# Hot Iron

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## Editorial

Reading PW last night, what's left of my brain, was stirred by the debate about the use of morse for commercial traffic and the future of commercially made amateur radio equipment. Most of you will know that BT has closed the UK ship to shore services operated as GKB of which perhaps the most famous station was Portishead Radio. (Not that its transmitting or receiving aerials were actually at Portishead! There was also a notable special radio event allowing cross-band operation between amateurs and the coastal stations which led to a mighty pile-up.) The decline in the use of CW has come about because satellite communications are now relatively cheap, don't require specially trained officers, and can handle speech, data or video relatively easily. However many commentators make the point that morse messages can be passed with very simple equipment so arguing that it will remain a strong contender where cost or reliability are paramount. This is why there is strong continuing interest in CW by radio amateurs and a feeling that distress radio 'watches' should continue on the internationally recognised HF distress frequencies.

The same financial pressures are also likely to apply to the large commercial markets for HF radio in the developing world: it is this market which pays for the development of most HF gear - amateur and commercial. Factory made microprocessor settings allow it to work only on the designated frequencies for each service. What happens when satellites also take over this commercial traffic - no amateur black boxes maybe - because the amateur market alone is too small? Although CW transmitters can be quite simple, this is not the case for receivers which will have to work in band conditions that are likely to remain heavily congested due to emissions from high bandwidth wire based telephone systems (ASDL etc.) and from spread spectrum networks - military or Government etc.. The regenerative TRF RX just will not do in these conditions! Will this lead to an upsurge in amateur radio building and be the saviour of kit suppliers?! I hope so - times are changing!

## New Developments

At long last I am able to announce that the *Bristol* will be available shortly! It is a major new high spec SSB and CW multi-band superhet for any band up to 10m using plug-in band cards. It has been over a year in development and there are still some associated subsidiary kits to be completed! However, the prototype is now working well and I shall be pleased to hear from any Club members who would like to help prove the Manual and have a go at an early model in exchange for a small discount! Eventually, it should be possible for it to have any number or combination of bands up to four plugged in and controlled from the front panel. It has many similarities to the Taunton but with extra IF amplifiers and a rather special adjustable CW filter which I have described later in this issue.

A major new project for keen constructors!          Tim Walford G3PCJ Editor
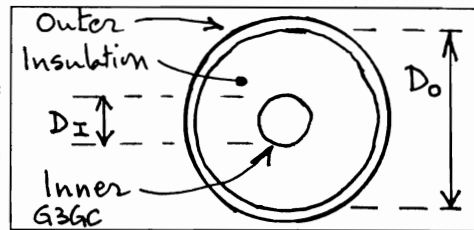
## _Odd bits of Coax - are they 50 or 75 Ohms?_ by Eric Godfrey G3GC

From time to time we all have odd pieces of coaxial cable of whose impedance and velocity factor we are not sure. Is it 50 or 75 Ohms cable and what is its velocity factor? Well there are a number of simple ways of finding the answers. The characteristic impedance of a coaxial feeder may be calculated from the physical dimensions of the feeder and is given by the formula:-

$$Z_O = VF \times 138 Log_{10}(D_O / D_I) \text{ Ohms}$$

Where VF is the velocity factor (depends upon the insulation), $D_O$ is the inside diameter of the outer conductor, $D_I$ is the outside diameter of the inner conductor. If you have a micrometer then it is easy to measure the dimensions and do the calculation. Since all coaxial cables have to have some form of insulation to support the inner centrally within the outer, the inside dimension of the outer may be found by measuring the outside diameter of the insulation. In the odd pieces of cable that we are likely to have or pick up at a rally they will most likely have solid polythene insulation and therefore easy to measure with a micrometer. The velocity factor for a cable with a solid polythene insulation is 0.67 and therefore the formula becomes $Z_O = 92.5 Log_{10}(D_O / D_I)$ Ohms. For cables having a partial air and polythene insulation such as foam polythene, then the velocity factor will have to be determined and, depending upon the ratio of air to polythene, will lie somewhere between 0.67 and 1.
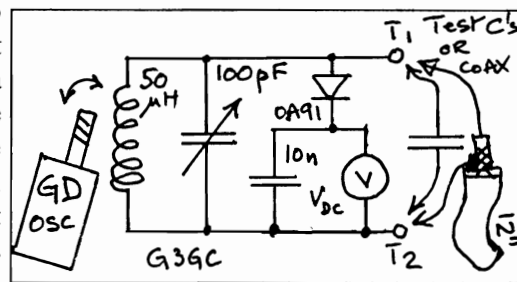
The above method is of little use to those of us who do not have access to a micrometer. However there is another way of estimating the impedance and that is to measure the capacitance between inner and outer per unit length. The capacitance per unit length is, irrespective of the physical dimensions, constant depending on the impedance and the velocity factor. For our use this reduces to a very simple formula:-        $C = (1016 \times 1/VF) / Z_O$ pF per foot

