

# H.A.R.S. Journal

Journal of the Hereford Amateur Radio Society

Issue No 7 • April 2017

**Chairman:** Nigel Hancocks G4XTF • **Treasurer:** Rodney Archard M0JLA • **Secretary:** Duncan James M0OTG  
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Dave Harris M0RNI; Mike Bush G3LZM; Tim Bridgland-Taylor G0JWJ; Geoff Wilkerson G8BPN

## Editorial

Constructors! This time the *Journal* presents details and circuitry of a self-build 40M TX which was previously reviewed in the ARRL QST as the Tuna Tin Special. Ten bundles of parts (not kits) are available, and are intended for serious constructors who will use their skills and imagination to build this no-nonsense; will-work: project. Good Luck!

In the last issue, Madley Communications Centre was reviewed. Now, geographically close to MCC, is ETL Systems Ltd. Read how this local, world-class company has a major role to play in all aspects of RF and Satellite Communications.

*Ed*

## HARS radio equipment available for loan to Club members

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

**Grid Dip Meter MFJ-201**

**Buddipole 10-40M** portable antenna with tripod and carrying case.

**Yaesu FT450** All bands to 50MHz. Needs a 12V PSU

**Pixie 7MHz QRP kit.** Needs assembling.

**Baofeng UV-5R** 70cms/144MHz hand-held complete with accessories.

*Go portable with the Buddipole! Ed.*

## Dear Member

Please think about submissions/projects you might like to send in or see.

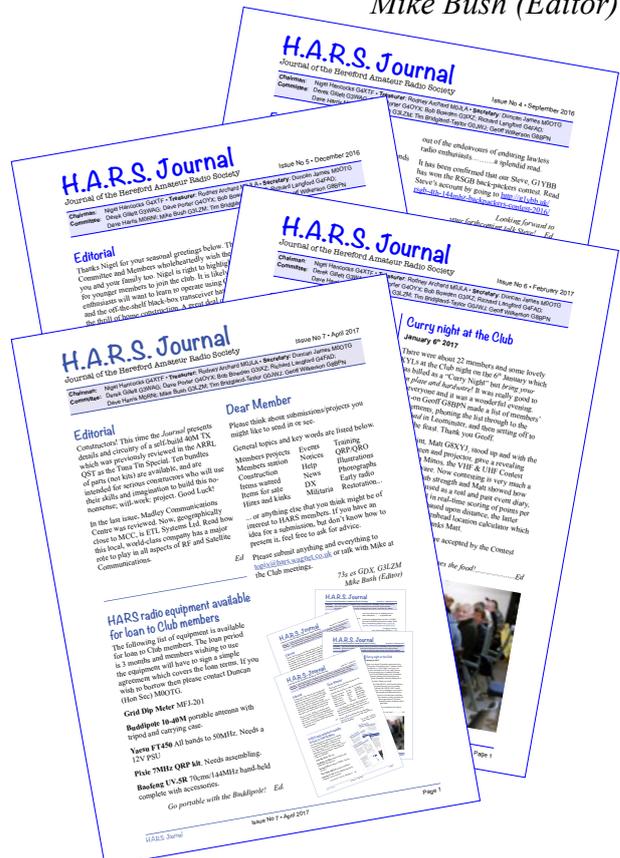
General topics and key words are listed below.

Members projects	Events	Training
Members station	Notices	QRP/QRO
Construction	Help	Illustrations
Items wanted	News	Photographs
Items for sale	DX	Early radio
Hints and kinks	Militaria	Restoration...

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

Please submit anything and everything to [topix@hars.wagnet.co.uk](mailto:topix@hars.wagnet.co.uk) or talk with Mike at the Club meetings.

*73s es GDX, G3LZM  
Mike Bush (Editor)*





*L to R: Emma Pardoe, Mike Evans, Ben Elms-Lester, Declan Collins, Stephen J Bunting, Ben Doughty, David Faulkner*

## Foundation License Course LATEST

*Well done to all the club members who passed the latest course.*

**David Faulkner – M6IIB** writes that he lives in Bromyard and has done for the past 30 years. However, fifty years ago, David had been mesmerized (like so many of us) by the short-wave broadcasts on the family radio in the living room. The dial showed wonderful place names such as Berlin, Luxembourg, Moscow and such like. Then, David bought an R1155 and, with the aerial wire stripped from a washing machine motor, he was able to listen to radio amateurs from all over the world. Sad to say, he then lost interest. After 40 years as a psychiatric nurse, and now into retirement, he noticed that “licenses” were easier to get and here he is again!! David plans to go portable with his FT817.

**Emma, M6IHZ**, writes to say that she is now on the air with a hand-held Pofung GT-5 and she says that she also has access to husband Dave’s kit when he is not using it – which is hardly ever! Emma is looking forward to constructional projects when she has gained her “Intermediate”. The future *Journal* projects might be able to help Emma! *Ed.*

**Ben Elms-Lester, M6KSX**, lives at Kerry’s Gate – IO81NX. Situated on the top of a hill, he overlooks the Golden Valley with views towards the Black Mountains. He gets into GB3ZA and occasionally GB3HC using a hand portable. Ben is currently setting up his shack in the “shed” which is wired and insulated. Construction and experimentation are the main interests linked hopefully to long

distance contacts and associated effects of propagation.

