Hot Iron

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Editorial

Gorgeous weather makes it rather hard to come inside and sit at the computing beast but this time I am pleased to have contributions from several members so I don't have to exercise the grey cells quite so hard! Thank you to those who have contributed. To those who have not yet done so, please do not think you have nothing to offer - I am quite certain that most builders have some tips or experiences that others would love to share. Do not be modest! There is one particular subject that should concern most future kit builders - namely the continued supply of chips suitable for home construction. Increasingly, new designs are surface mount devices and, judging by the deafening silence following my note last time about these techniques, none of you fancy building with them. There is a particular problem over mixer chips suitable for HF work to replace the well loved workhorse NE602 or 612 which form the backbone of many QRP rigs including mine; manufacture has stopped and they are no longer available at reasonable prices. While I have stocks to last for some while, I hesitate to incorporate them into major new designs. The alternatives that I have considered so far all have some significant problem, either needing more space and/or supplementary parts, or more LO power, or higher cost or are in surface mount format or a combination of all these points! Get your thinking caps on because this is a real problem especially for low noise and wide bandwidth operation.

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Kit Developments

First the good news; early reports on the **Sparkford** are very encouraging and I shall be doing a special offer for members of the GQRP Club soon - ask me if you particularily interested in this rig. I mentioned last time that I had in mind a phasing CW version of the Sparkford - after ugly style bench trials, I did a full design but sadly the performance was not good enough for the complexity and it has been consigned to the shelf of interesting ideas! Realizing that I needed a wider range of CW rigs, I have put the Frome scheme on to a single PCB, with the option for any 1 or two bands 10 to 160m, and called it the **Wellington**. This is considerable improvement brought about by a new Thompson chip which can drive an IRF510 to 5 Watts on 10m using a 13.8 volt supply. The scheme uses a 6 to 6.1 MHz VFO with crystals for each band allowing all bands to tune the same way with nominally 100 KHz coverage from the lower frequency band edge. This crystal mixing VFO scheme avoids chirp and gives good frequency stability. The single band TCVR looks like costing about £60-65. I could do with some early model builders please! The prototype is now working on 10 and 160m - the last few nights there has been a similar amount of (reasonable) activity on both these bands!

I continue to search for a cheap entry to 6m, including converters to 3.5, 7 or 14 MHz but given that most activity is FM, maybe that is the way to go. Any comments? Tim G3PCJ

Hot Iron is a quarterly newsletter for radio amateurs interested in building equipment. It is published by Tim Walford G3PCJ for members of the **Construction Club**. Articles on simple theory, construction, testing, updates on kits, questions and suggested topics are always wanted. Please send correspondence and membership inquiries to Upton Bridge Farm, Long Sutton, Langport, Somerset, TA10 9NJ. Tel 01458 241224 E mail walfor@globalnet.co.uk

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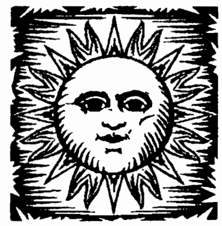


Non-Ionospheric Propagation

David Rowlands asks about the relative signal strengths, ignoring ionospheric reflection, that would be received for any band (KHz to GHz) over a distance of a few miles using a constant radiated power in the direction of the receiving site. The answer is not simple and depends on many factors.

Firstly, the method of propagation will depend upon the frequency. At the lowest frequencies it will be by surface (ground) wave and at the highest frequencies by the direct wave. Tabulated below is the commonly accepted propagation method for different frequencies used by professionals.

Frequency	*Main means of propagation*
Below 500 KHz	Surface wave (Ground wave)
500 KHz to 1.5 MHz	Surface wave for short distances and Ionospheric wave for longer distances
1.5 MHz to 30 MHz	Ionospheric wave
Above 30 MHz	Space wave (Direct wave) within line of sight