Obviously for air insulation this becomes $C = 1016 / Z_O$ pF per foot and for solid polythene insulation where the velocity factor is 0.67 then $C = 1516 / Z_O$ pF per foot. From this formula the capacitance per foot of a 50 Ohm cable with solid polythene insulation will be $C = 1516 / 50 = 30$ pF per foot and for 75 Ohm cable then the capacitance would be 20 pF per foot.

Now most of us these days have a digital voltmeter and the majority of these have the capability of measuring capacitance. So we can measure the capacitance of the piece of unknown cable (open circuit at both ends) and express the result as so many pF per foot. From this we will be able to determine if the coax is 50 or 75 Ohm impedance.

Another way to estimate the capacitance is to have a parallel tuned circuit, fed with RF from a GDO at about 2 to 3 MHz, the inductor is tuned to resonance by a 100 pF variable capacitor as shown alongside. The frequency should be adjusted to make the circuit tune somewhere near fully meshed, say at about 80 pF. A means of indicating the voltage across the tuned circuit will be required which may be a diode and voltmeter, as in the diagram, or scope _with_ divide by 10 scope probe. Note the position of the capacitor at resonance, indicated by maximum voltage, and then add a fixed 20 pF capacitor across the circuit at $T_1$ and $T_2$. Retune the circuit for resonance and note the new position of the capacitor. This is repeated for a 30 pF capacitor and again the position noted. These two positions indicate 50 and 75 Ohms respectively. To check the impedance of a cable ensure that the RF frequency is correct by adjusting for resonance with the variable capacitor in its original position and then connect twelve inches of open circuit cable across the tuned circuit at $T_1$ and $T_2$ and retune the 100 pF for resonance. The position of the capacitor will indicate whether the cable is a nominal 50 or 75 Ohms impedance, assuming you have checked it has solid polythene insulation.

The impedance obtained by both the mechanical method and the electrical method may be a few Ohms adrift from 50 or 75 - do not worry as we are not trying to actually measure the cable's impedance but rather to determine whether it is of a nominal 50 or 75 Ohms impedance. Next time I will explain how to measure velocity factor if I am allowed the space. (Of course - Editor!)

## *Versatile Pulse Generator*

The 555 integrated circuit is the basis of many interesting designs for pulse generating circuits. One of its major advantages is its strong output stage, being able to sink or source up to 200 mA directly from the output pin with supplies of up to 20+ volts. This is why it is often used for charge pump circuits generating subsidiary supply voltages. However, it does have a small drawback! In the simplest of circuits, the duration of the high and low sections of the output waveform do not have equal periods. Over the 25 years that its been available, many designs have been published to overcome this snag; most of them relying on separating the charge and discharge paths of the timing capacitor by putting diodes in series with separate charge and discharge resistors. Often there remains some minor interaction between the two sets of timing parts. The circuit shown alongside claims to overcome this so allowing independent control of the output frequency (or repetition rate) and the pulse width duration with two potentiometers. Changing the 47 nF timing capacitor will alter both the high and low sections of the output waveform. For a general purpose instrument, a range of capacitors could be selected by a switch. The value of the pots can be reduced for higher frequencies/shorter pulses but then diode resistance may lead to some interaction. The approach suggested here is equally applicable to the dual 556 or CMOS versions. G3PCJ
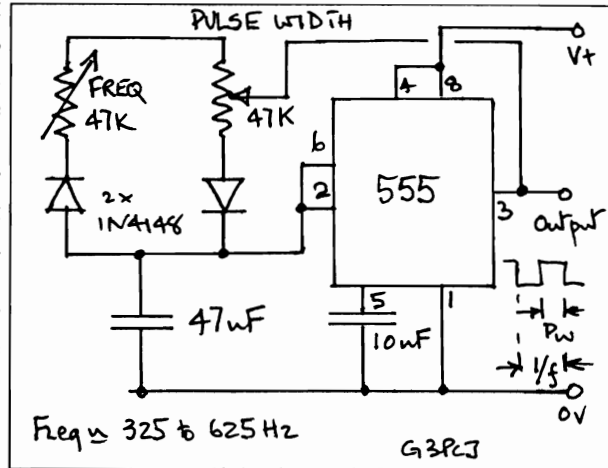
## *Supply Crowbar Circuits* by Joseph Bell G3DII