Ben’s future goal is astronomy but meanwhile he is planning to do the Intermediate Level exams. Of interest is Ben’s multi-various expertise beginning with the performing arts which, Ben says, led naturally to accountancy..., and subsequently driving lorries!

Be that as it may, Ben points out that 42 degrees is the angle at which the sun’s rays need to hit airborne moisture, to form a rainbow.

**Stephen, G6MMU**, is located at Harewood End, between Hereford and Ross. He uses an Icom 7300 for all HF activities. He also has several SW receivers which includes a Winradio SDR and his favourite Icom R20 which has travelled the world with him. Stephen uses his motor-home as his travelling shack which is complete with all comforts. Everything runs off 12V and is naturally “quiet” as a consequence. The main interests at G6MMU are HF SSB DXing (with CW on the way), 2M whilst driving, and a host of other operational challenges. Like many of us, Stephen is transfixed by the sight and smell of lit-up valve radios and tells about sitting in the dark next to such a receiver and listening to the other side of the world... with a glass of whiskey to hand!

*Wonderful, wonderful.. Ed*

# Contest Jargon for Beginners

by Matt Porter G8XYJ

After 5 years or so of contesting I have managed to get my head around the RSGB Club Championships for both the 80m series and the VHF/UHF series. However, I realise how bewildering it may be for beginners looking to get going on the contests. Mike G3LZM has asked me to assemble this document, so I hope this is of some use to you.

To keep it straightforward, I will focus this document on the VHF series.

The first bit of advice I have is to listen to the VHF contests, they always run between 2000-2230 local time. There is a full calendar located at <http://www.rsgbcc.org/cgi-bin/readcal.pl>, detailing the contest dates – always on SSB and CW.

Once you have heard them it will give you a chance to assess what is required to be exchanged. Most typical exchanges sound something like the below

**G8XYJ** – CQ Contest CQ Contest this is G8XYJ/P Golf Eight Xray Yankee Juliette CQ Contest over

**G4OYX** – G4OYX Golf Four Oscar Yankee Xray

**G8XYJ** – G4OYX you're 59, 034, IO82RJ India Oscar Eight Two Romeo Juliette, QSL?

**G4OYX** – Thanks for that, you're 57, 002, IO82PJ India Oscar Eight Two Papa Juliette, QSL?

**G8XYJ** – QSL that, many thanks, 73, QRZ?

So as you can see it is rather fast paced, it is all about speed. However if any part of the exchange is missed then you can ask for repeats, even big stations would rather repeat the details, than miss out on the points that would be lost if you missed any information.

## So what do the numbers mean?

**59** – Pretty self explanatory, this is of course the signal strength. I very rarely look at the meter in a contest and have 3 settings in my ears that I use – these are

- 59 = excellent copy
- 55 = good copy
- 51 = poor copy

You may wish to adopt a similar thing.

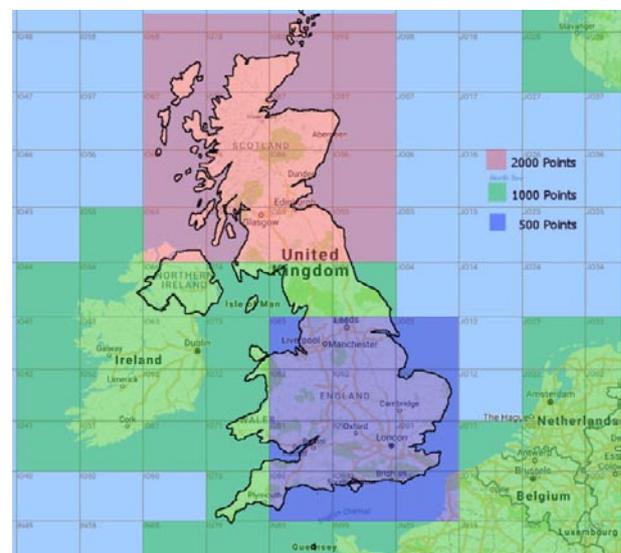
**034** – This is the serial number, so in this case G4OYX was my 34<sup>th</sup> contact of the evening, where as I was his 2<sup>nd</sup>. This increases by one for every contact you make. Some big stations can get up to 200+ on a particularly good evening.

**IO82RJ** - This is your maidenhead locator, so for G8XYJ/P it was IO82RJ, and for G4OYX it was IO82PJ. To find your maidenhead locator this can be done here - <http://qthlocator.free.fr/index.php>

Locators are important, the UK is divided up into several squares of differing values, our aim is to get as many squares (or as they're more commonly known, Multipliers) as the more you get, the better your bonus. The map below shows how the squares are assigned points.

