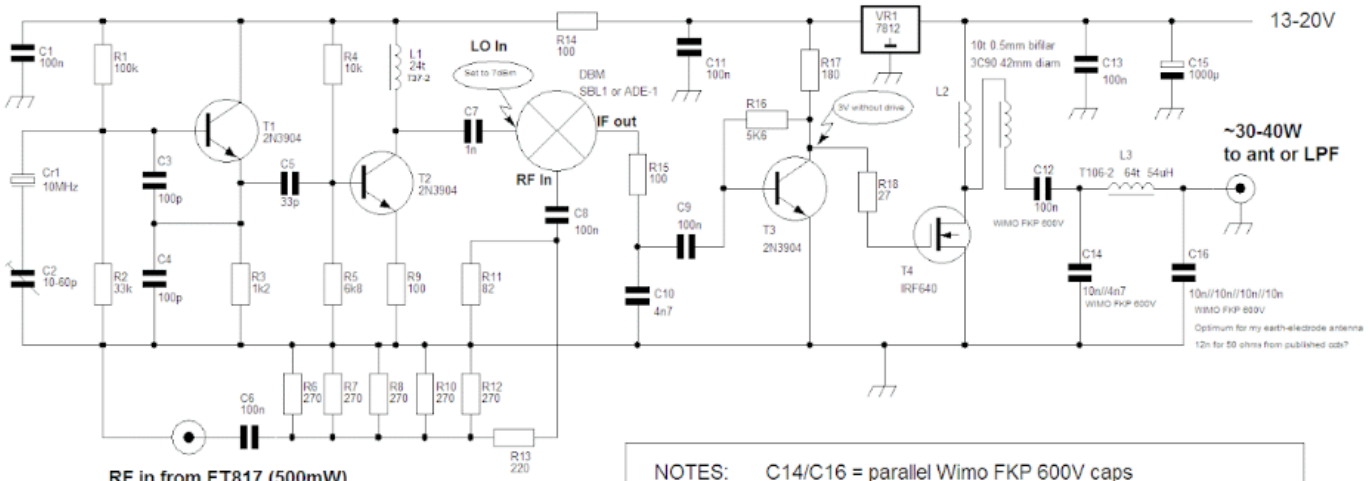

13.8V
R10
680
R3
10k
C2
1n
T2
2N3904
R7
1k5
C14
1n
7t 4mm diam 1t tap
L4
C17
35p
C21
1n
Rel1
RF and +5V TX on this line from FT817
C1
100p
L1
C3
100p
C8
1n
NE602
IC1
C15
1n
R20
5k6
T7
2N3904
C9
33p
XTAL
42MHz 3rd OT
R2
560
R4
4k7
C4
68p
R6
470
FT37-43 (12t/2t)
Tr1
C18
1n
To TX attenuator
A
T6
2N3904
28MHz
70MHz
0V
TX RF out to relay
C5
1n
R14
100
R16
10
SBL1 or equiv DBM
C11
1n
R12
1k5
L3
7t
C19
65p
R15
1k8
C22
1n
L5
7t
R17
680
R19
1k
L6
7t
C26
1n
C27
1n
Additional LPF section needed?
R5
470
C6
100p
T1
BF981
R1
100k
L2
7t 4mm dia 1t primary
C16
1n
C10
1n
T3
BF199
RFC1
C23
22p
T4
ZTX327
R18
47
D2
1N4148
T5
MRF237
C24
1n
L7
6t
C12
65p
R11
1k5
R13
47
C20
1n
D1
1N4148
C25
65p
C28
65p
0V
TX LO buffer
(other MOSFETs or FET OK)
TX first buffer
TX driver
TX PA
C7
1n
R8
470
C13
1n
From A (relay output)
P1
100
R9
56
10mW max
TX 28MHz input attenuator
NB Diodes in thermal contact with transistors
All coils airwound 4mm diameter
Power out approx 1W pep
R15/17 select on test to set class AB bias
SBL1 output direct to T3 base in first version. Extra tuned cct to be added.
G3XBM - Simple 70MHz 1W pep transverter
Rev C 16/2/11

2200m (137 kHz) Transmit Transverter

Although this was built initially as a transmit transverter, the same idea as the 472 kHz transverter would make it into a full transceive transverter. As the FT817ND is a bit deaf on 137 kHz, a receive pre-amp would be needed to allow effective use at LF. There is a video about this on my G3XBM video channel.

See https://www.youtube.com/watch?v=QHGLkA25MQA

The schematic of the transmit transverter is on the next page.



RF in from FT817 (500mW)
at 10.136kHz USB (for WSPR)

137kHz TX Transverter

Rev A 5.2.13 G3XBM Copyright 2013

NOTES:
- C14/C16 = parallel Wimo FKP 600V caps
- C12 = 3 x 470n in series (could be 1 WIMO FKP 100n)
- R17 = 2 x 390 in parallel
- External (v.stable) LO injected at "LO in" (if rqd) removing C7
- Adjust C7 to give 7dBm at LO port of DBM
- Additional LPF needed where antenna not high Q
- LO freq choice unimportant, but lower will give less Hz drift
- Keep crystal thermally isolated from PA
- L2 Farnell order code 1784187 (3C90 toroid)

70cm transverter

When I first came to Cambridge, I made a very simple transverter to get on 70cm AM. The circuit came from VHF Communications magazine. The circuit is long gone I am afraid, although back issues of VHF Communications may still be available on the Wayback Machine on the internet. The Wayback Machine is at https://archive.org/web/. You may find other sources.

With just a 4 element yagi made from pieces of copper laminate it got me about 160km to Sheffield when out portable on a local hill. Yes there are a few hills in Cambridgeshire!

In those days (1970s) a CQ call from a local hilltop on 70cm AM would result in a QSO with a local up to about 50km away. I think this was before the time when class B licencees were given access to 2m, so activity on 70ms was good. Also, this predates the Internet, so people used amateur radio for chats. There was no Internet and no CB.

As I remember, it used a varicap diode as a tripler on TX and as a mixer on receive. Being a passive mixer with no pre-amp, the noise figure must have been dreadful, but it worked. With most stations being crystal controlled, the fact that the transmitter was on a different frequency from the receiver did not matter.

In those far-off days it got me going on 70cm. These days, getting on 70cm is far easier.

It is a pity that it is still not in the junk box. It would be good to have it for sentimental reasons.

2m AM transceiver

This is in the wrong place, but is included for completeness.

This was a transceiver based on the PF2AMB with a tunable receiver and, I think, 6 crystal controlled transmit frequencies. It produced 500mW. It was built in an aluminium box covered in wood effect Fablon. Sadly, I do not have the circuit. In the photo it is the rig to the right of the EC10 with the black and white meter. It was used in the early 1970s, before most moved to FM!

Over-the-horizon Optical Communications
Non-line of-site (NLOS)

My main interest in optical communications was over the horizon beaconing with slow morse. I was surprised that with nothing visible in the sky, good copy could be obtained on a PC many kilometres away and well over the horizon.

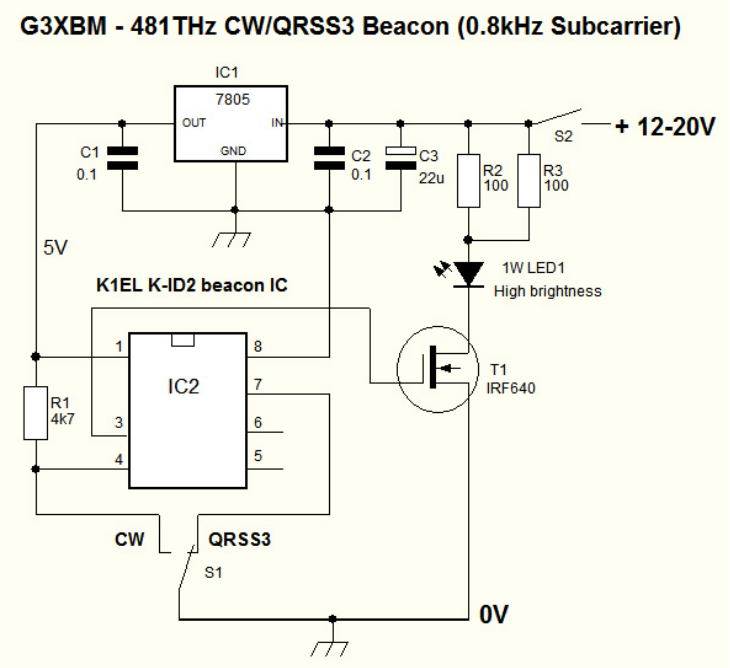
The other thing which surprised me was that the optical gear and test equipment was easy to make in the back of the garage. In fact, it was easier than microwaves. All the optics we made from PVC drain pipes bought from a local hardware store and magnifying glasses bought from local discount stores.