If you are going to use voltage sensitive equipment from a stabilised supply having pass transistors and a potentially damaging higher unregulated internal supply voltage, then you should use a 'crowbar' circuit because an ordinary output fuse will not blow quickly enough to protect your expensive device if the pass transistor/regulator goes short circuit. You need an electronic device to kill the volts long before your circuit melts!

The circuit shown right triggers at just over 5 volts so is suited to protecting digital devices running on a nominal 5 volt supply. The SCR should be connected across the supply to the regulator circuit and after a suitably rated fuse which will melt, so letting your SCR serve another day! While the SCR can be across the main supply reservoir capacitor so that it utilises a fuse between transformer and rectifier, it is better to fit two fuses as shown. Changing the zener diode will allow other output voltages to be protected but, whatever the intended output, do try these protection circuits first before you connect your valuable devices to the PSU. Test them by disconnecting the 'sensing' point S from the supply and explore the voltage at which the SCR triggers with a separate variable supply. The SCR should be man enough to pass a few times the rated supply output current. G3DII
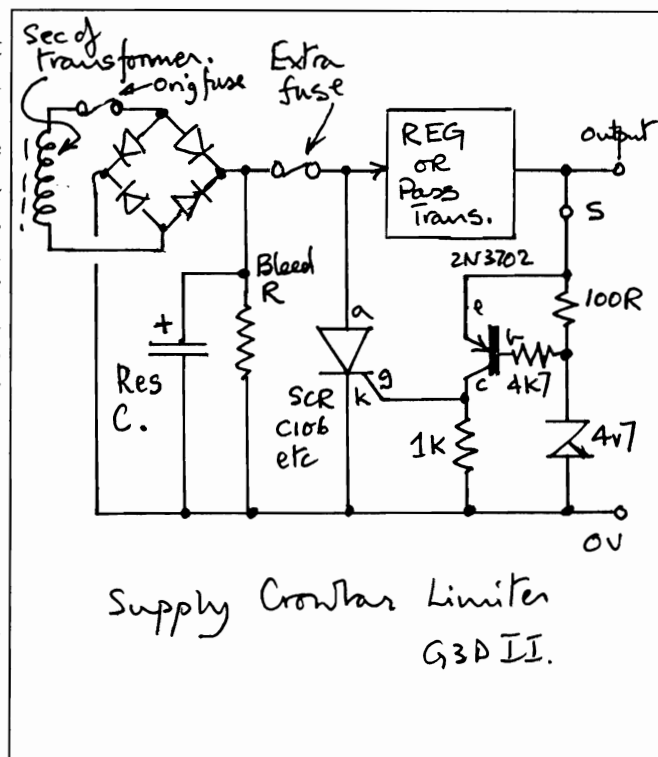
## *Assorted Audio Filters*

Jospeh Bell G3DII suggests that a tuneable 'state variable' filter would make a good construction project for use as a receiver adjunct. The filter part of the circuit uses 3 op-amps arranged as two identical integrators (which determine the frequency response) in a loop with a summing amplifier. It can provide a choice of second order high, or low, or band pass responses where the '3 dB down' frequency (for low and high pass) is the same as that of the band pass output's peak. The fourth op-amp (of a 4 device chip such as the TL074) can be used as an output buffer or replaced by a power amplifier such as the LM380 for driving a LS. It can be used to clean up a phone SSB signal or reduce the bandwidth for CW purposes. With the values shown it tunes from about 500 Hz to 5 KHz. The drawback is that it requires a dual ganged pot and extra parts for the mid-supply bias voltage. As