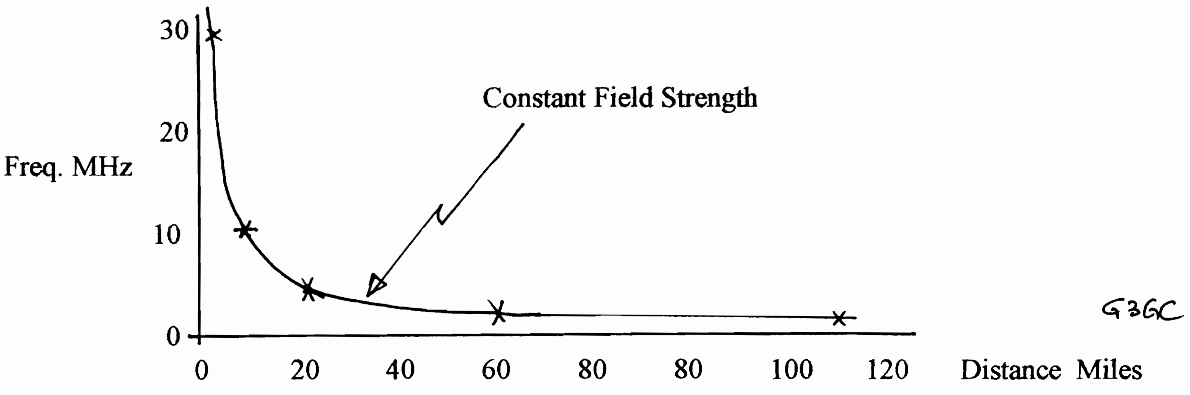
Obviously, the changes in the method of propagation are not discrete as the table suggests but tend to gradually change from one category to the next. This is quite obvious to us as amateurs as we will use many bands in the range of 1.5 to 30 MHz for local communication although admittedly this becomes more and more difficult the higher the frequency that is used.

The surface wave is the wave that travels just over and partly within the ground - hence its other name of ground wave. The wave front gets tilted downwards thus allowing the wave to follow the curvature of the earth. An example of this form of propagation is the BBC's long wave transmitter at Droitwich on 198 KHz. This, as you all know, covers most if not all of the UK without any of the fading problems that are experienced by the medium wave (0.5 MHz to 1.5 MHz) transmissions due to ionospheric reflection and propagation. Even lower frequencies than this are used for secure long distance communication. The depth of penetration of surface wave into the earth varies depending on the ground's characteristics and the frequency in use. This can be as much as fifteen metres at broadcast frequencies but only one or two metres at shortwave frequencies. This penetration means that some of the power is dissipated in the earth's surface, thus reducing the signal strength as the distance to the receiving station increases. These ground losses depend upon two main factors namely the "Relative Permitivity" and the "Conductivity " of the ground. The higher both these are, then the lower are the losses. Tabulated below are the values for different types of surface.

Type of ground	*Relative Permitivity*	*Conductivity (mho/m)*
Sea water	80	5
Fresh water	80	0.005
Moist soil	15 - 30	0.005 - 0.01
Rocky ground	7	0.001
Dry soil	4	0.001 - 0.01

Theory shows that at low frequencies the surface wave is dependent mainly on the conductivity and is strongest for high conductivity. At higher frequencies a high permitivity is the important factor in giving a strong surface wave. Thus for all frequencies surface wave propagation is best over a sea path and worst over dry ground.

If one uses a short ground based vertical aerial radiating a constant power then for the same received field strength the distance increases as the frequency decreases. The graph below is the curve of constant field strength plotted for frequency against distance.



From this graph it can be seen that with ground wave propagation the same field strength is obtained at 3 miles on 30 MHz as would be obtained at 20 miles on 3 MHz or 110 miles on 0.5 MHz.

Above 30 MHz, the ground wave as we understand it, does not exist and the main method of propagation is by the direct wave. If there are no reflected waves from the ground, buildings or other objects, then the received signal will approach the free space propagation law:-

E_0 (dB, µV/m, one KW) = 102.8 - 20logD   where D is the distance in miles.

This simply means that if the power radiated in the direction of the receiving site is 1KW then E_o is the field strength in µV/m expressed in dBs. If the power is not 1KW but 100W then this reduction expressed in dBs is 10 and E_0 would be reduced by this amount. An amateur station on two metres with a high gain aerial and using full power can easily have an effective radiated power of 1KW. For the formula to apply with any degree of accuracy, then the aerials must be elevated above ground to ensure there is a "line of sight". The radio horizon from an elevated position is further than the figure obtained by calculation using the physical diameter of the earth. The reason is that, due to refraction in the atmosphere, the radio waves are bent downwards and therefore they can "see" further than would be expected. This is the same as saying that the earth is a bit flatter or has a larger diameter than it actually has. The factor taken for normal atmospheric conditions is that the earth's diameter is effectively increased by some 30% or that its diameter is four thirds the physical diameter. The formula for calculating the "radio horizon" for a four thirds earth is given as $D = \sqrt{1.414 \times H}$. Under abnormal weather conditions, the refraction becomes greater and the 4/3s factor will increase considerably with consequent increase in the distance to the radio horizon. This is what we call a "lift".

