

# Hot Iron

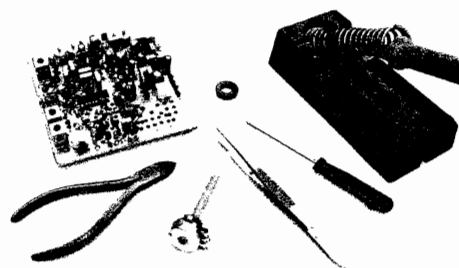
Autumn 2004  
Issue 45

## Contents

Mixing up a Fivehead  
Like a squeeze?  
Computers in rigs  
Active filter types  
Mains and PME  
Brent detector  
R & C in series/parr  
Snippets  
Mini Mixer kit  
**Crystals!**

## Editorial

I see that I mentioned water in my last editorial! My word - I could dwell at length on that subject again! From a farming perspective, its proving very difficult for a great many farmers all over the Country. Since that excellent weather in May, we have had sunny periods and showers almost continuously - or so it seems! We are lucky, in that we have managed to do all our wheat harvest with just two fields left of barley and beans. It has nothing to do with electronics but I hope you don't object to the odd comment on rural matters!



I see I mentioned static inverters and the like - pondering if anybody was interested in a kit - evidently not! I have just lashed out on a photovoltaic 100W panel, deep cyclic duty 12 volt battery and a commercially made static inverter. I have yet to get it up on my roof properly because the best site is too high for comfort! I suspect an investment in heavy copper wire and sitting it on a nearby low barn will be better. Think of all that energy going into the cells for free! Totally uneconomic - more of that when its working!

The Walford Electronics website is also at [www.walfordelectronics.co.uk](http://www.walfordelectronics.co.uk)

## Kit Developments

Its been a busy time! After much evaluation, & change, the **Locking** 20/40/80m specialist CW TCVR is now available but I must emphasize that it is complex rig and is very full and quite a big project. Definitely not for those who have only built a crystal set previously. Many thanks to Craig, Jorgen and Andy for their help in sorting out early problems. I have just finished a new starter rig called the **Catcott**, this is a 20/40/80m regen RX for first time constructors. See the photo later. £24. I have also just finished building the prototype of a new 1.5W CW DC TCVR called the **Brent**, full break in and good performance etc. Supplied normally for 80m (100 KHz range), but will do any band to 20m with a crystal & so a limited tuning range. Hence the new Mini-Mixer kit to regain the 100 KHz by mixing the 80m VFO with a crystal for the chosen band. It seems quite promising, supplied in flat format, 80 x 100 mm PCB for 80m. £34 or +£14 with the mixer for full CW section coverage of other bands. See later - an early builder would be handy!

I am preparing another multi-band RX project called the **Sutton**, and associated CW TX called the **Mallet**; both are well developed but still in my mind! I had best not tell you too much or I wont finish the Brent! More on that next time since I hope it will be working by then. Tim

**Hot Iron** is a quarterly subscription newsletter for members of the Construction Club. Membership costs £7 per year with the first issue for each year appearing in September. Those people joining later in the year will be sent the earlier issues for that year. Membership is open to all and articles or questions or comments or notes about any aspect of electronics—principally on amateur radio related topics— is very welcome. Notes on member's experience building their own gear, from kits or otherwise is most interesting to other constructors. To keep it interesting, your thoughts and ideas are required please! For membership, I only need your name and address and subscription. Send it or any other suggestions to Tim Walford, Walford Electronics, Upton Bridge Farm, Long Sutton, Langport, Somerset TA10 9NJ © G3PCJ