Adjustable filter, $G_v=1$, $d=0.2$, $Q=5$, LP, BP or HP.  G3DII/G3PCJ.
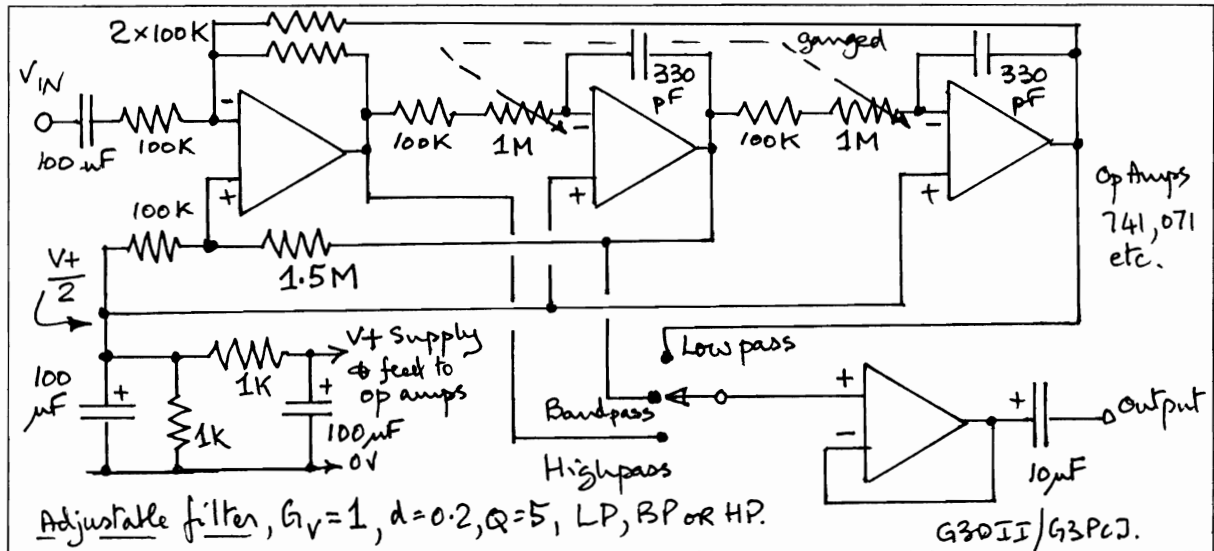
an alternative, a fixed frequency band pass filter such as might suit a simple CW rig is shown on the left below. This circuit has a voltage gain of about 50 so it is important to use a low noise device such as the TL071 if it is in the early audio stages of a direct conversion rig. It has a second order band pass response centred on 725 Hz with a Q of 5. The circuit on the right is actually a second order 800 Hz low pass filter with good HF attenuation but the values give a hump in the response just before the attenuation starts so in use it actually appears to have a band pass response. Voltage gain is approx. 3.
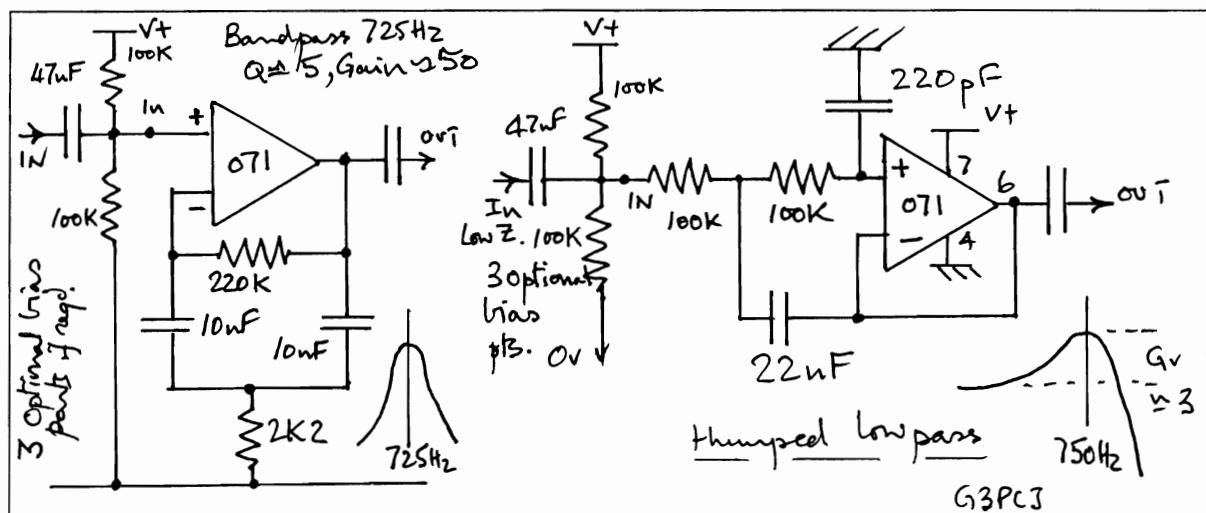