The effect of using a low aerial will not only be to reduce the distance to the radio horizon but it will also reduce this field strength due to losses from objects in the line of path. This is commonly called clutter loss. A further effect that will affect the signal strength at gigahertz frequencies is the amount of water in the atmosphere either as droplets or as rain.

Propagation is never a precise discipline but I hope the above helps. Eric Godfrey, G3GC

Zinc-air cells and Battery Technology

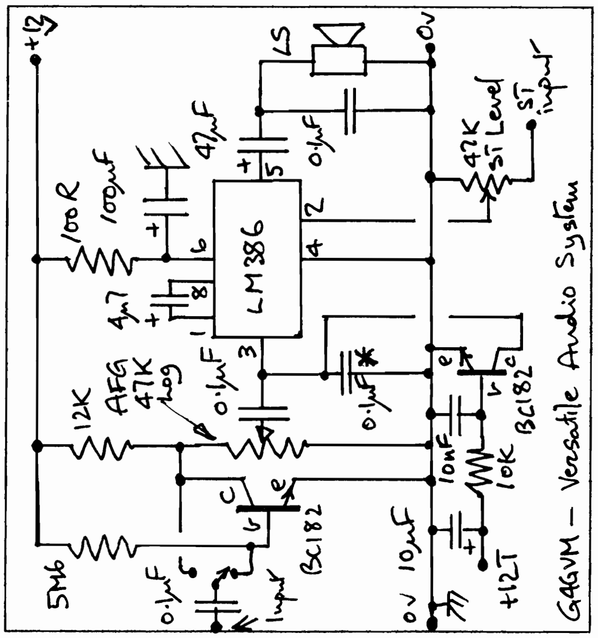
Following the note in Hot Iron 18 about rechargeable batteries, I spied the following note in a trade magazine:- "The battery industry uses three measures to compare battery technology. They are: energy per pound weight, energy per volume and cost per unit of energy. Rechargeable Zinc-air cells have 1) almost twice the energy per pound weight as Li-ion; 2) slightly more energy per volume than Li-ion and 3) cost just one third of Li-ion per unit energy." Watch out for them in future!

A Versatile Audio System

The circuit alongside has become my standard audio system for DC rigs etc. because it uses few components, is stable and compact. An input port for a sidetone oscillator is available at pin 2 of the IC and muting at pin 3 is easily achieved when used with a transmitter.

For general use it is made up as a separate unit with the input switchable to include the pre-amp for very weak signals such as from a crystal set, or mixer, or for signal tracing, or as the power amplifier to drive a loud speaker for stronger input signals.

Derek Alexander G4GVM

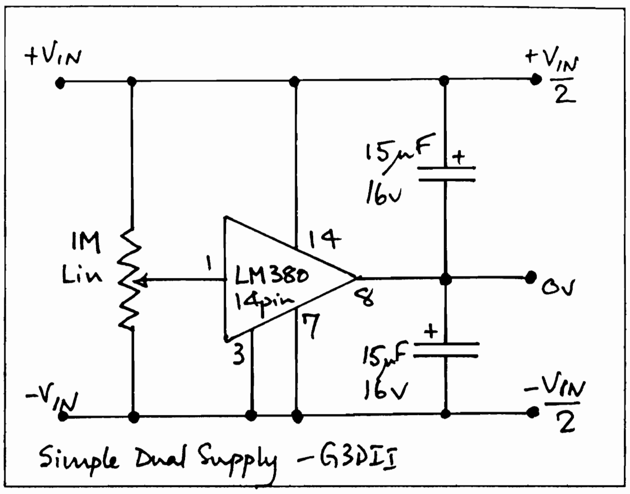


(Note that Derek has set the capacitors for CW, so if used for phone, the starred input capacitor would need to be reduced and the output coupling capacitor might need increasing depending on LS impedance. G3PCJ)

Taunton Tips

When tuning up two band cards, David Rowlands G6UEB suggests that after you have set the first band's inductor cores, that you cover them up with some form of tape to prevent inadvertant adjustment while setting those for the second band. Alternatively, mark the cans with the band's wavelength! He has also done away with the fine tuning control by using a slow motion drive on the main tuning pot. Other builders advocate glueing the ends of the band card connectors with araldite.