Judging by my results, *much* further is possible. Indeed the world record is well over 100km over-the-horizon. Some have bounced signals off the base of clouds, but my own over-the-horizon work was on clear nights with no clouds, suggesting this was scattering off dust particles. On some occasions nothing could be detected whereas at other times signals were 20dB over the noise. One thing I recommend is a decent tripod. Mine was a bit flimsy and a sturdier one would be better.

This is definitely an area of experimentation open to all and right at the frontiers of our hobby. I don't think this needs a licence either. It is also great fun.

481 THz optical beacon transmitter

This beacon was built so I could range test my optical signal over the horizon (NLOS).

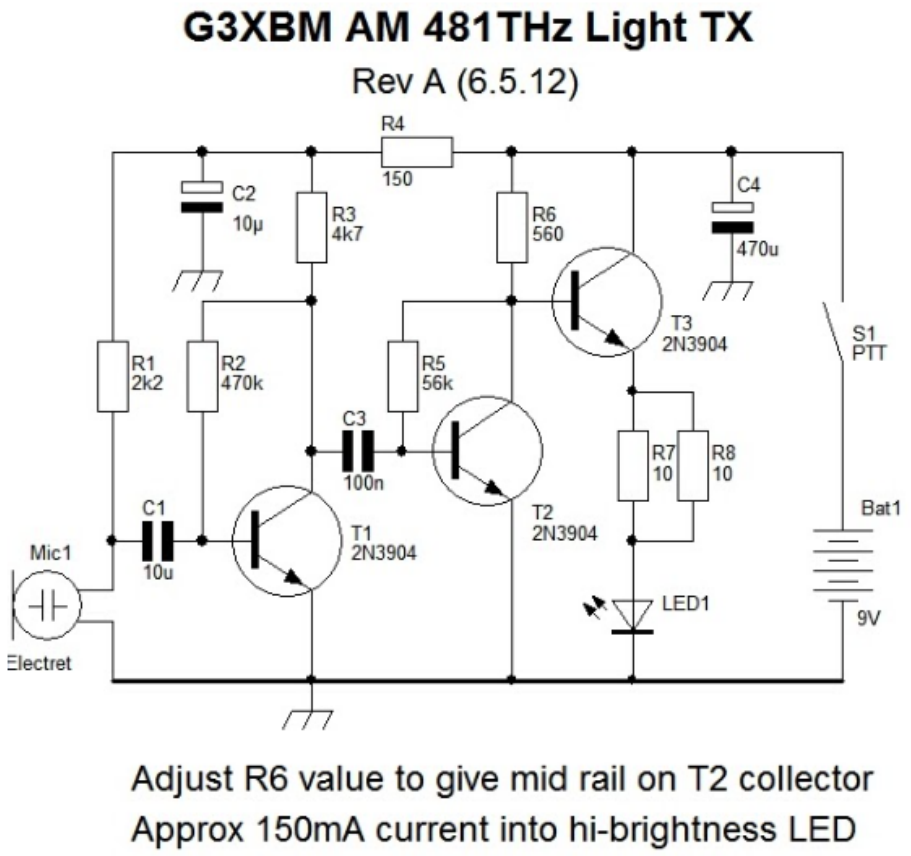


481 THz AM transmitter

This was made for some line-of-sight tests. Good signals were received over an 11km path with a fellow local.

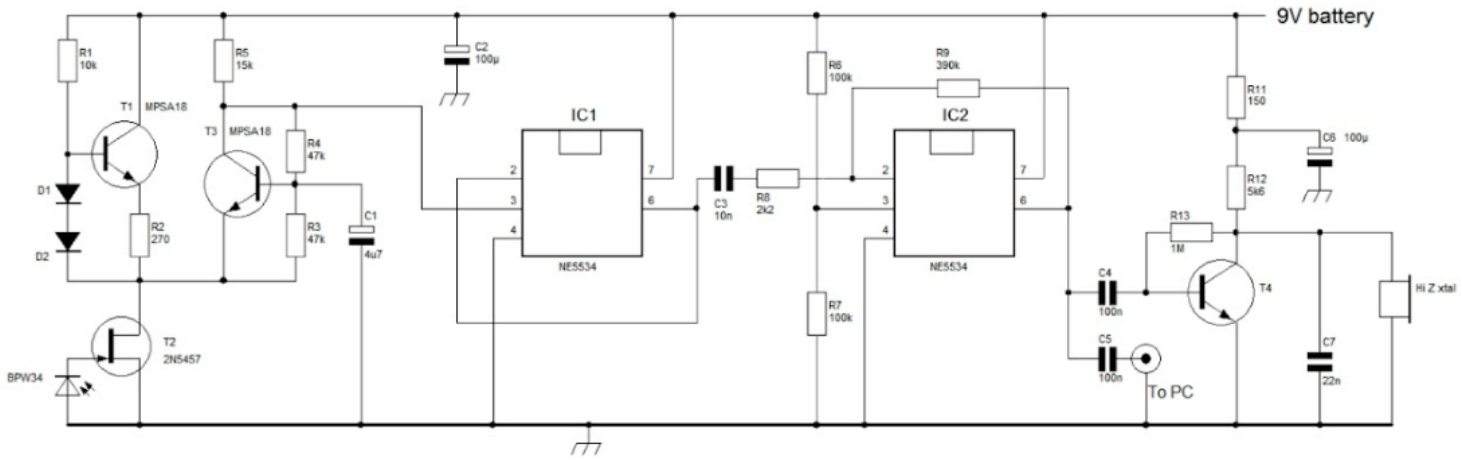
My “thing” has been weak signal optical beaconing over the horizon, but I used this simple AM transmitter for a line-of-sight contact some years ago.

It is simple, but works. I obtained the LEDs from eBay. I bought some more powerful Flatlights, but these were never used. They should have made my signal 6dB stronger. For optics, I used 100mm magnifying glasses from Poundland in PVC drainpipe. With a Fresnel lens, more gain is possible. For really long line-of-sight paths this may be an advantage. I have never used these.



481 THz Optical Receiver

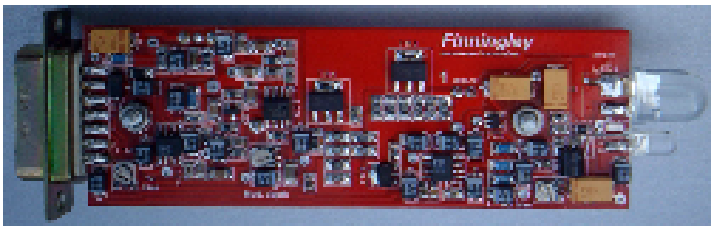
This receiver proved very sensitive in the dark. It is based on one by K3KCP, which I found on the Internet. Cheap 100mm Poundland magnifying lenses in PVC drain pipes were used. If using it in daylight you might find it gets desensitised by strong lights and sunlight. Most of my tests were done in the dark.



G3XBM 481THz Optical Receiver
Rev A (based on KA7EOI and K3KCP designs
27.2.2012

Finningley optical transceiver

This was my only SMA project and it was built shortly before my stroke, so was never used. It has since been sold.



With 100mm lenses it is capable of at least 65km range line of sight. I have heard from others that it works very well.

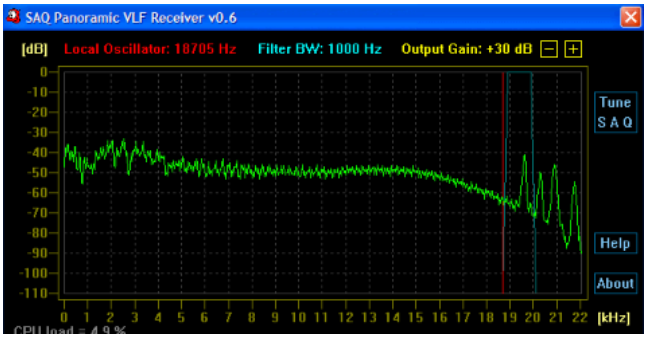
Amateur VLF

One of my interests was amateur radio below 10 kHz. This is quite different from amateur radio at higher frequencies.