A more recent approach is to use a 'switched capacitor' filter whose frequency response can be easily adjusted by a single control. This is the type of filtering used in the **Bristol** to narrow the nominal IF filter phone bandwidth down to near 800 Hz for CW. There are many chips available but my preference is the MAXIM 297 which contains a single op-amp and an 8th order clock tuneable low pass filter with an elliptic response - all in a single 8 pin DIL. The advantage of the elliptic response is the exceedingly fast fall off just beyond the 'corner' frequency where the response is 3 dB down. For example, when set to be 3 dB down at 1 KHz, the response will be about 80 dB down at 1.5 KHz! It's

like the proverbial brick wall but is moveable! It requires a driving clock whose frequency has to be 50 times the desired corner frequency. The circuit below is from the Bristol. The MAX297's internal chopping action generates low level clock hash which has to be removed by a simple conventional filter after the main elliptic filter - the values used here don't generate a hump like the earlier low pass filter circuit! The MAX297's self-biasing op-amp is best used to raise the input signal level to the elliptic filter, so improving the signal to noise ratio, and to keep the input signal bandwidth well below the clock frequency so avoiding aliasing and spurious responses. The clock is easily generated with one section of a CD4093 two input Schmit trigger AND gate. A single pole switch selects the resistor chain for the timing capacitor; if desired the preset can be made a front panel control for ease of adjusting the CW bandwidth. Other coupling capacitors in the audio chain provide a 300 Hz high pass response; the spare devices in the op-amp/gate ICs are used elsewhere in the rig.     G3PCJ