So as you can see, the Blue squares are worth 500 points additional points (for the first time you speak to somebody from the square). The Green are worth 1000 points and the Red are worth 2000.

The points are based on the population and the amount of active people in those



Claimed scores for 70MHz UKAC

19 Jan (65 scores)

Section FILTER ▼	Callsign	Loc	QSOs	QSO Points	P/Qso	Bonus Points	Total Points	Best DX	Dist	Power	Ant	Comments	Email
AR	G4CLA	IO92	113	16,265	144	18000	34,265	PA5Y	489	40	7ele	Conditions up a little, high local noise levels.	<a href="#">Email</a>
AR	G7LRQP	IO91	113	17,592	156	15500	33,092	GM4JJJ	506	40	6 Ele	Thanks For QSO.s. Less people beaming south so a struggle at times.	<a href="#">Email</a>
AR	GI4SNA	IO64	54	16,203	300	15500	31,703	G3MXH	530	35	7 Ele Yagi		<a href="#">Email</a>
AR	M0GAVP	IO93	94	13,887	148	16500	30,387	G3WCBP	370	40	5 Element	quite a good result for last minute effort.	<a href="#">Email</a>
AR	G0VVE	IO91	92	16,871	183	13000	29,871	GM4NFC	529	60	9y	Noise level got higher as contest went on, particularly to north. Thanks for all qos	<a href="#">Email</a>
AR	G0EHVP	IO84	57	12,152	213	16500	28,652	G4DFA	408	40	5 Element	Lively night - new rig and/or conditions? Balmly weather but v. foggy at QRT. Enjoyable as always. Thanks QSO.s.	<a href="#">Email</a>
AR	G3VCA	IO93	92	12,663	138	14500	27,163	GM4JTJ	389	40	5 el beam	A busy contest but signals went down as it progressed with QSB and noise increasing. Sorry for the stations I could not fully copy.	<a href="#">Email</a>

squares (based on contest data from previous years). So clearly as there are less people in Northern Scotland compared to London they have assigned that square to be worth 2000 additional points. This is why a site that favours the North and North West from Herefordshire, is a massive advantage.

Equally this is why a Scottish station can have a significant smaller amount of QSOs but can beat the stations in the South of the Pennines, who may have had 2 or 3 times the amount of QSOs.

Look at the table above and you can see how this happens. This is for the 4m UKAC in January, AR Section. G4CLA is based in IO92 and had 113 QSOs and is top of the leader board with is 18000 bonus points and 16265 points generated from his QSO tally. However look who is in 3<sup>rd</sup> place, GI4SNA only had 54 QSOs but because his Bonus rate was high he came in 3<sup>rd</sup> when the QSO tally and Bonus points are added together.

Moving away from the map, one thing to notice from the exchange is the order, it always goes Callsign, Signal Report, Serial Number and Locator.

**Other Jargon terms you may read about or here on air are the following**

**ON4KST** – This is effectively a radio amateur based chat room that allows us to arrange QSOs with stations. For example, if say GM4JJJ is on ON4KST, then I can send him a message saying “Hi John, please can we try

a QSO please” he may well respond with a Frequency or QRG – Say “144.360 I will beam your way.” We can then tune our radio to that frequency and rotate our antenna to best hear him and then we may be able to hear his signal and exchange contest details. This website is available to all and is free to use - <http://www.on4kst.com/chat/start.php>

You will have to register with his website to use it fully though. Even if you do not use it, you can actively look at it on the screen and quite often you can see on what frequency some stations are allowing you to tune to the frequency, wait for their QSO to finish and then effectively “piggy back” the contest

**S and P** – This stands for “Search and Pounce” this describes the actions of somebody that is tuning their radio up and down the band listening for a contest station. Once they hear somebody new, they pounce on them and get their details.

**Run Station** – This is the opposite of a S and P station, a run station sits on one frequency all night and calls CQ waiting for somebody to find them. If I am in a dominant portable position with a large signal, this is the approach I prefer to take. However if I am at home, then I adopt the S and P state.

**MGM** – Stands for “Machine Generated Mode” this is a very popular mode on 6m, a station will use JT65 (A digi mode) to have a QSO – Quite often this is arranged via the chatting software ON4KST. So instead of using their voice, they use a PC to generate the