## Mixing up a Fivehead

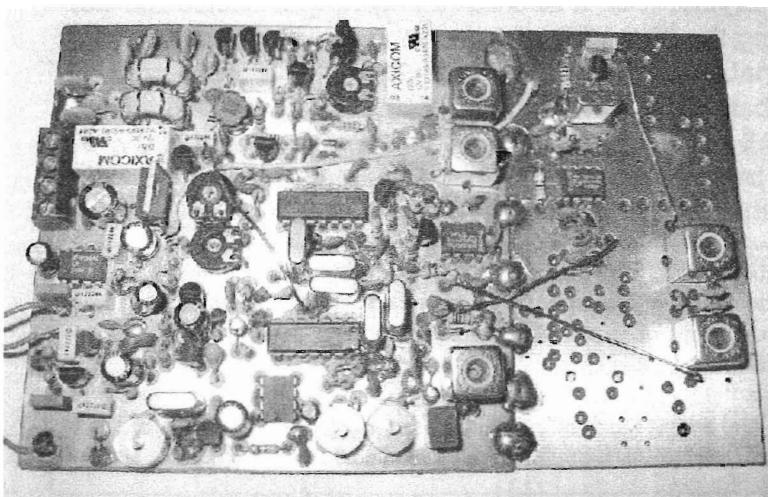
28 MHz or 10 meters as most folk call it, is an excellent QRP band, when conditions and sunspots allow. You can work the world with a few watts and a very simple, compact antenna. That wasn't the main reason why I wanted to build a single band 10m rig though. The plan is to use it as a tuneable IF and SSB exciter in order to drive a 70 MHz transverter. By doing this, it releases my Bristol to do things more HF, and I'll also have a nice little 10m rig for portable work.

Having already successfully built a Fivehead for 40m, I was happy with the design and performance. In order to get the rig working on 28 MHz you need to add an extra mixer and filter stage to the VFO. Enter the mixer kit. By making the Fivehead on board VFO run at 4 MHz and then mixing this variable frequency signal with an 18 MHz crystal, you generate a VFO or local oscillator signal at 22 MHz, the clever part is the original stability of the 4 MHz VFO is retained. The band pass filter after the extra mixer stage is necessary to pick out the wanted 22 MHz signal as with all mixing processes you generate a sum and difference frequency. The new 22 MHz VFO is then fed back into the main Fivehead board.

Having built one already, construction of the second Fivehead and extra mixer was straight forward, although as Tim always reminds you, you do need to take care with the BS170's ! I used an old Jackson air spaced variable capacitor with a value of about 200 pf for tuning the VFO, rather than the supplied polyvaricon component. At this frequency I decided that any extra stability was worth a bit of mechanical complexity. New air spaced capacitors like this cost a fortune, but if you are lucky like me to have access to lots of junk 1960's transistor radios - you'll find one in just about every set.

To get the mixer VFO working and on frequency, first of all set up the 4 MHz variable oscillator - easiest with a frequency counter but you could also use a communication receiver to get it roughly on frequency. Next thing was to check that the 18 MHz oscillator is running on the mixer board - no problems there. Setting the bandpass filter for 22 MHz is easiest using a receiver with an S meter. Assuming the 4 MHz VFO is set to 4 MHz, the output sum should be 22 MHz. So tune in 22 MHz on your receiver and you should be able to pick up the generated carrier. Adjust the cores of the two Toko coils on the mixer board for maximum S meter deflection.

That's it, the rest of the construction is the same as any other Fivehead transceiver. Guess what... it works! I must confess though to a few mistakes which needed sorting out. With my 200 pf or so tuning capacitor I've managed to achieve a swing of about 450 KHz, it seems stable too even with the PCB on the bench with flying leads running to the capacitor. The receiver is adequate, but could possibly be more sensitive. My feeling is that the 4066 signal switching at this frequency is pushing it a bit and is this is likely where the signal loss is. On transmit with all specified components in the PA it develops about 700 mW of clean RF using a 13.8V supply - more than enough to drive my transverter or possibly in the future a two stage linear amplifier to give a few more watts on 10 when the higher bands are quiet.



In conclusion I think this has been a worthwhile experiment, and I am pleased with the results. As a mono-band rig for 17,15 or 10m the extra work involved is minimal. 17m is a cracking QRP band, very low noise and not crowded. I'm happy to hear from anyone else who attempts a mixing Fivehead. Maybe this one should be called the Tenhead!

Richard Booth GOTTL

See elsewhere in this issue about the **new, smaller, simpler and cheaper mixer kit** that will also go with the Fivehead! G3PCJ

## Would you like a squeeze? by Eric Godfrey G3GC

I have been asked about different types of keyer. The following is an extract from an Edge-ware Club Newsletter that I wrote years ago considering if 'squeezing' is worthwhile.