Part of Bristol audio filtering G3PCJ
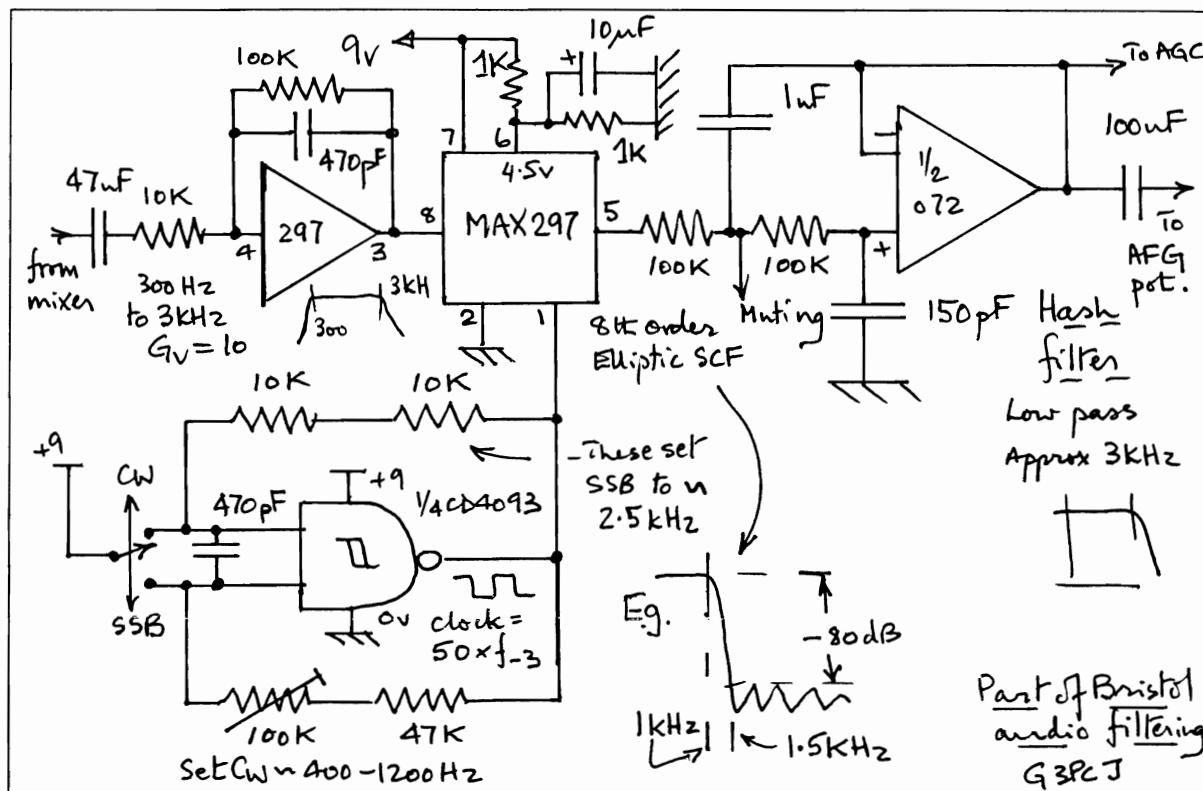
## Rig Experiences!

**Radstock**        Craig Douglas G0HDJ reports almost total elimination of night-time broadcast station breakthrough on 30 and 40m by reducing the 6 MHz band pass filter coupling capacitor C126 to 2p2. There was no loss in sensitivity. He adjusted L100/101 for maximum signal with very slight detuning of the band RF resonators L161 and L171 away from the broadcast stations. He has also changed C131, 47 pF, from the original COG blue type to an N150 type which improved frequency stability.

**Bruton**        A customer's rig fitted with a CW kit, showed persistent breakthrough of microphone audio into the RX audio output stage during transmission despite having been fine without the CW kit! He had all the usual screened lead, good earth connections and short lead precautions but still had problems! Eventually I found the only way to cure it completely was by 10 nF disc capacitor soldered directly across the two audio input pins of the LM380 chip. It seems the device does not like differential RF input signals! I have seen this problem before but never found such a good solution!

If any customer wants these extra parts please let me know.

## Replacement for the SL6270 VOGAD chip?

Charles Wilson M0CDD suggests the Analogue Devices chip SSM2166P would make a good speech amp; it has internal audio derived AGC and can be used in the audio stages of a receiver with a signal strength meter and noise gating. Shame I had already designed the Bristol's AGC!

## Somerset Contest

Peter Barville G3XJS will be publishing the full results in Sprat but the winner Rowland G4APO has very kindly donated his prize to a worthy cause chosen by G3RJV. I have sent a George a 20m Minehead and await to hear where it went. Congratulations to all entrants, much better this time!

## Slow Scan TV

Peter Nicholson G3MYZ has been using one of his two Tauntons for SSTV work on 14 MHz. He sent me some colour stills via the Internet - sadley I cannot publish them due to my using a photocopyier for Hot Iron. Nevertheless, they are very good and reveal all sorts of interesting information about the people and shacks for those contacts where he has exchanged TV QSL cards.