Simple Dual Power Supply

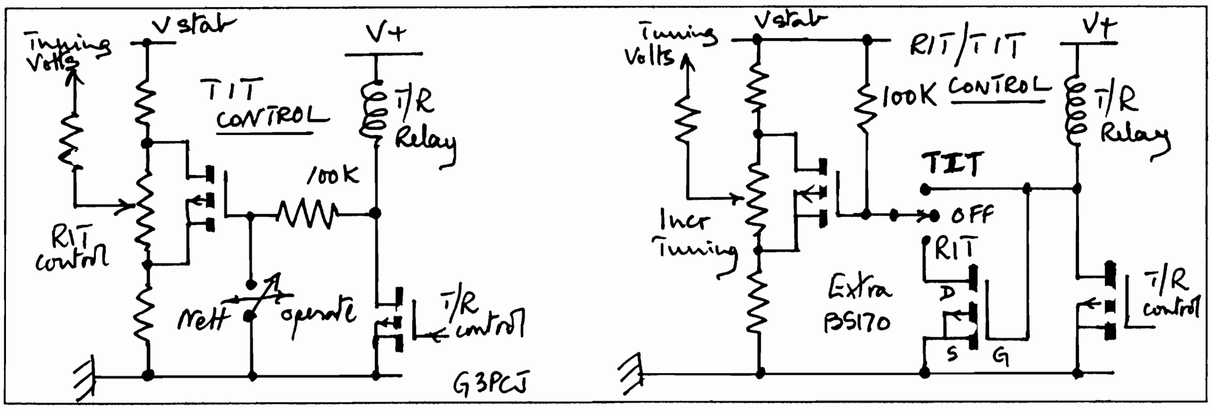


A glance through the list of operational amplifiers available will show that only a few are designed for use with a single supply. This can be a nuisance to the constructor when, for instance, he wants to build in say a 741 into a circuit using a common supply. It is well known that it is sometimes possible to bias pin 3 of a 741 and the like to work from a single supply but this dodge cannot always be used.

The circuit alongside offers a cheap and simple way of obtaining a split supply using a LM380 audio power amp IC. The device is internally biased so that with no input, the output voltage is held mid-way between the supply rails. The 1M pot should be initially set to mid-travel and is used to nullify any unbalance in the output. The regulation of V_{out} depends on the regulation of the source supply but positive and negative outputs will track accurately irrespective of input regulation and unbalanced loads. The maximum free air dissipation is a little over 1 Watt so extra cooling in the form an aluminium fin stuck to the top of the package maybe required. The device is fully protected and will go into thermal shut-down if dissipation is exceeded. Current limiting occurs if the output current exceeds 1.3 Amps. The input voltage should not exceed 22 volts. The details given are for the 14 pin version, the 8 pin can be used with less dissipation. Joseph Bell G3DII

Changing TIT to RIT

David Proctor G0UTF told me how he had changed the Frome's frequency offset arrangements from a Transmit offset, set with a netting control, to provide Receive Incremental Tuning. To make this change, the signal driving the offset gating transistor needs to have its sense reversed. Usually the tuning offset is inhibited when the controlling transistor FET gate is high at 8 or more volts - thus we need to arrange for this gate voltage to be high (8 volts or more) during transmission or when the RIT is switched off. For the Frome this is easily achieved by disconnecting the gate of TR307 from R316 and the output at pin 10 of IC301C and reconnecting the gate of TR307 to pin 11 of IC310D. In simple rigs, TIT control is often provided since it can be driven from the TR relay without further transistors - this is the scheme in the Wedmore sketched on the left below. It is easily changed to RIT control by adding a second BS170 inverting stage and re-arranging the resistor. In fact, using a centre-off toggle switch allows you to have RIT or TIT as you prefer! Remember the tuning procedure changes; for TIT you tune initially for either sideband with the TIT off and then, with the TIT on, adjust the TIT control for zero beat. For RIT, you tune for zero beat with the RIT off, then switch it on and select whichever sideband you want with the RIT control. With care, provided you always tune in the same direction (to always use the same sideband) you do not need to keep switching the RIT on and off as you tune around; but you do need to always tune for the same pitch that you earlier set the RIT control to achieve when the main tuning without RIT gave zerobeat. G3PCJ