"To refresh our memories, a squeeze keyer has two paddles, each with a single contact, mounted side by side. The left paddle is capable of being moved to the right causing the contact to close and the keyer to generate a series of dots; and the right hand paddle can move to the left, generating a series of dashes. If both paddles are operated so that both contacts are closed, then a series of alternating dots and dashes are generated (the first and last character are determined by which paddle contact is closed first and opened last). This is the condition which gives the keyer its name since the two paddles are squeezed together between thumb and forefinger. On the other hand an ordinary electronic keyer has a single paddle, with two contacts - one on each side of the paddle, which may be moved from its neutral position to either left or right which generates a series of dots or dashes respectively.

I believe the argument for using a squeeze keyer is that it reduces the number of movements required to send morse. In the Table below are listed the number of movements (closing and opening a contact is considered one movement) for both types of electronic keyer and also for a hand straight key (not bug). From the Table it can be seen that there is quite a reduction from the hand key to the ordinary electronic keyer (34.5%) but only a reduction of six movements (11%) between the ordinary and squeeze keyer and these are confined to the letters C, F, K, Q & R. The number of movements for numerals is exactly the same for either electronic keyer which effectively reduces the 11% down to 8%.

Returning now to my opening paragraph where I asked the question is a squeeze keyer really worth while, I doubt it very much since, for a small saving in operator movement/fatigue, there has been a further complication introduced into the sending technique - when to squeeze and when not! In any event, whether one has an ordinary or squeeze keyer, a lot of practice is required before going on the air or one may join the ranks of those who send at character speeds of 25 wpm or more with an average speed of 10 wpm or less due to continuously having to correct errors.'

(There were some further comments from the EN's Editor but space has run out! Next time if wanted.)

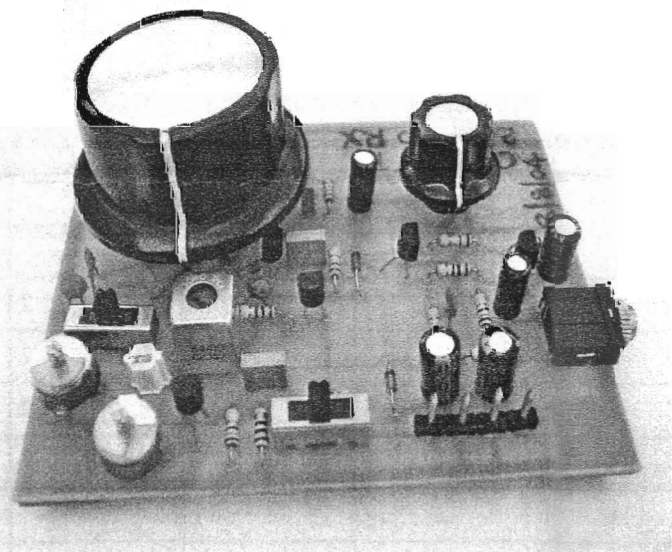
Letter	Hand key	Electronic Keyer		Letter	Hand Key	Electronic Keyer	
		Ordinary	Squeeze			Ordinary	Squeeze
A	2	2	2	N	2	2	2
B	4	2	2	O	3	1	1
C	4	4	2	P	4	3	3
D	4	2	2	Q	4	3	2
E	1	11	1	R	3	3	2
F	4	3	2	S	3	1	1
G	4	2	2	T	1	1	1
H	4	1	1	U	3	2	2
I	2	1	1	V	4	2	2
J	4	2	2	W	3	2	2
K	3	3	2	X	4	3	3
L	4	3	3	Y	4	3	3
M	2	1	1	Z	4	2	2
Totals	42	27	23		42	28	26
Key movements Squeeze action required				Brght fwd	42	27	23
				Grand Tot	84	55	49

## Computers in rigs

Adding a computing type device to most consumer gadgets brings masses of benefits at little extra production cost! Such devices, in almost single chip form as micro-processors, are increasingly being used in even small radio projects - both commercially made and home produced. In extreme cases much of the filtering and lower frequency (IF and AF) signal processing will be done digitally within the micro. One of the simplest and most obvious uses is to drive a digital read-out of the tuning frequency. Modern micros are well able to count the LO input frequency. They can then directly drive the display without having to worry about dedicated decoding chips for seven segment displays and the like! Often, an LCD display is more expensive than the micro! Adding a microprocessor to the local oscillator control arrangements, will bring many benefits too! Band changing becomes much easier with the dividers of the LO phase locked loop being under control of the micro! The micro also switches the associated RF filters either using relays or semiconductor switches. When such a rig is provided with 'two VFOs' it does not actually have two VFOs - merely a memory location in which the second VFO frequency is stored when not being used, so that it can be instantly recalled to control the VFO PPL when the correct button is pressed!