## Decibel Relationships!

I have extracted the following useful notes from the back of a Texas Instrument data sheet:-
dB is a relative measure, either one thing to another, or one thing to a reference.
dBm is power referred to 1 mW, dBmV is referred to 1 mV, dBW or dB is power referred to 1 Watt, dBc is referred to the carrier level; usually dB and dBm refer to power into a 50 Ohm load.
Voltage Gain $dB = 20Log(Vout/Vin)$          Power Gain $dB = 10Log(Pout/Pin)$
$dBm = dB$ per mW      $dBmV = dB$ per mV,     Half power $= -3$ dB,     Half voltage $= -6$ dB
Converting from dB to dBm $= dB + 30$, converting from dBm to dB $= dBm - 30$
Converting power in Watts to dB, $P(dB) = 10LogP$, for example 3 Watts, $P(dB) = 10Log3 = 4.8$, and 1.5 Watts $= 10Log1.5 = 1.8$ which is 3 dB less for half the power. 100 Watts $= 10Log100 = 20dBW$.

## Antenna Matching Unit for 40m doublet

Craig Douglas G0HDJ asks what component values to use in a balanced link coupled AMU feeding the antenna by twin feeder. First a theoretical approach! An old suggestion is to use 1.5 times the wavelength in picofarads as the nominal resonating capacitor, so on 40m this is 60 pF. For a split capacitor to feed the balanced line it requires twice as much or 120 pF, but practically say 250 pF on each side to allow for adjustment. The main secondary inductor has to resonate with 60 pF needing 8.6 ,uH which requires 26 turns on a red T200/2 powdered iron toroid. The primary should have a reactance of at least four times the rig feeder impedance, or 200 Ohms, so needs to be 4.5 ,uH implying 19 turns. The adjustable link capacitor needs to be able to resonate with the primary so needs about 120 pF or maybe 250 pF practically. The antenna feeder is connected with symmetrical taps across the secondary for best match. My practical feeling is the turns ratio is not large enough so I would tend to use a main winding of about 36 turns with a primary of about 9 turns giving a turns ratio of 4 and an impedance ratio of 16 (50R x16 = 800R) which might be more use for a high Z actual antenna feeder impedance. For a low actual feeder impedance the taps would need to be about 10 turns apart. Tell us if it works Craig! Comments welcome, including from our resident AMU consultant!
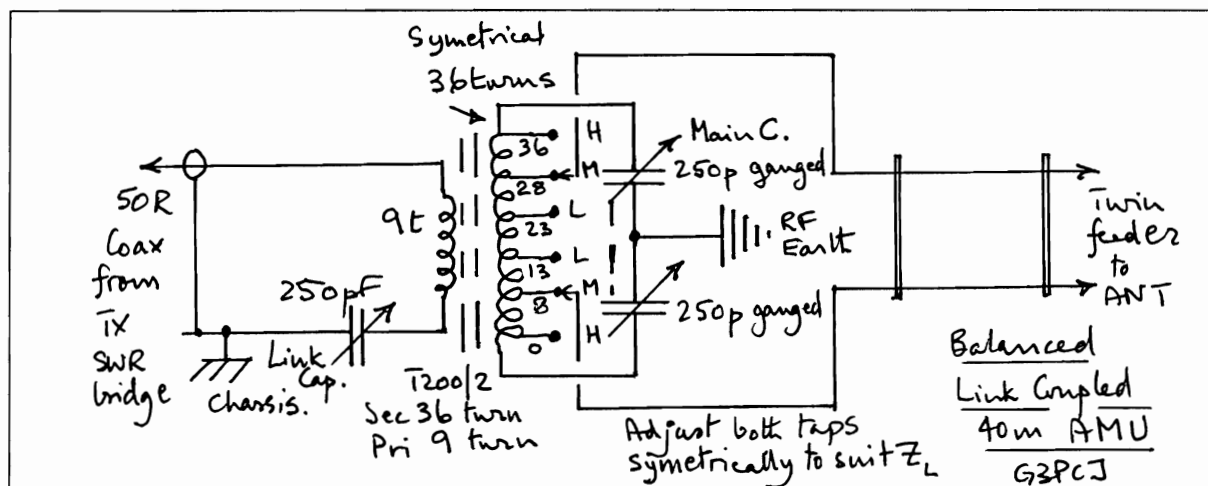


## Subscriptions!

I regret its that time of year again. Let me have £6 by Sept. 1st 2000 if you wish to continue receiving Hot Iron. I shall not be sending reminders so act now! Thanks for your support. 73, Tim