A casual listen is extremely unlikely to lead to success. Many amateur radio successes sub-10 kHz have needed extreme stability and integration of the received signals for hours or even days. I have received amateur signals under 10 kHz from across Europe with my receiver locked to a commercial VLF MSK signal to allow great stability over very long periods of time. For sub-10 kHz radiated DX big antennas and high power are needed. For receive only, tiny E-field probes or loops are perfectly fine and these can be very small.

For amateur earth-mode, the system can be very simple and I have covered 6km with just 5W. This is a form of VLF amateur radio open to all with simple, homemade gear.

VLF Software Receiver



I found this on the internet some years ago. It is very simple and works very well. Mine tuned up to about 22kHz. Bandwidth is adjustable. It was originally intended as a receiver for SAQ, the heritage alternator TX that sends CW on 17.2 kHz VLF on special occasions.

I am pretty sure there have been developments since then by others. Google for others!

See https://sites.google.com/site/sm6lkm/saqrx-vlf-receiver

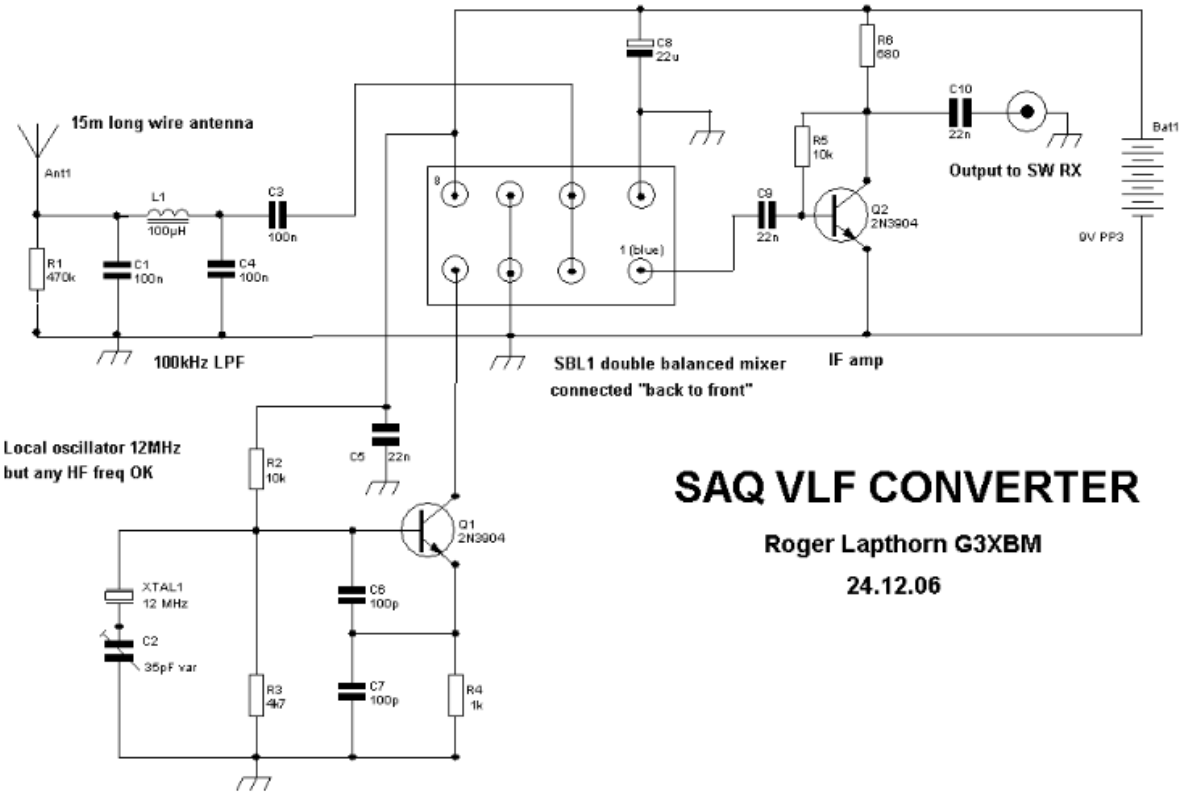
See this on my YouTube Channel.
https://www.youtube.com/watch?v=TDxRhQYg7lQ

VLF up-converter

Some years ago I was looking for a simple VLF upconverter for up to about 100 kHz. This was mainly to explore what was “down there”. Since my design appeared, others have suggested improvements that are also shown here. I have no doubt that my design could be improved as it was just “thrown together”. As I had loads of 12 MHz crystals, these were used. You may have other frequencies that may be equally suitable.

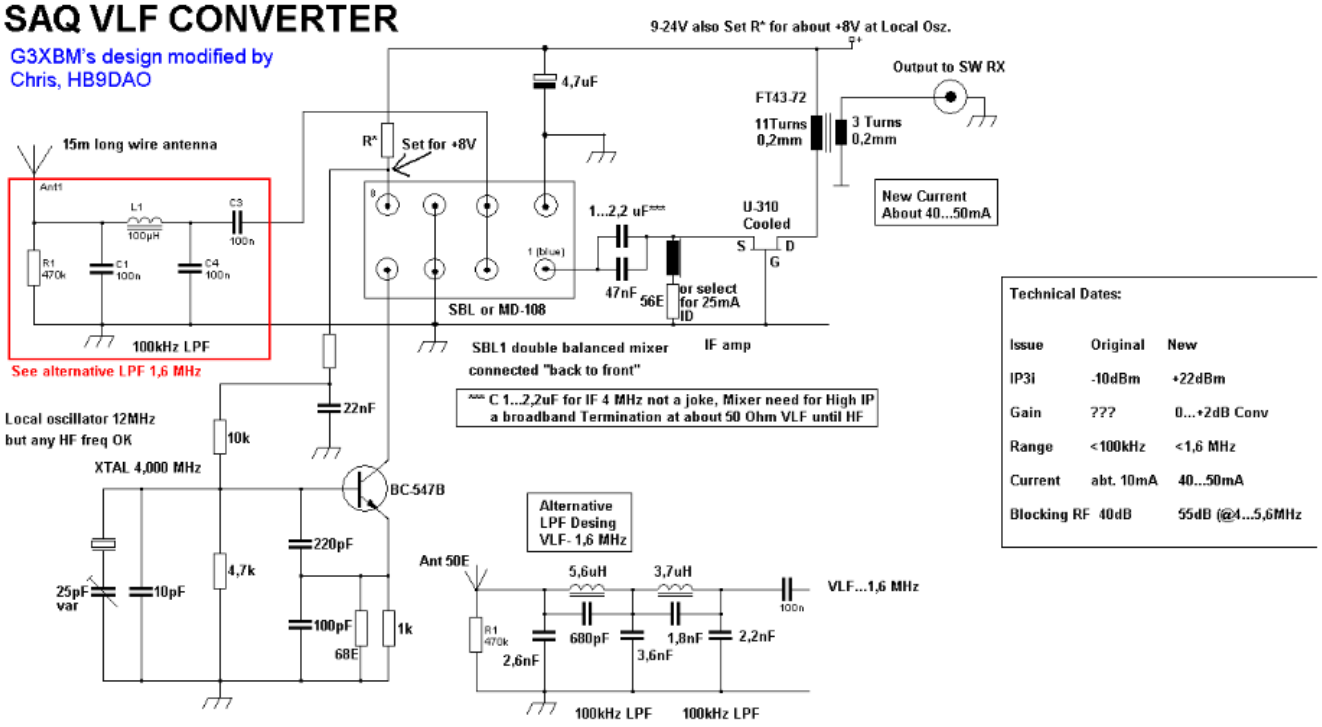
As it was, it was good enough and allowed lots of VLF stations to be copied on an HF receiver. If the SBL1 is hard to find, I am sure there will be similar double balanced mixers that will work too. As external noise dominates, I went for a passive mixer and no RF amplifier.