Spotter	Freq.	DX	Time	Info	Country
OK1SC	144428.0	DB0JT/B	08:34 06 Feb	JO70OB<TR>JN67JT audible=BN	Fed. Rep. of Germany
OK1SC	144482.0	HG8BVA/B	08:32 06 Feb	JO70OB<TR>KN06PW audible bad	Hungary
CT1EEC	144500.0	CT1EEC	08:32 06 Feb	Camaval de loule 2017	Portugal
OK1SC	144481.0	SR3VHX/B	08:32 06 Feb	JO70OB<TR>JO82LJ 549QSB=BN/N	Poland
OK1SC	144450.0	DM0HVL	08:31 06 Feb	JO70OB<TR>JO62KI 519=BN/N	Fed. Rep. of Germany
OK1SC	144434.0	DB0LBV/B	08:30 06 Feb	JO70OB<TR>JO61EH 549=N	Fed. Rep. of Germany
OK1SC	144444.0	DB0FGB/B	08:30 06 Feb	JO70OB<TR>JO50WB 52/39=BN/N	Fed. Rep. of Germany
SM7NMO	144412.0	SK4MPI	07:00 06 Feb	JO77ER<>JP70NJ svaga signaler	Sweden
DK3XT	144366.0	OZ1BEF	06:31 06 Feb	JN49fe<MS>JO46oe tnx Dan	Denmark
KF4WE	144200.0	K8TQK	02:39 06 Feb	EM56NL<>EM89IF	United States
W7MEM	144112.6	S57M	01:08 06 Feb	DN17NT<EME>JN76PO	Slovenia

noise that will be decoded by the computer of the receive station.

**DX SUMMIT** – This is another website that is worth having open, it is a DX cluster that shows where stations are calling CQ or where they have been “Spotted” (worked by somebody else who uploads the details to an online log). Here is a link to the website - <http://www.dxsummit.fi/#/> you then click on the filter tab and filter the bands that you want to see.

Above is a screen shot, so we can see that OK1SC heard DB0JT/B on 144.428MHz at 0834 on 06/02/17 with the details of where the station is located? During the contest, this is handy as you build up a rough idea of where stations are during the two and a half hours, you can make notes on a piece of paper and return to the frequencies at a later time. When they’re spotted, they may not be beaming at you, but at least you have their frequency, so

you can check this regularly and wait until they’re beaming at you.

**Section Details** – Earlier I mentioned AR, these are your section that you enter based on the power and the arrays that you use.

- **AO = Open section** – This means maximum legal limit of 400 watts (6m, 2m, 70cm, 23cm) and multiple antennas. The maximum power is 160 watts on 4m.
- **AR = Restricted section** – This details as 100 watts (6m, 2m, 70cm, 23cm) with one single antenna. For 4m the restriction is 40 watts.
- **AL = Low section** – This is 10 watts (6m, 2m, 70cm, 23cm) with one single antenna. For 4m the low power is 4 watts.

This is purely your choice, I would rather take my 50 watt radio and knock the power down to 10 watts and have the best possible chance in the AL section as 50 watts in the 100 watt

section is nowhere near as competitive as 10 watts in the 10 watt section. As I say, everyone is different and it is entirely your choice.

**Minos** - This is a contest logger that is very popular, I gave a brief demonstration on this at the club night in January 2017, if you missed this then please let me know and I can bring my laptop to a club night and show you how to use it when we have Tea and Biscuits. Alternatively, Steve G1YBB has written an article on his website, found here - <http://g1ybb.uk/entering-rsgb-vhf-contests-with-minos-logger/>

**RSGbcc** – This is the **Radio Society for Great Britain Contest Committee** – They are a voluntary bunch of keen testers who co-ordinate the contests. They quietly get on with making sure we can enjoy the contests and have a platform to support the contests through maintaining the website. This is available at <http://www.rsgbcc.org/>. They attend the National Ham Fest at Newark, so if you see them there, please thank them for all their hard unpaid work.

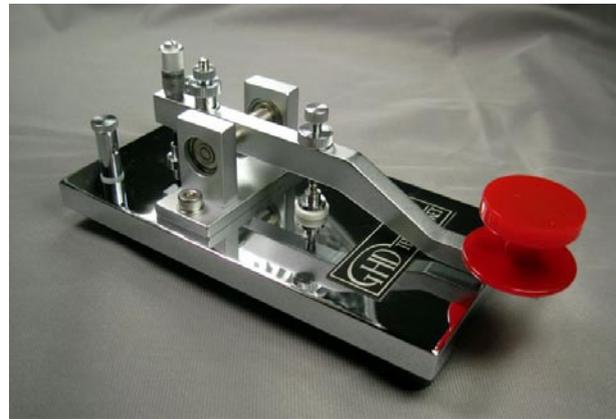
**Frequencies** - Here is a list of where you will hear activity on the SSB portion of the bands – All values in MHz

- 6m – 50.130 – 50.300
- 4m – 70.100 – 70.300
- 2m – 144.100 – 144.400
- 70cm – 432.100 – 432.300
- 23cm – 1296.100 – 1296.300

Anyway, I hope that this has enlightened some of you, and I hope that for some people, I have not taught you to suck eggs. Have a listen and have a play!

73 Matt G8XYJ

*Thanks, Matt... Ed*



## Morse Key Keynotes

For those of us who still like straight Morse keys, this model GT501MIL is truly fabulous.

Designed for the American market, it measures 5 x 3.25 inches and is finished in mirror-polished hard chrome. Adjustment is down to micro-movement employing super bearing technology; and the contacts are embedded in ceramic. Weight, 3.5lbs.