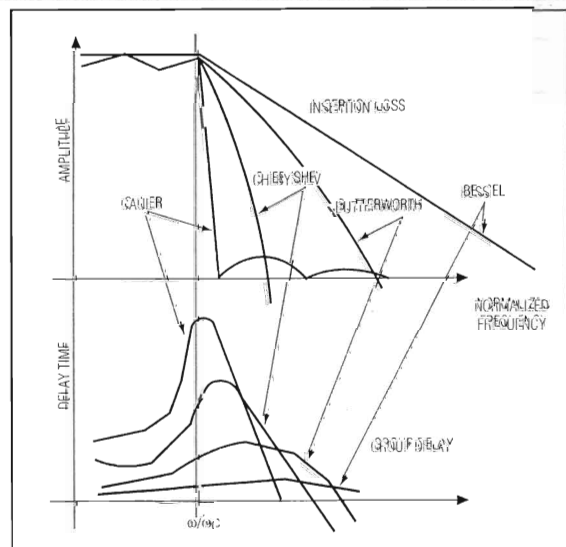
But there is the first hint of trouble! Too many buttons. The range of options just becomes so great that the required controlling keyboard is bigger than the signal handling part of the device and a degree in 'buttonology' is required! (Yes - my age is showing!) Is this device easily understood? Does the operator understand the processes going on to achieve the desired filtering etc - if not, they will not get the best out of the rig and there is little hope of making sensible adjustments for alternative conditions. Do you know how to alter the coefficients in the Kalman filters to change the bandwidth or damping? What happens when it goes wrong? Can you stick your common test instruments into it to fault find or do you always pay somebody else £40 an hour for the pleasure? When it becomes slightly older, will they still be able to get the specialist parts? What of the electrical noise from all these wide bandwidth digital circuits which have to run in an unsynchronised noisy manner the whole time? Especially if they control high current things like LED displays!

In short, for keen home constructors there is much to be said for using micros rather sparingly! They do nothing for understandability, adaptability and repairability! They can improve performance but the technology needs applying judiciously. All of which is long winded way of saying KISS - keep it simple, stupid! This is a convenient entry for showing you a picture of the new **Catcott 20/40/80m** regen TRF receiver! You cannot get much simpler than this! G3PCJ



## Active Filters

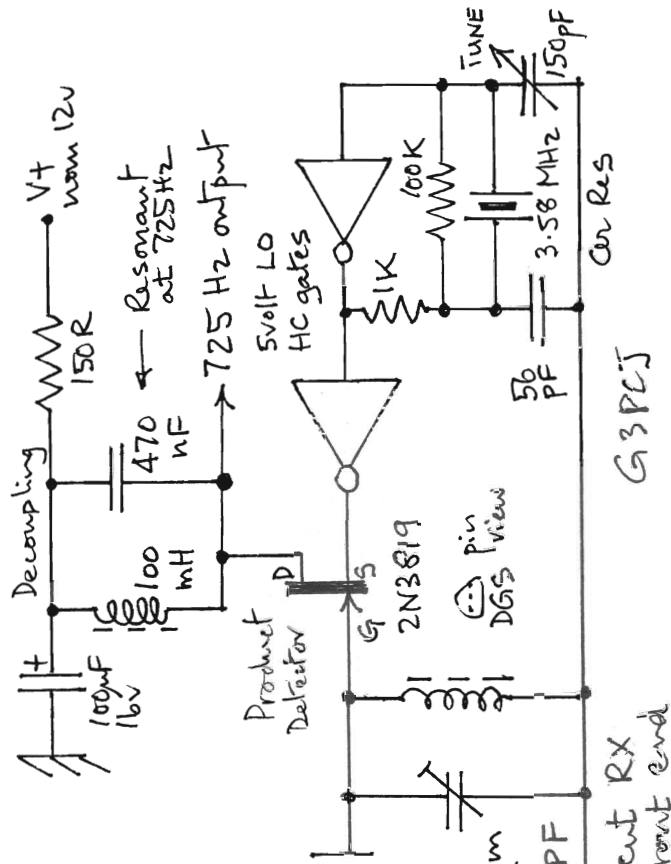
The diagram on the right was in a recent Maxim application note. It shows the amplitude and phase response of several different types of filter. Any of them can be built (in principle) for any frequency range - audio or RF etc.. In many situations, one would imagine that a sharp filter roll-off (high attenuation outside the pass band) would be the obvious choice; this is not always so because the associated phase or time response can distort the wanted information. This is why Butterworth filters are often used as a good compromise in RX audio filtering. These responses can be produced with normal continuous time filters or using switched capacitors. G3PCJ