By changing the input filter, the range could be changed. I chose the values to attenuate LW and MW broadcast signals. You could increase the cut-off to allow higher frequency signals through or lower to attenuate them even more. Ideally choose a quiet IF to avoid shortwave stations breaking through. Some shortwave stations can be *very* strong! Ideally choose an IF that is quiet.



SAQ VLF CONVERTER

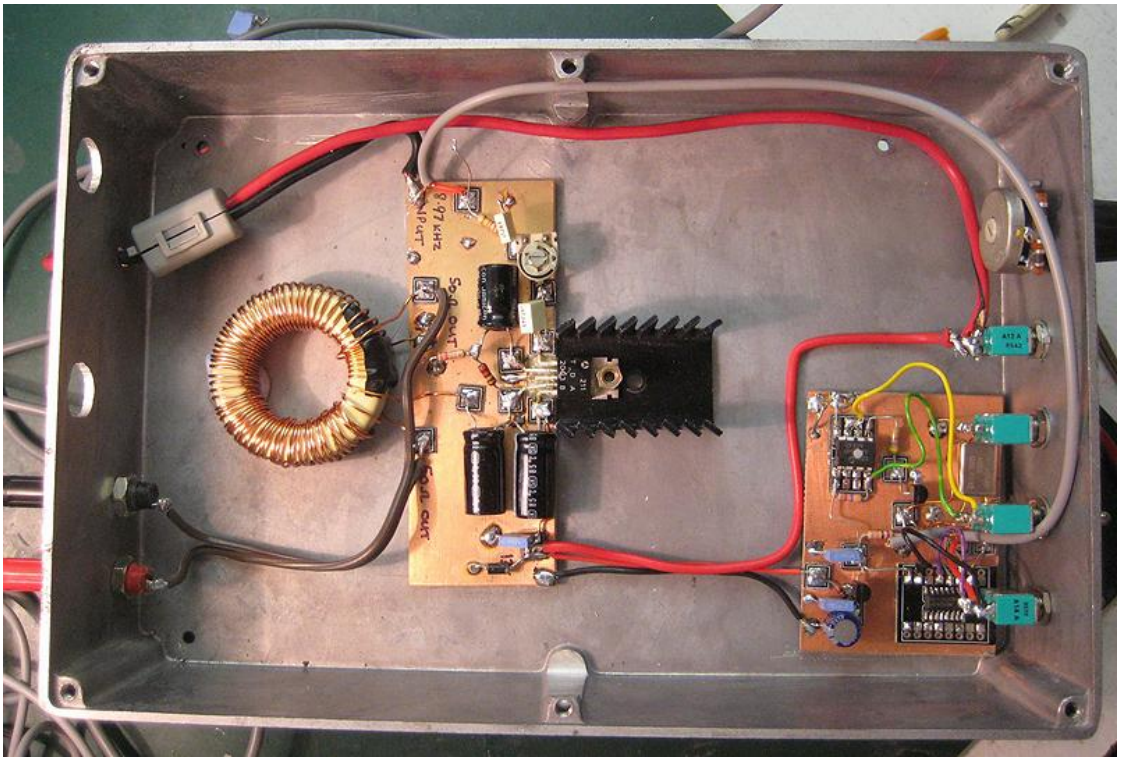
G3XBM's design modified by
Chris, HB9DAO



Technical Dates:		
Issue	Original	New
IP3i	-10dBm	+22dBm
Gain	???	0...+2dB Conv
Range	<100kHz	<1,6 MHz
Current	abt. 10mA	40...50mA
Blocking RF	40dB	55dB (@4...5,6MHz

5W transmitter for VLF earth-mode

This 5W transmitter was made for VLF earth-mode at around 8.9 kHz, which is basically conduction communications though the ground. It used a TDA 2003 audio IC intended for audio hi-fi applications and was matched to my earth-electrode transmitting “antenna” in the ground.



Using QRSS (slow CW) it achieved a range of 6km using pipes or other metal work in the ground (I think). As far as I know OFCOM is not interested in licencing such methods of VLF transmissions. As I am not a legal expert you need to seek your own legal opinion.

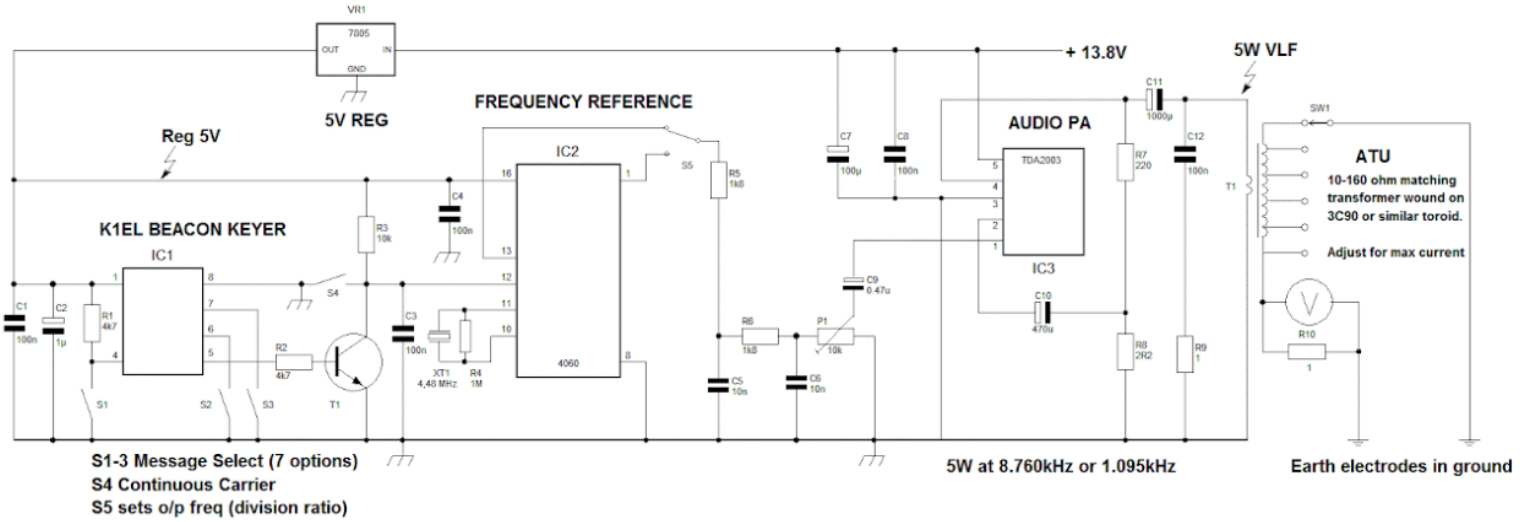
Much greater earth-mode ranges should be possible even with this low power. With more power and greater lengths between the earth-electrodes far greater ranges are possible. In the end, the *radiated* component will become significant and ranges much further will become possible. Indeed, some have used earth-electrode antennas to radiate VLF and ULF amateur signals over amazing distances.

I am not sure what radiated ranges are possible with higher power from back gardens.

For this, GPS or similar frequency locking will become very important so the signal can be integrated for hours or even days. Such radiated signals will need licences in some jurisdictions.

In many parts of the world, 8.27kHz and below do not need a licence.