[www.morsex.com](http://www.morsex.com)

### HF DX

There's a voice inside the static,  
And it's calling out CQ  
CQ DX, is anyone there?  
He wants to speak to you!

You've set up your antenna  
You're receiving loud and clear  
You're going to call out now to the  
voice you can loudly hear.

You shout out your call-sign,  
He says he can hear you fine..  
receiving above the noise...  
your signals 5 & 9!

You exchange important info',  
find out what you need to know,  
Say 73's and 88's.....  
And QSL via the Bureau!

*By kind permission from  
Louise M3TLL*

## Club Personalised Merchandise

For availability and prices contact the Hon. Sec.



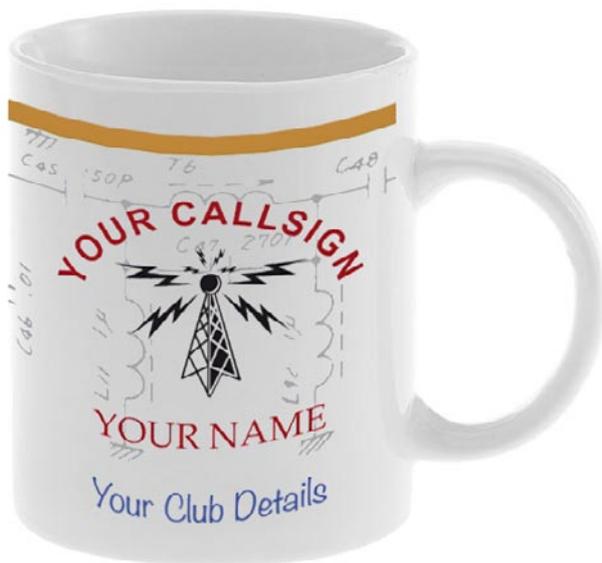
### T Shirt

The printed T shirt has your call sign on the front plus your club details.



### Cap

The printed cap has your call sign on the front plus your club details.



### Mug

This is available printed front and back with your call sign and club detail.

An exotic China version is available.



### Illuminated Plaque

This is available with your call sign engraved. A 12V DC supply is needed. You will be able to select Green/Red/Blue by means of a small switch at the rear.

# Construction -- Building a QRP 40m Tx

Permission has been given by Ed W1RFI, Steve WB8IMY; of ARRL, and Giles G1MFG of the RSGB, (IARU), for the following circuit to be published in our Club Journal.

## History

Back in the mid 70's Doug W1CER of ARRL laboratories produced the Tuna Tin Special, a 40M QRP transmitter housed in an empty Tuna can. It was so simple that it was labelled as a "Weekend" project. Transmitting 300mW CW on 7.040MHz, the QRP frequency, Doug managed to work all States within a very few days. Note that the UK QRP frequency is 7.030MHz.

Because of its simple no-nonsense design and popularity, the Tuna Tin Special was reviewed and slightly updated, in QST in the year 2000, and was subsequently called the TT2.

The Journal now presents this enduring transmitter design for all of you construction addicts who are desperate to try something new.

## The Circuit

This is not an off-the-shelf kit and you do not need a tuna tin. But, there should be absolutely no difficulty in making this circuit work, indeed, if you have never built any RF equipment or even if you are not a CW operator, you will be in for a treat and a lot of fun building this TX from scratch. If you can operate CW, how about trying for WAB!

The first transistor stage Q1 is a Pierce series resonant crystal oscillator which drives the power amplifier Q2. L1 is the oscillator choke and its value could be as high as 500uH. The collector

impedance of Q2 is around 250 ohms so T1 is used to step the impedance down to about 60 ohms (4:1 transformation) so that practical values in the pi output network, can be used. T2, part of the pi network, needs a little adjustment. With a 50 ohm load, move the turns together or apart slightly for maximum output. When satisfied, fix the turns with a glue such as polystyrene. The 40M pi network is designed to have a low Q thereby eliminating the need for tuning. Increased power can be achieved by lowering the resistance in the emitter of Q2 to a maximum emitter current of 50mA. This equates to approximately 400mW output. Much more than this may damage the transistor.

For circuit checking note that the DC voltages are given in the square boxes. The RF voltages are given in the rounded boxes. For these measurements an RF probe will be needed. If you don't have one of these, a design to use with your DC meter will be given in the next issue of the Journal, or possibly at a Club meeting.