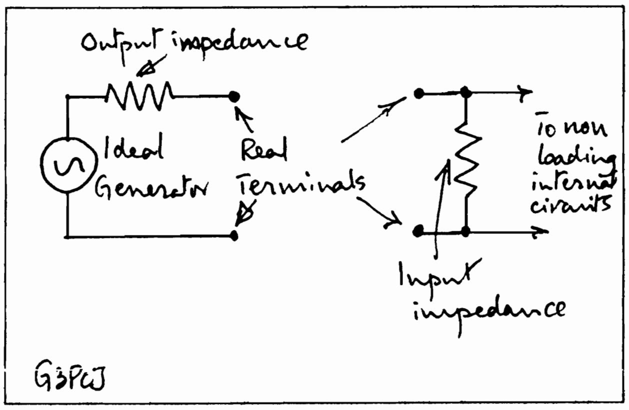


Boxes

Jim Geary advocates the JS19 from JAB which is 202x204x75 for 2 PCB rigs. It costs £6.25 + 1 P&P

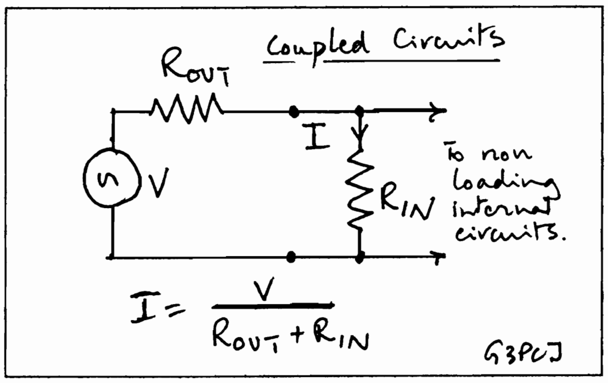
Interstage Coupling and Impedance

Constructors often lift circuits from different sources and couple them together only to find that they do not perform as expected - frequently the culprit is mismatched impedances. All real circuits have an input and output impedance and knowledge of these, or at least their rough magnitude, is essential to transferring energy satisfactorily from one to the other. Take the simple example of a small zinc-carbon primary cell. It is said to have an output voltage of 1.5 volts but in reality you can only draw a fraction of an Amp out of it (for a moderate sized cell) because it has internal resistance. This is its output impedance. The term impedance is rather more general, since it also covers AC situations, but for this note I apologise for being slightly loose with the terms impedance and resistance/reactance. The equivalent circuit of the above cell can be represented by an ideal voltage source or generator in series with a resistance - see the left diagram below. The actual values can be easily measured; the voltage of the ideal generator is measured with a voltmeter (having a high input impedance which draws a negligible current hence no volt-drop in the internal resistance), the internal resistance or output impedance is assessed by measuring the current through a short circuit across the output. Then the internal resistance is worked out by Ohm's law (R = V/I) using the previously measured voltage. Another less damaging method is to use a resistor across the output, whose value is adjusted till the voltage across it is half the open circuit voltage. The value of the external resistor is then the same as the internal impedance. (If doing this at HF remember to not introduce extra capacity from the resistor or voltmeter.)



In a similar way, the input of a circuit can be represented by an impedance across the input terminals with some sort of ideal generator creating an output depending on the applied voltage - see the right hand diagram. The actual value of the input impedance can be measured by seeing what current a known applied voltage creates and then use Ohm's law. You can also use a variable resistance in series and adjust it till the voltage across the unknown input is half that from the source. The resistance then has the same value as the input resistance.

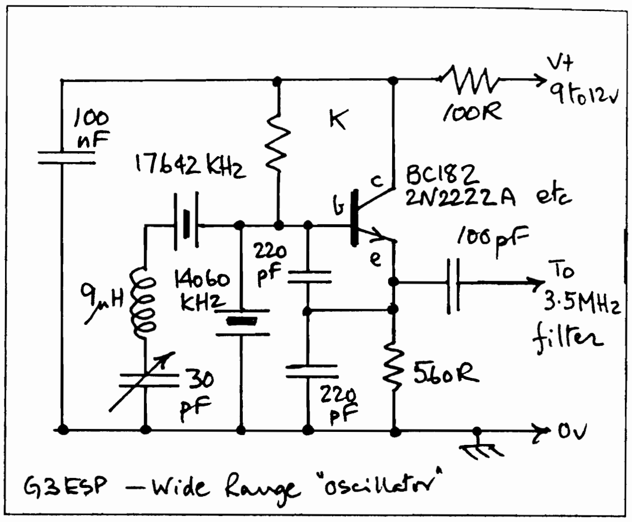
When two such circuits are connected together, the actual current that flows between them is dependent on generator voltage and both output and input resistances - see below. The problems arise when one of the resistances is very much larger than the other so that it massively restricts the current that would flow into the load circuit. Try putting a high wattage torch bulb across the single cell - it doesn't even glow because the cell's output resistance is much higher than the load resistance! Note that either of them maybe the culprit limiting the desired current flow. Generally, the desire is to transfer maximum energy from the driving circuit to the load circuit and theory shows this occurs when input and output impedance have the same value. For example, 50 Ohm interstage impedances in the front end of a RX. In the later stages of a RX, when noise is less important, the rule can change to ensure that the load impedance is somewhat larger than the output impedance so that there is negligible voltage drop across the output impedance. In all cases, *the important thing is to make certain that the load impedance is equal to or higher than the source impedance.*