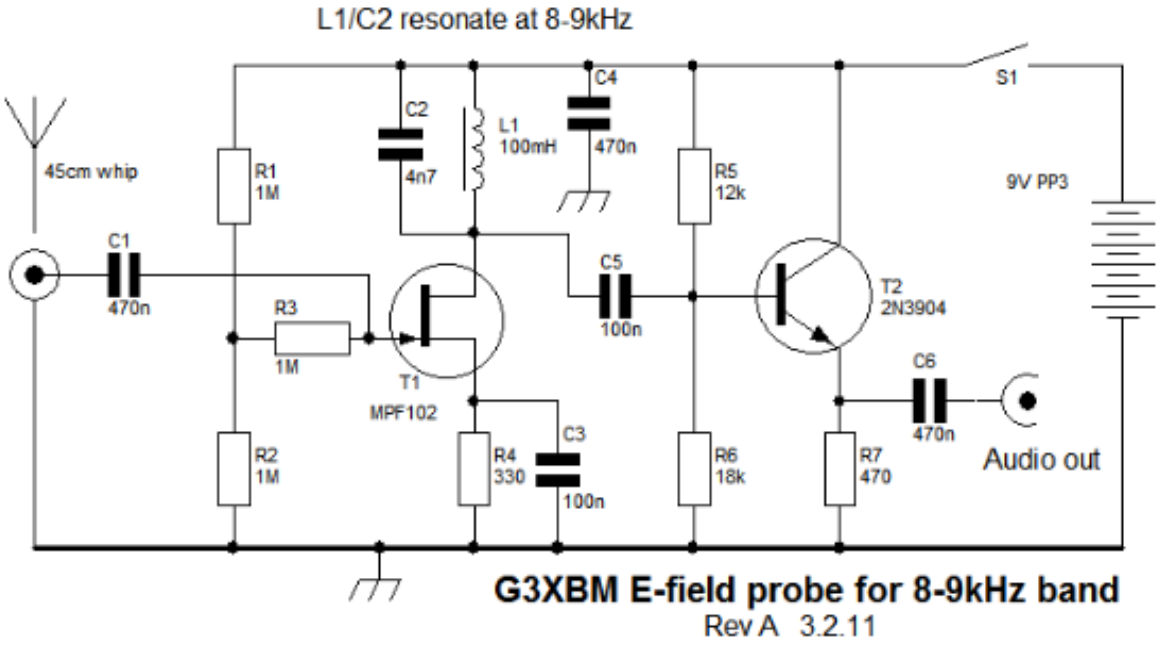
This is the schematic of my beacon used in earth-mode tests.



VLF E-field Probe Preamp

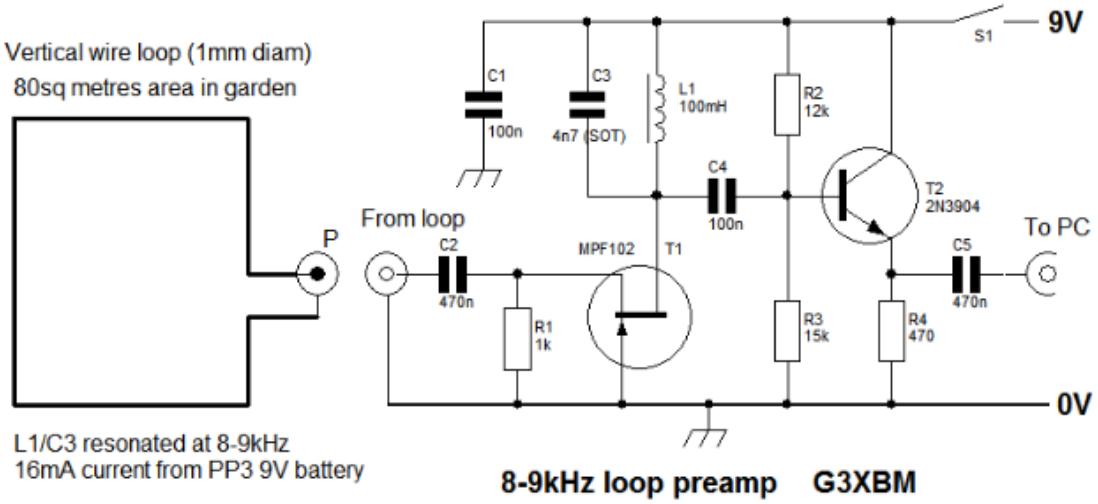
If you want an E-field probe for VLF, this preamp may be useful. It uses a resonant circuit, which helps gain at the receive frequency, the tuned circuit is adjusted so it peaks at the receive frequency. Mine was tuned to 8.97 kHz, but most amateur operation is around 8.27 kHz as in some countries a licence is not needed.

The photo shows a friend holding the E-field probe when I was receiving an earth-mode signal from a friend 3km away. The strong signal is shown on the PC screen.



VLF Loop Preamp

This tuned preamp was used with my 30 turn portable loop at VLF. This was mainly used for VLF earth-mode tests. The loop was resonated to peak at the receive frequency. Best results on utilities assisted earth-mode reception were with the loop on the ground, presumably as this gave good coupling into the utilities in the ground.



8m Projects

Many years ago I got a Notice of Variation (NoV) to my amateur licence to operate around 9 kHz. In their wisdom (or is it ignorance?) OFCOM decided that it did *not* want to issue NoVs at 8m and instead wanted money for a Test and Innovation (T&I) licence. These are not Amateur Radio in the UK so licence holders are not allowed to “work” amateur radio stations. We can get reports from others in the UK and abroad if we give them permission.

There are no commercial amateur rigs readily available for 8m and all OFCOM had to do was allocate just 5 kHz at 8m by NoV, restrict the ERP, and restrict the modes to narrowband digital only on a strictly non-interference basis. This would have allowed serious “self-training” and advanced radio propagation science.

OFCOM, and the RSGB (?) do not seem to want an amateur band at 8m, despite this being at a very interesting part of the spectrum. In my view this is crass stupidity! I suspect the military has to approve and they want to hang on to spectrum and keep the “plebs” out. OFCOM has said it does not want “more of the same”, which I can understand. What I want at 8m is serious experimentation and self-training!! At the same time they can find 2 MHz of precious VHF spectrum primarily aimed at DATV research around 71 MHz and 146 MHz. I am not complaining about this, but it does seem that begrudging just 5 kHz for serious propagation research seems a bit odd.

In my case, my “experiment” is to find out how QRP and simple low antennas work at 8m. My rig is a modified FT817ND, that covers 40 MHz by tuning down from 50 MHz. My mod was done by the dealer. Tuning upwards from 28 MHz did not work as TX coverage seemed to stop at 33 MHz. In all, my QRP FT8 8m signals have been spotted in 22 countries, mostly by sporadic-E (Es) propagation. On receive, my best reception were of stations in South Africa, which I suspect were a combination of Trans Equatorial (TEP) and Es propagation. 8m stations with a higher ERP have worked some remarkable 8m DX with FT8. On TX, the furthermost is the Caribbean.

In all, I have been spotted on FT8 by many locals and several stations by sporadic-E, mostly in Europe. The main limitation at the moment is the number of monitors. Better equipped European stations with big beams and far more power have been spotted in the Falkland Islands and in South Africa and worked the USA from Europe.

My antenna is just a low wire dipole. This seems not to get my QRP FT8 or WSPR to more distant UK stations, but does get me into Europe and the Canary Is by Es propagation. Signals on Es can be very strong.

In summary, 8m is a fascinating band at the boundary between HF and VHF. We can only hope that OFCOM and the RSGB see sense and change their minds so we can all enjoy it. In the meantime there is nothing stopping you giving those with 8m transmit permits your reports. They would be much appreciated.

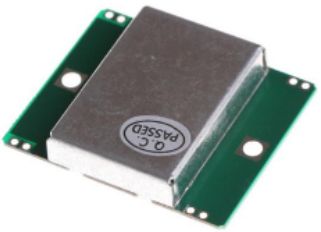
Let's hope 8m becomes a future amateur band and that OFCOM and the RSGB see sense.

There has been discussion about access to the 40.66-40.70 MHz ISM band by *non-licenced* people at very low power. In certain countries such access may be legal. If this is so, many more people may be able to operate on 8m using FT8 or WSPR. It would appear that anyone in the UK may beacon 40.66 - 40.70 MHz *without a licence* as long as the technical requirements and IR 2030 are met. In the UK this means 10mW ERP maximum in this ISM band. On WSPR this could, at times, span 1500km by Es. Local tests have proved that 17km *at least* can be spanned with non-resonant receive antennas with WSPR. Not being a legal expert, you will have to check if my interpretation is correct. My interpretation was that this is legal. Not having been inspected in 50 years, I cannot imagine OFCOM having an interest as long as we accept interference and cause no interference.

The Cornish beacon GB3MCB has been granted permission to add 8m and 5m beacons, but only with a (paid for) T&I permit! Sorry, but to my mind this is STUPID!!

Rigs that did *not* get made

Since my 2013 stroke, my experimentation has largely stopped. There are a few things that I *wish* I had done. It would not surprise me if others have already done these!