## Brent Product detector

When scheming ideas for the **Brent** CW TCVR, I wanted to get away from the complexity of quad diode mixers. (A product detector is a specific case of the general mixer, so arranged to mix the two input frequencies down to audio.) Space was likely to be tight and low cost was pretty important as ever! The simpler diode detectors using just two diodes were ruled out due to high LO drive requirements and signal attenuation requiring more gain elsewhere in the RX. This led to consideration of the simpler active mixers using either bipolar or field effect transistors. The FET approach has the advantage of a high input impedance allowing the RF input to come directly from the inductors of the receiver's RF bandpass filter utilising the input step up from the aerial.

Normally, the advice when using a junction FET mixer, is that the weak RF signal be applied to the device gate and the strong LO signal be applied to the source; with output at the drain being filtered for the desired mixer sum - subtraction to audio in our case. The LO input should just switch the device on and off completely so that it chops up the wanted weak input signal.



## Resistors and Capacitors in series/parallel

First the easy cases!

**Resistors in series** The values just add together! Obviously a large one will dominate the combined value if the other is much smaller. eg. 100K in series with 1K is 101K.

**Capacitors in parallel** Again they just add together! The range of standard value capacitors is a limited so Cs in parallel are often needed. eg. 100 pF par 22 pF gives 122 pF.

Now for the harder cases!

**Resistors in parallel** Stated simply, the resulting value is the reciprocal of the sum of the reciprocals! Mumbo jumbo I hear! If the resistors are R1 and R2, the resulting value  $R_{par}$  is:-

$$R_{par} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$$

*$R_{par}$  is always lower than R1 or R2!*

Quite often one actually needs to find what values to 'add' together in parallel to achieve some specific value  $R_{des}$ . In this case, the formula is turned around, in terms of the desired and one 'guess'  $R_g$  value, so  $R_{sel}$  is:-

$$R_{sel} = \frac{1}{\frac{1}{R_{des}} - \frac{1}{R_g}} \quad R_g > R_{des}$$

The steps on my scientific calculator are listed right for both. Its worth noting that many resistors will have a 5%, or greater, tolerance so that using two components of widely different values will be unsatisfactory. This applies whether they are in series or in parallel. Keep the larger no more than 4 times the smaller. This applies to capacitors too.

**Capacitors in series** This is just like the resistors! The combined value  $C_{ser}$  of C1 and C2 is:-

$$C_{ser} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}}$$

When you need to achieve an odd value  $C_{odd}$ , the formula can be turned around in terms of what you have  $C_{have}$  and what you need to select  $C_{sel}$  from the junk box:-

$$C_{sel} = \frac{1}{\frac{1}{C_{odd}} - \frac{1}{C_{have}}} \quad C_{have} > C_{odd}$$

Note that for all these sums, provided all the components are using the same basic measurement values, then you don't have to enter the component multiplier. So you can add pF to pF so obtaining a result in pF; but you must not add pF to nF or KOhms to MOhms! Clear as mud now? G3PCJ

R's in parallel		
key	display	notes
1	1	
0	10	R1 value 1K
shift		
1/x	0.1	1/R1
+		operator
2	2	
2	22	R2 value 22K
shift		
1/x	0.04545	1/R2
=	0.14545	
shift		
1/x	6.875	$R_{par}$ value
10K in parallel with 22K = 6.88K		

R to achieve a value!		
key	display	notes
8	8	$R_{des}$ value
shift		
1/x	0.125	1/ $R_{des}$
-		operator
1	1	
0	10	$R_g$ value - 10K
shift		
1/x	0.1	1/ $R_g$
=	0.025	1/ $R_{sel}$
shift		
1/x	40	$R_{sel}$ value
Find a 40K resistor to go with 10K to achieve 8K.		