### Parts Bundle

There are ten bundles of components available to serious constructors. Each bundle consists of:

- Vero style pcb
- Xtal
- Transistors
- Toroids
- Transformer wire
- Other items (Cs and Rs)

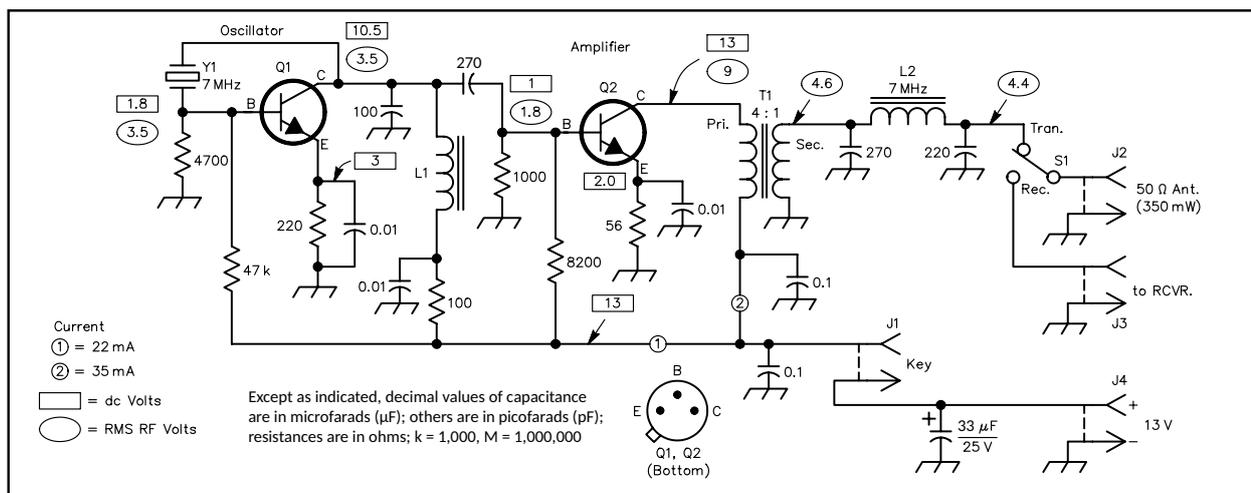


Figure 1—Schematic of the Tuna Tin 2 QRP rig. Note that the polarized capacitor shown in the schematic is an electrolytic.

J1—Single-hole-mount phono jack. Must be insulated from ground. Mounts on printed circuit board.  
 J2, J3, J4—Single-hole-mount phono jack. Mount on tuna tin chassis.

L1—22 µH molded inductor  
 L2—19 turns of #26 wire on a T-37-2 toroidal core  
 Q1, Q2—2N2222A or equivalent NPN transistor.  
 S1—Antenna changeover switch. Miniature SPDT toggle.

T1—4:1 broadband transformer. 16 turns of #26 wire on the primary, 8 turns of #26 wire on the secondary, on an FT-37-43 toroidal core.  
 Y1—Fundamental crystal, 7 MHz.

## Contest Corner

February has been a pretty good month for the club in the RSGB UKAC campaign. We now have Dave G4ASR as a club member and entering scores for HARS. As many will know Dave is a regular at the top of the open section tables so his scores will be a good bonus. We have also had some great membership on the air making up numbers. This is essential as the big scorers alone cannot compete with many stations entering scores.

As it stands now HARS is sitting 4<sup>th</sup> overall out of 31 clubs in our section, in reach of 3<sup>rd</sup>. Not bad for the beginning of our first concerted effort season.

In Feb 144MHz we had 12 club members entering scores and have moved up to 3<sup>rd</sup> and are only two good scoring entries away from leading!

We also moved up to 5<sup>th</sup> in 432MHz with 8 club entries. Next month we should have more.

50MHz was good with 12 members entering and retaining 2<sup>nd</sup> place again only a couple of good scoring stations behind 1<sup>st</sup> place.

In 70MHz we have made a big jump up the table from 9<sup>th</sup> to 5<sup>th</sup> and on the night HARS came 3<sup>rd</sup> in the local club section!

On 1296MHz we have a couple more active.

*73 Steve GIYBB*

### Upcoming Contests:

144MHz UKAC	04-Apr-17	1900-2130 (UTC)
432MHz UKAC	11-Apr-17	1900-2130 (UTC)
80m CC SSB	12-Apr-17	1900-2030 (UTC)
50MHz UKAC	13-Apr-17	1900-2130 (UTC)
1.3GHz UKAC	18-Apr-17	1900-2130 (UTC)
70MHz UKAC	20-Apr-17	1900-2130 (UTC)
80m CC DATA	27-Apr-17	1900-2030 (UTC)
80m CC SSB	01-May-17	1900-2030 (UTC)
144MHz UKAC	02-May-17	1900-2130 (UTC)
432MHz UKAC	09-May-17	1900-2130 (UTC)

### RSGB UKAC Overall Local Club Standings 2017

	Club (31 clubs total)	50MHz	70MHz	144MHz	432MHz	1.3GHz	SHF	Total
1	Sheffield & DWS	1000	1000	970	885	1000	306	5161
2	Bolton Wireless Club	588	552	1000	1000	672	1000	4812
3	Worksop ARS	538	682	831	983	246		3280
4	<b>Hereford ARS</b>	<b>819</b>	<b>407</b>	<b>868</b>	<b>439</b>	<b>428</b>		<b>2961</b>
5	RAF Waddington ARC	603	464	438	547	454	45	2551
6	Trowbridge & DARC	246	204	582	383	236	739	2390
7	Coulsdon ATS	266	252	192	285	156		1151
8	Parallel Lines CG	177	229	173	205	274	67	1125
9	West Kent ARS	252	159	290	187	83		971
10	Cheltenham ARA	130		96	92	144	406	868