In many practical situations, the exact impedances are not known but their approximate value can be assessed or guessed from experience. Series tuned circuits have very low impedances, while parallel tuned circuit have very high values - but the impedance presented to other circuits can be altered by inductive or capacitive 'tapping down'. Active circuits tend to have 'middling' impedances but feedback can modify them up or down - this is a widely used and powerful technique beyond this note. Components directly in parallel with the input or output, in a signal sense; set a maximum for the impedance; similarly components in series with the signal line will set a minimum value. Modern op-amps have very low output impedances which are further reduced by feedback. A derivative of the impedance rule is 'don't mix impedances unless you have an idea of their values'! Tim G3PCJ

Wide Range Crystal Control for 80m

Walter Farrar G3ESP sent in the circuit on the right which generates a wide frequency range for the 80m band by pulling a high frequency crystal and mixing with another. Frequency stability is excellent. He happened to have two crystals which enabled an output from 3509 to 3587 KHz with the values shown. The circuit works by oscillating on both frequencies at the same time and mixing them together all in one transistor. The detail of the output filter is not shown because it will depend on what it is driving. The 9 /uH inductor can be 44 turns on a T68-6 toroid o a 10 /uH small choke.
(Make the 14.060 MHz crystal the variable one and it might do 20m as well! G3PCJ)



Somerset Homebrew Contest

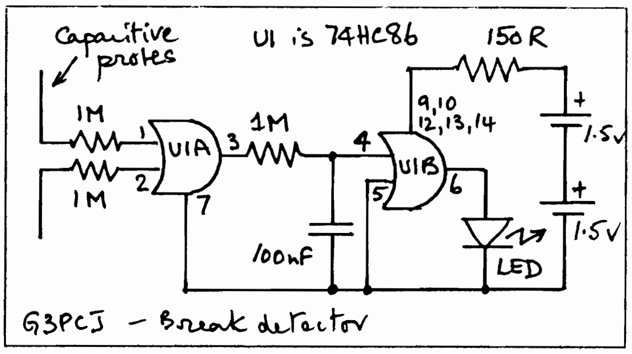
The full details will appear in Spratt but Stan Laing G4MQC has been declared the overall winner this year. He was using a Taunton! There was a larger entry with some overseas operators which is good. Get your rigs ready for next year! Thanks go to Peter Barville G3XJS for organising it.

Web sites!

There is a wealth of fascinating information available on the World Wide Web. For example, the ability to down load the full data sheets of any device you fancy using is worth a lot time and money. There are also some very interesting home pages from many radio amateurs including that from Frank Lee G3YCC who has some smart colour pictures of his Taunton. His home page address is http://www.homeusers.prestel.co.uk/g3ycc and of course there are others for the GQRP Club etc. My son is supposed to be working on mine!

Christmas Tree Lights!

Its a bit early yet but finding the failed bulb in a long series connected string is very tedious! The circuit right appeared in a US journal and should save many hours of frustration and broken bulbs due to screwing them in and out! Wave the two capacitive probes slowly all around the string when it is connected to the live mains. At the failed bulb, the voltage difference is high which, when coupled to the probes, causes the LED to light. Nifty! G3PCJ



Various PCBs

I have surplus to my needs:-

One pair of new Yeovil RX and TX PCBs plus another TX PCB.

A Coxley PCB with minor track defect. The associated 20, 40, 80 Regen TRF RX kit is available. There is also the matching Godney 3 band CW TX.

Slightly damaged variable CW filter PCB - rest of kit is also available.

A number of Issue 4 Taunton PCBs which need only minor alteration to update them to the latest Issue 5 state - rest of the kit also available.

Please contact me if you want to build these kits or use any of the PCBs.

Subscriptions!

I am afraid it is that time of year again! If you wish to continue receiving Hot Iron, I need to have your subscription by the next issue, due out in early September 1998. £6 please for UK members and £8 for overseas. I shall not be sending any reminders. Back issues for complete years are available for £5. Thank you for your support during the last year and I hope for articles for the next. Tim G3PCJ