One is a simple wideband FM transceiver for 10 GHz based on the HB100 Doppler radar module. These can be obtained on eBay at very low cost. They are the modern equivalent to the Gunnplexers. It should be possible to make a very simple wideband FM transceiver based on these, even without any microwave engineering if the PCB antennas are used. Coupled with a dish, great ranges should be possible. In Italy, well over 100km ranges have been possible with these and dishes on ATV.

A very long time ago a 10 GHz Gunn diode oscillator was made in some non-common waveguide.I think this was WG18. After a few tests over a few metres it was abandoned.

Similar Doppler modules are available for 24 GHz, so I expect someone has built a 24 GHz wideband FM transceiver around these.

Another area not tried is amateur television. With digital TV and narrower bandwidths some remarkable ranges become possible. As they say though, we can only do so much! I have received slow scan TV on the HF bands, but never transmitted SSTV.

I have dabbled with amateur satellites, but not seriously. It seems odd to me that Oscar 100, the geosynchronous satellite, never really took off. I guess more and more amateurs are “appliance operators” using commercial transceivers. For these people, I guess getting going on Oscar 100 is just too difficult! Sadly, some amateurs seem to know remarkably little!

Oscar 100 would be popular if there was a black box rig available, although I think this unlikely from Japan as there is no home market and no USA market.

Pedestrian Portable Operating

One of my interests used to be pedestrian portable operating, usually from some place on the clifftops. Sadly, this is less possible these days.

When HF conditions are reasonably good, it is time to get out in the great outdoors and work some HF and 6m DX with the hand portable rig. Here I am talking about true handheld operation rather than setting up a portable QRP station with a "proper" antenna. During the last sunspot maximum it was possible to work some impressive DX using just a 2.5W portable, a base loaded whip antenna and a short counterpoise wire. This is intended to give you a flavour of what is possible and what can realistically be expected.

Many people assume that QRP DXing requires CW or digital modes. Certainly these are effective modes, but nothing beats actually TALKING with someone thousands of miles away from a handheld transceiver. So, what do you need?

- A QRP portable transceiver - something like the FT817/FT818 is ideal producing 2.5W from its internal battery and with enough energy to last an hour or two of casual operating, with the NiMH pack at least. Second hand Mizuho single band HF rigs are also a possibility. The IC-705 is another possible rig but is more of a manpack. Another possibility is a homebrew DSB rig especially on a band like 10m or 6m. Another possibility is the KX2 or KX3 from Elecraft.
- A whip antenna - several people make lightweight base loaded whips for the higher HF bands. Choose one that is not too heavy i.e. a single band version. A whip with the loading coil some way up the antenna would be slightly more efficient but I've not found a commercial source of such antennas. An ideal antenna is one for 15m which can also be used on 12m and 10m by reducing the whip length when extended to obtain best SWR on the band on which you are operating. Antennas such as the Miracle Whip are fun, but several S-points down on a good single band whip in my experience.
- A wire counterpoise - this consists of a short length of wire attached to the ground point of the transceiver and which is cut to a length to

suit the band in use. In practice, one for 15m will be OK on 12m and 10m.

- A small notebook to log contacts or a portable voice recorder in which you can dictate calls, reports time, date etc.
- A Morse key - if an SSB QSO gets marginal then swapping to CW is worth another 10dB. However, these days not all SSB operators can read CW.
- A pencil or pen - all too easy to leave at home!
- A case to carry all this in - ideally a small waterproof case suitable for SLR cameras is ideal. These come with internal dividers that can be adjusted to suit the camera and lots of zip pockets to house antennas, Morse keys, mics, pencils and paper.
- Some modern rigs have built-in logging and recording.
- The IC-705 has a voice recorder and GPS built in so you can record QSOs and know your QTH locator.

Well, anywhere is possible but some locations offer better chances of success than others. For example, operating on clifftops seems particularly good, with good low angle take-off in the direction of the sea if the ground slopes away steeply. Such locations are worth many dB of effective "gain". I believe Les Moxon (famous for the Moxon antenna design) did some work on such sites back in the 1980s and used them to work the Antipodes with 1W QRP. Height, as such, is less important on HF than on VHF. What is more important is a clear take-off in the direction you're interested in and ground sloping away from you in the direction of interest.

Another obvious consideration is interference: working portable in locations well away from man-made noise sources is a great pleasure. So, getting out away from built-up areas can help reception.

Think about the impact of your operating on others. Operating on a quiet and lonely hilltop site is one thing, but a clifftop path frequented by walkers may be less suitable with people walking by being annoyed by this weirdo talking loudly into a black box with a long wire attached! In the picture above I was sitting on a seat in Devon on the SW Coastal Path and had people walking by about every 10 minutes. I stopped operating if anyone wanted to sit on the adjacent seat, for obvious reasons.

As with QRP SSB from home, the most successful technique is " hunting and pouncing" rather than calling CQ. Find stations ending a QSO and try giving them a call, or call stronger stations calling CQ. Don't waste time calling weak

stations unless you are sure they are also QRP too. The difference in S-points needs to be such that the distant station has a reasonable chance of hearing you, so choose stations running at least RS58 to have a decent chance. You may get lucky but this sort of approach gives you the best results. Once you have a QSO and mention you are "pedestrian portable" and running a handheld others may call you. Adjust a whip antenna for lowest SWR carefully as some rig's PAs do not like large mismatches. Listen a lot and call when you have a good chance as this reduces battery drain.

When summer sporadic-E is around most of Europe and North Africa can be worked from the UK on SSB on 15, 12, 10 or 6m with some patience and luck and a modest station and antenna. When the bands are truly wide open then F2 DX to far more distant locations is certainly possible. I have worked many stations in the USA in a contest on 10m SSB with a handheld FT817 laying on the bed at home, so from a good outdoor location with sloping ground and a clear take-off then DXCC on SSB is not an unrealistic target with a few watts. My best DX "in the field" was a YV station 8000kms away from my mother's back garden but working LU at 11000kms from the bedroom table with a Miracle Whip suggests working much greater distances are certainly possible from a good location.

Don't expect such QSOs to be easy: you will be competing against a wall of stations running hundreds of watts to beams, so your signal may be many S-points weaker. However, being handheld you can move around to get the best direction and angle and even a few degrees of change to antenna position can make several dBs improvement. If on a clifftop watch where you are walking and don't fall over the edge in your enthusiasm! Having said this, sometimes conditions are so good that you will be in with a very good chance of success. Believe anything is possible.

In the excitement of a QSO it is all too easy to forget to log the details for later. Try to have a piece of paper to note down the details as soon as you can. Some use handheld voice recorders instead and transcribe log details later. Believe me, you will forget who you've just worked at some point.

- Don't operate with whip antennas if there is bad weather around. Long metal whips and storms do NOT mix.
- Take care with trailing counterpoise antennas: you could trip over these and so could people nearby.

- Watch where you are walking - cliff edges, rabbit holes and the like are all dangerous, especially if you are out alone.
- Let someone know where you will be and have a mobile phone handy so you may be contacted.

There was information from Bonnie KQ6XA on the Miracle Whip Yahoo group some years ago about counterpoises. You may find it helpful in working out what lengths to try. These are for counterpoise wires that trail on the ground. Expect to experiment and optimise the lengths that work best for you. A counterpoise can make a lot of difference.

Band	Counterpoise Length (m)
10m	2.3
12m	2.6
15m	3.0
17m	3.3
20m	4.2

These days ERP can be important. With QRP, this is less of a concern, but always hold the antenna as far from you as possible. Never use the rig pedestrian portable if ERP is a concern.

Microwave DX BY Noctilucent Clouds

There was a MOST interesting note on the ARRL propagation report a few years ago.