C to achieve a value!		
key	display	notes
3	3	
8	38	$C_{odd}$ value in pF
shift		
1/x	0.0263	1/ $C_{odd}$
-		operator
1	1	
0	10	
0	100	$C_{have} = 100pF$
shift		
1/x	0.01	1/ $C_{have}$
=	0.0163	1/ $C_{sel}$
shift		
1/x	61.29	$C_{sel}$ value
Find a 61pF cap to go with 100 to get 38!		



## Snippets!

**Digital Radio Mondiale** DRM, as this is known, is a means of obtaining broadcast FM quality while staying within the 9 or 10 KHz allocated for each channel on LF, MF or the HF broadcast bands. It depends on a clever modulation scheme using many sub-carriers to compress and convey the audio information. The BBC are radiating DRM material on the old 405 line TV frequencies.

**Resonant Circuits** Dave Buddery G3OEP kindly suggests an alternative more friendly but very slightly less accurate formula, for relating L, C and F in resonant circuits:-

$$f \text{ in MHz} = \frac{159}{\sqrt{LC}}$$

L in microHenries  
C in picroFarads

He also has an interesting tip for sizing the components for a given frequency. First change the frequency to wavelength (by dividing the MHz into 300), then the capacitor in picroFarads should be half the wavelength in metres, and the inductor in microHenries should also be half the wavelength in metres. They can also be scaled up and down provided the product is unchanged.

**Auto electric!** I recently received a PR note for a new chip which is intended for the higher battery voltages which are coming into use on newer vehicles. 42 volt systems are being increasingly used, based on nominal 36 volt lead acid battery technology. At this higher level, currents are appreciably reduced for a given load and copper losses are also much reduced. This new chip is used to drive 6 power FETs (each rated at 100 volts and 600 Amps!) in a complex half bridge arrangement across the battery supply, coupled to a standard 3 phase rotary machine, so that it can either act as starter motor or as alternator to charge the battery. Hence less weight! The chip includes soft start technology to limit inrush currents, which the bump helpfully explains are a potent source of EMI - as if we didn't already know that!

## Mini Mixer kit

This is a simpler, smaller, and hence cheaper version of an earlier kit, shown in Richard Booth's photo in this issue. It comprises a NE612 mixer, plus crystal to suit the mixing task, and a buffer which drives a pair of toroids and trimmers for the RF bandpass filter - instead of TOKOs. The original task was to obtain reasonable coverage of the CW section of each band when used with the **Brent** on bands above 80m. The scheme is to feed the normal 80m VFO from the Brent to the mixer, where it is mixed with the band dependent crystal, through the band pass filter to select the wanted sum or difference frequency, and then back to the Brent LO stages for the rest of the rig. For example, to obtain 20m, the 3.5 to 3.6 MHz coverage of the standard Brent VFO is mixed with a 10.5 MHz crystal, and the RF BPF is tuned to 20m with output over 14.0 to 14.1 MHz.

An alternative use of this kit is as a receiving converter for higher bands, <sup>with</sup> your existing base RX. In this role the mixer RF BPF is tuned to the wanted higher band, say 20m. The BPF is connected this time ahead of the mixer, where the signals might then be mixed with a 10.5 MHz crystal, and fed from the mixer output direct to your existing 80m RX. The RF filters of the 80m rig will automatically selected the wanted difference frequency and reject the unwanted 24.5 MHz output! It is a double sided 50 x 80 mm PCB but even some of this can be cut off if space is tight! It costs £14.

## Crystals!

Some members took up my offer of supplying crystals from the range below but I still have masses of all these values. The offer is still open! Send a stamped address envelope, and they wont cost you anything more! Just tell me what and how many you want.

Parallel Resonant - MHz - 5.0688, 5.6914, 5.752, 6.0177, 7.20, 9.30, 9.60, 10.2775, 10.44, 11.0258, 12.73819, 14.84830, 15.375, 16.5888, 16.623333, 17.9, 18.26, 20.105, 20.78

Series Resonant - MHz - 15.0, 18.0, 20.0, 21.0, 24.0

I have some TTL oscillators (sq wave output) which need padded bags so £2 in stamps please for P & P for these - MHz 24.0, 30.0, 32.0

I also keep a largish range of integer value MHz crystals and an increasing number of X.5 MHz ones. These are all fundamental 30 pF parallel load types. Let me know what you want. G3PCJ