### Club Band Standings

	50MHz (24 clubs)	Total	70MHz (20 clubs)	Total	144MHz (27 clubs)	Total	432MHz (26 clubs)	Total	1.3GHz (20 clubs)	Total
1	Sheffield & DWS	11242	Sheffield & DWS	8743	Bolton Wireless Club	11,530	Bolton Wireless Club	9,737	Sheffield & DWS	7304
2	<b>Hereford ARS</b>	<b>9205</b>	Worksop ARS	5959	Sheffield & DWS	11,188	Worksop ARS	9,573	Bolton Wireless Club	4907
3	RAF Waddington ARC	6783	Bolton Wireless Club	4826	<b>Hereford ARS</b>	<b>10,013</b>	Sheffield & DWS	8,617	RAF Waddington ARC	3316
4	Bolton Wireless Club	6611	RAF Waddington ARC	4060	Worksop ARS	9,576	RAF Waddington ARC	5,330	<b>Hereford ARS</b>	<b>3123</b>
5	Worksop ARS	6053	<b>Hereford ARS</b>	<b>3557</b>	Trowbridge & DARC	6,705	<b>Hereford ARS</b>	<b>4,275</b>	Parallel Lines CG	2000
6	Triple B ARCG	3009	Coulsdon ATS	2206	Triple B ARCG	5,716	Trowbridge & DARC	3,727	Martlesham RS	2000
7	Coulsdon ATS	2992	Parallel Lines CG	2000	RAF Waddington ARC	5,046	South Notts ARC	3,224	Worksop ARS	1798
8	West Kent ARS	2836	Trowbridge & DARC	1782	West Kent ARS	3,340	Coulsdon ATS	2,775	Trowbridge & DARC	1726
9	Trowbridge & DARC	2765	Martlesham RS	1684	South Notts ARC	3,322	Parallel Lines CG	2,000	Cambridge & DARC	1654
10	Leicester RS	2186	Telford & DARS	1500	Vecta CG	3,266	Vecta CG	1,955	Northampton RC	1484

*Thanks, Steve... Ed*

# Radio Communications under the Sea

By Derek G3WAG

As amateur radio enthusiasts we are used to communication from station to station via ground or sky waves, depending on which type of antenna configuration and frequency you are using. So have you ever wondered how submarines receive radio signals when they are submerged for most of their working life?

For obvious reasons, I am bound by the *Official Secrets Act* which prohibits me from stating certain system configurations together with specific data values, although a lot of the information is available in the public domain.

The simple answer is; the use of VLF (Very Low Frequencies: 3 kHz – 30 kHz). Using these frequencies with high power, it is possible to get world-wide coverage (well almost) even under the sea. So how is this achieved?

Submarines by their very nature have to remain submerged most of the time to avoid being detected by either surface vessels or other surveillance systems. Acoustic detection such as SONAR and other similar systems are used to 'Listen' to see what is going on under the sea. I will not be referring to this area of communications as it is a sophisticated topic. If you have seen the film "The Hunt for Red October" you will understand.

## Topics covered:

- The transmission system
- What sort of data is transmitted
- How Submarines receive this data
- Modern Systems

## The Transmission System

VLF (Very Low Frequency) communications

Many countries use VLF systems to communicate with submarines. At these frequencies the antenna system will be huge, taking up a large amount of 'real estate'. Consider a quarter wave vertical for vertical for 15 kHz, which works out at 20,000m, totally impractical.

Therefore just like amateur radio antennas, it is necessary to reduce the overall size of the

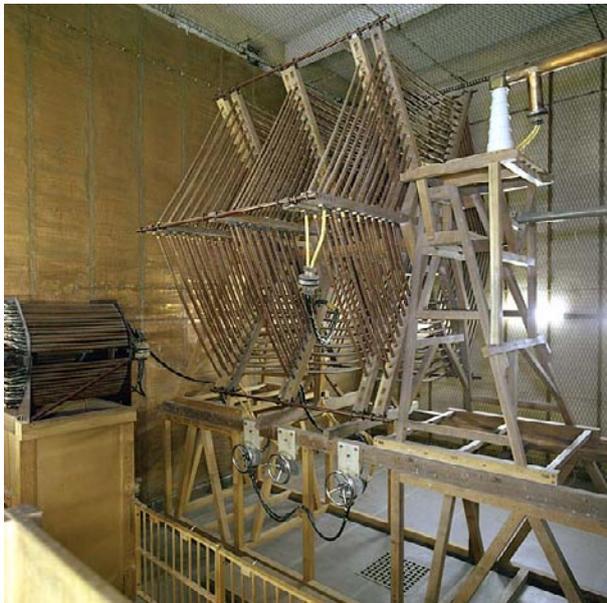


The 250M high masts at Rugby

antenna by adding *Inductors* and *Capacitors*. Those of you who have worked on the LF bands will be familiar with the use of loading coils capacitance hats or spikes.