> *"Noctilucent Clouds Return - As reported at spaceweather.com on June 1, 2009, the first noctilucent clouds (NLC) of the 2009 season were sighted over Russia on May 27. NLCs typically appear about 20 days prior to the summer solstice, increase quickly to a high summer level, and then disappear about 50 days after the summer solstice. These clouds are mostly a high latitude phenomenon, and are believed to be composed of ice crystals. VHF radars see very strong echoes from these clouds, and since they are at mesospheric heights (80 to 90 km), they are also known as polar mesosphere summer echoes (PMSE). These clouds are hypothesized by JE1BMJ and others to be responsible for 6m propagation across high latitudes (for example, from the East Coast of North America to Japan) during the northern hemisphere summer. This mode of propagation has been dubbed Summer Solstice Short-path Propagation (SSSP). Check out page 34 of the February 2009 issue of WorldRadio Online - available free at www.cq-amateur-radio.com/back_issues.html (this link was not working when I last tried) for a general discussion of PMSE and SSSP and for references in the technical literature. To reiterate, SSSP is still just a theory, but the occurrences of QSOs appear to match the occurrence pattern of PMSE."*

Now, there is also evidence from radar returns that microwave DX might be possible using the same noctilucent clouds, possibly allowing superb DX on 10 GHz even with low power. This is a whole area of future ham research just waiting to be exploited. It may be one upside of global warming as these high altitude clouds are now more common than hitherto. I am very surprised there seems to be so little interest in this by microwavers worldwide. If keen microwavers set up beacons on possible paths for mesospheric DX then some quite phenomenal DX might be achieved. With modes like FT8 monitored 24/7 imagine the possibilities. I am not sure what Doppler shift does.

Japanese and other Far East stations are regularly worked on 6m from Western Europe in June and July.

13 stations in Japan were copied here on 6m JT65 last year. Japanese stations have been spotted on several mornings on 6m this year. My antenna is just a V2000 omni vertical fed with lossy coax. My RX is just an FT817 ND - no big antennas or anything special! If I can spot these I am sure others can too.

Sporadic-E (Es) - the QRPer's friend

Very little power is needed in a decent Es opening. Es mostly occurs in spring and summer i.e. May, June and July in the northern hemisphere. There is a smaller peak around New Year. Es can occur at any time of the year.

Just low power and a low wire dipoles are enough to work 1000-1500km in a decent Es opening on 10m, 8m, 6m and 4m.

This is why Es is a QRPer's friend as just very modest stations are needed. In the better openings just uWs are often enough, especially on modes like FT8 and WSPR.

Often very low power can result in S9 reports. In my experience the best time is June.

F2 propagation can also result in strong signals at times. However, Es frequently allows QRP signals to get a long way. Often Es openings can be fleeting, which is where modes like FT8 come in. FT8 and FT4 work with signals weaker than CW and the short duration of the TX burst (under 15 seconds for FT8 and half this for FT4) as well as lots of people monitoring, mean that even short openings are unlikely to be missed.

Lightning and thunder

Let me say from the outset that I am definitely *not* an expert on lightning protection. Ever since a very ordinary friend's house was struck many years ago I have treated lightning and thunder with great respect.

My policy has always been to disconnect everything where there is a risk approaching. If a storm is already here it is too late! By everything, I mean *everything.* This includes antenna, rigs, PSUs, PCs etc. Everything connected to the mains is at risk from a power surge, even if the storms are some way away still.

The chances of getting a direct strike are, thankfully, low in the UK yet I still get nervous. If you install grounding strategies to help minimise damage, you have to install very heavy gauge straps as a lightning strike can be very very powerful.

It is always worth watching for approaching storms by looking where storms are currently and seeing where they are moving. I use https://www.lightningmaps.org/ . I find these maps very useful.

My overall message is to always treat thunder and lightning with respect.

Internet Time

Partly as my voice is poor these days, I like digital modes such as WSPR and FT8. These work with signals that are very much weaker than SSB or CW, but usually these need a PC. It is very important to ensure your PC timing is good with these modes.

Most people synchronise their PC clock to Internet time when using modes like WSJT-X. Several ways are available and usually you can decide how often synchronisation is done. I used to use https://www.worldtimeserver.com/atomic-clock/, but you may prefer a different one. I think mine resynced every 10 minutes or so.

After doing a sync at the start of the day (probably not needed), it just worked in the background. It means your timing is spot-on all the time. Some people use GPS to get accurate time, but I have never tried that.

With later versions of Windows 10 and 11, this is not necessary, although I am not sure how often the PC clock is synchronised to Internet time. To be sure synchronise regularly.

Which Dealers and Commercial Products?

One of my concerns is the future of our hobby. Certainly in the UK, many radio amateurs are getting older and this is, overwhelmingly, a male hobby. I have no real idea why this should be so. It is odd how some occupations, at least in the UK, seem to be male dominated. I remember in my electronics course at university 1967-1970, we had just 1 girl and 108 men! Girls still have this notion that engineering is “dirty”. With electronics, this is just *not* true. You would hope years later this would have changed.

As the average age increases, fewer new amateur radio products will get sold and some manufacturers will struggle to make profits unless they can reduce costs. Dealers will see fewer new radios sold, so may reduce their magazine adverts. Some magazines may be forced to close. Some dealers will leave our market.

In all this, the question remains - what should we do? Well, for starters we need to attract *and keep* younger people. Ours is a great hobby. Share the fun! As I hope I have shown, deep pockets are definitely not needed to gain immense pleasure.

I have had good service from Martin Lynch and Sons in the UK, although I suspect they may make too much profit on the items they sell. Certainly, you can buy abroad for far less. Others may have good experiences from other dealers.

My cautions are:

- Will this dealer still be around to mend your radio and honour the guarantee?
- Can the commercial rig be serviced?
- Is the quality of what you have bought of the standard you expect?

The future is in our hands.

Personally, I expect some manufacturers, dealers and magazines to leave our market in the next few years, so think carefully before you buy!

As for kits, it is very hard for kit makers to make money from amateur radio. There are some good ones that will still be around, whereas some will come then go. Think carefully.

Personally, I think the future lies with low cost projects and not expensive commercial transceivers. Many of us invest in commercial rigs, but we do not

want to put off newcomers who think a very expensive transceiver, beam and tower are prerequisites to get into our hobby. I hope some of my projects have taught you otherwise!

One thing is certain: change always happens. Amateur radio is likely to be very different in the future and we have to embrace the changes.

Useful Links

These are a few of the links that I have found helpful over the years. I am sure there are others!

QRZ.com - useful to get info on amateurs -	https://www.qrz.com/
Solan - solar data -	https://www.solen.info/solar/
Southgate Amateur Radio News -	http://www.southgatearc.org/
Amateur Radio Weekly - news of interest -	https://hamweekly.com/
WSJT-X - the site for free digital software -	https://physics.princeton.edu/pulsar/k1jt/

Commercial Rigs Owned

Although I prefer to use simple rigs I have made, a few comments on the commercial rigs I have owned over the years would not come amiss. These are my *personal* views and others may not agree! The order is in time from when they were bought (I think!).

Heathkit Electronics Workshop

This was bought as a Christmas present in 1961. It was my introduction to radio that was later to become so important as a career and hobby. Various projects could be made without soldering by attaching wires to spring connectors. I remember MW DXing on it that first Christmas. Tuning was by slug tuning the coil, so there was no dial.

DST100 receiver

This was my first commercial radio. I think it was a tank radio from WW2 made by Murphy. It was *very* heavy and big and covered from 50 kHz to just over 30 MHz. In those days (mid 1960s) most amateur operation was on AM. My best DX was a ZL4 on Campbell Island. I think this was on 20m AM. I recall being puzzled by the broad tuning on the lower band, not realising that as the range was so limited, broad tuning was inevitable as a few centimetres covered about 5 kHz!

Codar T28 receiver

This was the companion receiver to the AT5 codar transmitter covering 160m and 80m. I think it was originally designed with mobile operation in mind. It was pretty bad! Mine was used mainly as the tuneable IF for VHF converters. I recall copying USA stations on 2m via the Oscar 6 and 7 satellites. At the time I remember coveting an AT5 transmitter.

Pye PF2AMB

This was a 3 channel 500mW AM handheld. I modified mine so I could tune the receiver with the volume knob. In the days of AM with crystal controlled transmitters and receivers “tuning low to high”, it was quite a nice rig.

Pye PF2FMB

This was a 3 channel 2W FM radio much like the AM version above. Mine was used on 2m simplex and the local repeater. I think I added a 1750Hz tone generator to access the local repeater.

Eddystone EC10 receiver

The Mk 1 version of this sold for £48. Later versions added an S-meter. It had a low IF and the image rejection on the higher HF bands was really poor. By modern standards it was unbelievably bad apart from the mechanical construction which was very good. A wolf in sheep's clothing comes to mind. Looking back, I wonder why so many of us thought they were wonderful! They sell on eBay for ridiculous prices. I got mine via a friend whose dad worked for Eddystone in Birmingham. I think mine was a pre-production unit.