The old Rugby VLF Rugby station's (which has long since gone), antenna consisted of twelve 250 metre (820 ft) high, guyed steel-framework masts insulated against ground and carrying an aerial wire. This wire was configured to have a high capacitance.

In addition to this top capacitance, the antennas has base loading coils wound as spirals on five hexagonal wooden spiders, roughly 4m in diameter. These spiders could be moved to vary the inductance. When transmitting the antenna Voltage would be in the region of 220kV and 600A. With so much capacitance and inductance loaded into the antenna system the Magnification factor (Q) was so high that the bandwidth could not cope with the data being transmitted, requiring an active antenna tuning system that was capable of tuning as fast as the data was being transmitted, this did not apply to all stations however. To achieve such powerful ground



*Base loading coils*

wave coverage it was necessary to run the transmitter at 500kW.

### **Transmitted Data**

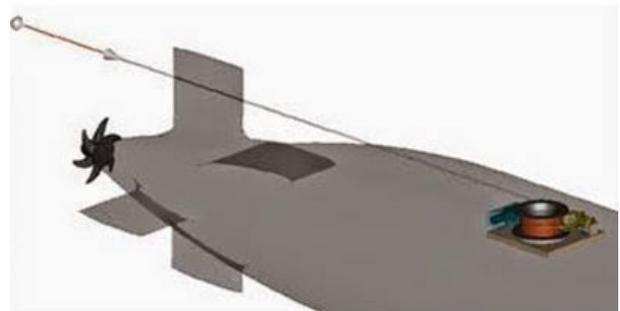
The Rugby station was capable of transmitting a number of modes with main modes being Morse code, FSK (Frequency Shift Keying) and Minimum Shift Keying (MSK) the latter being used the most for efficiency. During the 'Cold War' days transmission would be 24/7 with 'Filler data' sent in place of 'no data' rather than no transmission at all. This was just one of the techniques used to confuse any would-be unauthorised monitoring of the transmission. e.g. If an unauthorised station was monitoring the frequency, suddenly saw a large stream of data they knew something was happening. Other means of data security and in band security techniques were also employed. The data rate sent is very slow for a number of reasons.

- a: Slow data means low bandwidth
- b: The data has a very high level of redundancy which employs special techniques for ensure the transmission is error free.

### **Receiving the Transmissions**

During my working life I was heavily involved with various communications systems and I certainly witnessed the reception of UK transmissions on VLF in mainland China (PRC).

As mentioned earlier submarines in the main spend most of their working life underwater, this presents problems for most communications systems. However, VLF can penetrate water to a reasonable depth. The depth of penetration is dependent on the salinity and temperature of the water. Geographical location is also an important factor. All these parameters are well known to the operators and operational depth is achieved for best results. The antenna is nothing more than a long piece of wire (length



*Antenna trailed behind submarine.*

is adjusted for frequency of use), with flotation pods attached to ensure that the antenna has neutral buoyancy. Having a neutral buoyancy means that the trailing antennas will follow the submarine under the water and not come to the surface, leave either a trailing wake or something that looks like the 'Loch Ness Monster'.

### **Modern Systems**

Although modern systems still use VLF and ELF they are far more sophisticated. Furthermore, the use of satellite technology is used for communication systems on submarines with covert antennas placed on certain position on the hull and other structures.

Modern submarines also have a far more sophisticated periscope system which no longer penetrates the hull. The onboard systems are now so sophisticated that they fall within the highest level of security...

*So interesting Derek!  
Thanks ....Ed.*



Left hand side: 96x384 VULCAN L-band Matrix System - Right hand side: 128x128 Enigma Matrix System

## ETL Systems Ltd

ETL Systems Ltd is a world-class company with headquarters located near to the Madley Communications Centre (MCC). The campus comprises modern buildings, facilitating high-tech research & development processes and production activities.

The Company has over one hundred employees and develops a wide range of professional products mostly to do with Satellite Communications, but covering the whole RF spectrum up to 40GHz. ETL's world-wide customers range from commercial to military.

Imagine the complexities of an L-band matrix. The purpose of these systems is to allow signals from a multiplicity of antennas to be routed through to an endless mixture of destinations. The complexity is further added to by the need to make the matrix “distributive”, meaning that a single antenna input might need to go to many destinations in a combination which might need to alter suddenly.

ETL Systems Ltd manufactures these matrices, and they can be as large as 256 x 256 (inputs v. outputs).

Interestingly, the matrix described operates over the satellite Intermediate Frequency (IF) range, 850-2150MHz. The amateur band 1200MHz (23cms) is in the middle of this range, although interference either way will not occur.

For further details [www.etlsystems.com](http://www.etlsystems.com)

*A great place to work... Ed*