Belcom Liner 2

This was the transceiver that brought VHF SSB to the masses in the 1970s. It was converted from a 10m rig. Later, a 70cm version was made. It used a crystal mixing VXO and was notoriously bad at producing spurious outputs and splatter, especially if the power was cranked right up. However, compared with AM, it totally transformed what was possible on the 2m band. I recall working unheard of distances.

Yaesu FT7 transceiver

This was a 10W pep rig covering 80m to 10m. I owned it in the early 1980s before the WARC bands were allocated. It had limited 10m coverage. There were no memories, no synthesisers, but did have a superb receiver that was really quiet. Later there was a 50W version that covered all of 10m. If I am honest, it was one of the best commercial rigs I have ever owned. By modern standards it was not small (I guess the FT817/818 is about 1/5th of the volume but covering far more bands and modes and with an internal battery!). There were no surface mount parts and all the modules plugged in.

ICOM IC202/IC402

These were the successors to the Liner-2. They were 3W pep radios (I think) and one was a 2m radio and one 70cm. I think there were 6m and FM versions too. They used a VXO to cover 200 kHz with each crystal. Compared with the Liner-2 they were clean. Even today, they are still used to drive transverters. I used mine with a homebrew 1W pep 10m transverter (circuit long lost!) and worked the world on SSB. They were styled as military looking, upright, transceivers.

Yaesu FT77

This was a 100W transceiver covering all HF bands including the WARC bands. It had a synthesiser. To be honest, I never liked it much. It had too much power for my liking and I guess I was spoilt by the FT7!

Philips FM321 70cm FM mobile

This was based on the Australian FM320 UHF CB radio. As I recall it was the very first synthesised amateur radio product. It was made in Australia. It covered all the 70cm simplex channels as well as 70cm repeaters. With a hand rotated J-beam designed for TVs it made some impressive simplex DX contacts. 70cm was like that. In many ways tropo openings were more localised and more frequent than on 2m. It produced 4W RF. Ergonomically it was excellent.

Yaesu FT747

This was another 100W transceiver. I think mine dated from the early 1990s. It was Yaesu's attempt to save money by using a metalised plastic case. It was an OK radio, but I never warmed to it.

Yaesu VX1 and VX2 FM Handhelds

These were tiny dual-band FM handhelds covering 2m and 70cm. They also had wideband receivers. Best results were obtained by replacing the supplied helical antennas with longer whips. The more recent replacement was the VX3, although I never had one

of these. Mine were mostly used on nearby repeaters with the occasional simplex contact.

Lincoln President 10m Multi-mode

This was used in the 1990s, I think. I have now got the Mk 2 version which has similar capabilities. Overall, the earlier version was well used, although I have not used the Mk 2 version for some years. I think these were originally intended as CB rigs. If your main interest is 10m, these and similar transceivers may be a low cost way of getting on HF. You should certainly work the world on SSB.

ICOM IC-706

This covered HF, 6m and 2m with later versions including 70cm too. The fan annoyed me and there was more RF power than I needed.

Mizuho MX2

This was a 2m SSB handheld. It produced 200mW and was VXO controlled covering 100kHz over 2 ranges. It worked some impressive handheld DX on 2m. The main issue was poor battery life, so I often used it with an external rechargeable 9.6V battery pack. It was also used to drive homebrew 10m transverters. As you can imagine, the desk looked pretty empty.

Versions for other VHF bands were also sold, although I did not have these.

ICOM IC703

This was a good QRP transceiver. It covered HF, 6m and 2m at 10W and had an internal auto-ATU that matched most of my random wire antennas well. It was sold to another local, which was a big mistake! Looking back, it was a great QRP radio that I should have kept. Along with the FT7, it was one of my better purchases.

Elecraft K1

This was a QRP CW transceiver. I made mine from a kit and chose the 4 band version with 40m, 30m, 20m and 15m with the auto-ATU. It worked plenty of stations including some good DX.

MFJ Cub 15m

This was a single band 1W CW transceiver. This performed well and it worked some impressive DX. I still have it, although it is rarely used these days.

Yaesu FT817/FT817ND and the FT818

The FT 817 and its successors must be one of the most successful transceivers ever made. It covers 160m-70cm all modes (not 60m, 4m or 1.25m) at up to 5W and comes with an internal battery.

The FT818 addressed some of the obsolescence issues, but left many people amazed that Yaesu could miss such a great marketing chance. A few years ago, they could have sold a decent replacement across the world had they added a few simple improvements like a speech processor and internal auto-ATU. Instead they launched the FT818 that had none of these features, so ICOM was able to walk in with the IC-705. Yaesu could have even used the same mechanics! I very much hope Yaesu launches a new QRP radio soon.

SignaLink USB

This is an interface between a PC and a transceiver. I used mine with the FT817ND and FT991A.

DYC-8x7 speech processor

This goes in line with the mic of the FT817. It adds speech processing, which is not included in the FT817 and FT818, goodness knows why. An audio speech processor would have cost pence. I cannot recall whether I bought this assembled or as a kit. It makes a very useful improvement on SSB transmissions. If required, the processing can be turned off. I have no idea if it is still available. Mine came from Germany.

Yaesu FT991A

This is a 100W radio covering all modes and bands from 160m - 70cm (not 4m and 1.25m). It has an internal auto-ATU, but with a fairly limited range i.e it is usually unable to match much beyond 3:1 VSWR.

ICOM IC-705

Although too expensive at the time of writing, this is truly a “radio station in a box”. It comes with an SDR receiver, Wi-Fi, GPS and a host of features,as well as a battery, so it may be used portable. Many were disappointed when an internal auto-ATU and 4m were omitted. In terms of features, it is probably the most feature rich transceiver I have ever owned. It covers 160m-70cm (not 4m and 1.25m) with all modes. With a USB cable between the radio and PC, many have experienced noise issues unless the earthing is good, the cable well screened and chokes are fitted. For FT8 and WSPR I still tended to use my FT817ND. With a decent screened and choked USB cable between the IC-705 and PC these problems can be overcome.

Inrico T320 network radio

This is like a VHF handheld, but it uses the Internet as the backbone. It has a PTT and an antenna. After first using it at

sunspot minimum it is hardly ever used. It may appeal to some, but not to me. Perhaps it is too easy?

Elecraft T1 auto ATU

This had to be built (although I think it can be bought pre-made), but mine was used with my FT817. It had a wide matching range. For home use I preferred the Z817.

Z817 auto-ATU

For home use, I prefer this as it sits just above the FT817 and seems to do a similar job to the Elecraft T1 unit. It has internal batteries and latching relays, so is ideal for portable use as well.

Yaesu FT-710

This is a very good 100W transceiver that is near the top of the famous Sherwood tests. It includes 4m, but does not cover 2m and 70cm. It has an internal auto ATU. I owned one for several months. I was rather hoping Yaesu would introduce an SDR based replacement for the FT817, but it never happened so I went back to the IC-705.

New Projects

Recently, I have bought a 2W 23cm transverter that I hope to use in the 23cm activity contests. So far, this transverter has only been used locally with the 2 element test antenna supplied indoors with the transverter. My transverter was from SG labs in Bulgaria.

I have a QDX digital transceiver from QRP Labs. This covers 20m - 10m QRP. It is mostly used on 10m FT8 and WSPR. It works with WSJT-X. It is tiny and works really well.

Other G3XBM Sites

These are some other sites that I maintain. You may find these useful.

My main website	http://www.g3xbm.co.uk
My YouTube video channel	https://www.youtube.com/user/G3XBM.
My blog	http://g3xbm-qrp.blogspot.com/

My blog is updated most days. My YouTube channel has many videos that add to my projects. My main website is not updated that often.

Final Remarks

Hopefully, you will have found something of interest here.

Although I doubt you will duplicate my circuits, my wish is that you are set on a path of experimentation just for fun. Fun is what I have enjoyed over the years and I hope you feel inspired.

My enduring message is just enjoy yourself. Experimentation does not require much money and can give a lot of pleasure.

In some ways this is my legacy, so I cannot charge money to jot down all my fun! Let's hope you have as much pleasure as I have had down the years.

Go on, roll your own!

If you spot mistakes, please let me know using my email address. There will be things that I have forgotten, but these will have to await a later edition.