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Hot Iron

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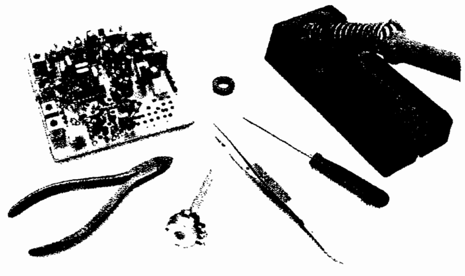
Contents

The Walford Electronics website is also at www. walfordelectronics.co.uk

Editorial



My mind is still in neutral due to the cold (again) and colds! I am longing for some warm Spring sunshine to lift our spirits and get out to those outdoor tasks. I am glad to say we have not burnt out any more 11 kV local mains transformers! However the recent energy price rises does make me wonder if I should expand the solar plant and have a 50 Hz inverter running continuously for lighting loads. I just wish the cost of solar voltaic panels would drop significantly, particularly the sort that can be made into the roof's waterproof covering. It cannot be long before most new south facing houses have them a standard. The greatest physical challenge (for existing roofs) is to mount and properly anchor the panels on top of the tiles, slates or whatever without breaking the water barrier. Corrosion and cleaning are further important matters for such long term investments. Fortunately, for most self build radio design projects, total energy consumption is not a major design criteria but it is vital for modern commercially made electronics. Hence the keen interest in improving power supply efficiencies and the resulting desire to move away from 'linear' regulated supplies. See later, Tim

Kit Developments

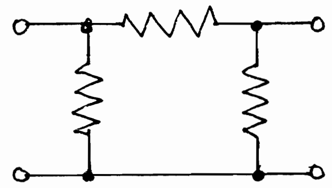
I seem to have been typing instructions or articles for publication non stop on this machine since the last Hot Iron! The revised website is active and will have a few more extras added shortly. Meanwhile the new relay selected twin BAND pass filter is available - the standard kit does any pair of amateur bands, 20 to 80m, but with other part selections, it can do any 'band' in the HF spectrum. In due course this and other modules can be used to make up a two band RX. I have also built the prototype Mk 2 Signal Generator, its fine but I need to also try out the two band VFO aspects of it.

I have also completed the new Supplies kit; a single set of parts does the timing for two uses - firstly as a Static Inverter, or alternatively a Supply Booster. The Static Inverter will produce 50 or 60 Hz mains from a nominal 12 volt DC supply and the devices are suitable for driving a transformer rated at up to 200 VA. There are many possibilities to use whatever you have to hand so the transformer is not included - apart from its cost & postage! When used as a Supply Booster, it can nominally double a 12 volt supply to 24v (off load), or around 20v delivering 2 Amps. It can alternatively generate a negative 12 volt line giving up to 2 Amps. It has a simple form of maximum voltage regulator and does not need a transformer since it uses a charge pump technique. Tim G3PCJ

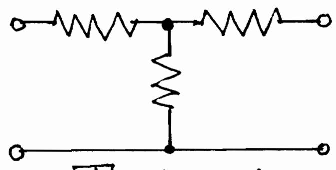
Hot Iron is a quarterly subscription newsletter for members of the Construction Club. Membership costs £7 per year with the first issue for each year appearing in September. Those people joining later in the year will be sent the earlier issues for that year. Membership is open to all and articles or 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

High Attenuation Attenuators by Gerald Stancey G3MCK

The function of an attenuator is to provide a controlled amount of loss in a matched impedance system. The usual configuration is either a pi or T network, see right. The choice of configuration usually depends on the components that are to hand. These attenuators only introduce loss into the circuit; they do not change any impedances. Consider a signal generator whose output impedance is 50 Ohms and is connected to a 50 Ohm load. Adding an attenuator between the generator and the load will only introduce a loss into the circuit. The generator will still be looking into a 50 Ohm load and the load will still be being fed from a 50 Ohm source.

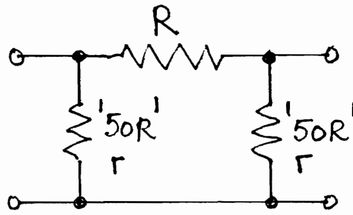


π attenuator



'T' attenuator

Attenuators are designed for use in systems of a given impedance. This means that an attenuator that has been designed for use in a 50 Ohm system cannot be used (sensibly/accurately) in a 75 Ohm system. The usual handbooks give values for the resistors that are needed for the most commonly used attenuations and 5% tolerance preferred values are usually satisfactory for amateur use. Attenuations can be simply added, irrespective of the form of the actual circuit - pi or T. If you need a 9 dB attenuator, all you need to do is put a 3 dB attenuator in series with a 6 dB attenuator. It is usual to build them in screened boxes and toggle switches are satisfactory for switching them out at HF and low VHF. Again, good examples of construction are shown in many of the handbooks. (I intend shortly to be offering low cost 50 Ohm attenuators that will do 0 to 20 dB in 1 db steps - Tim.)



High Value attenuator where:-

Attenuation (dB)

$$A = 20 \log_{10}(R/25)$$

e.g. if R = 1k, A = 32dB

OR

$$R = 25 \times 10^{A/20}$$

eg if A desired = 30dB

$$R = 25 \times 10^{30/20}$$
$$= 25 \times 10^{1.5}$$
$$= 25 \times 31.6$$
$$R = 790R$$

G3MCK

It is customary to limit the attenuation of any one section to no more than 20 dB. This is done to make sure leakage around the attenuator is much less than the intended loss. However there are times when you just want to put more than 20 dB of attenuation into the circuit but are not too bothered about either the exact amount or impedance. In this case a short cut can be used to calculate the main series resistor value - R of the pi form. R is assumed to be appreciably higher than either the load or source impedance and they are matched by the 'fixed' 50 Ohm resistors at each end. The formula right gives the attenuation in terms of R; this can then be turned around to find out what value of R is required for a given attenuation. For example, in this 50 Ohm system, when R is 1K, then the attenuation will be 32 dB. Normally the value of both resistors labelled r, would ideally be just greater than the system impedance; in practice they can be whatever is to hand in the range 47 to 56 Ohms. Such an attenuator can be lashed together on a piece of PCB material as it is not meant to be used in a precision manner.

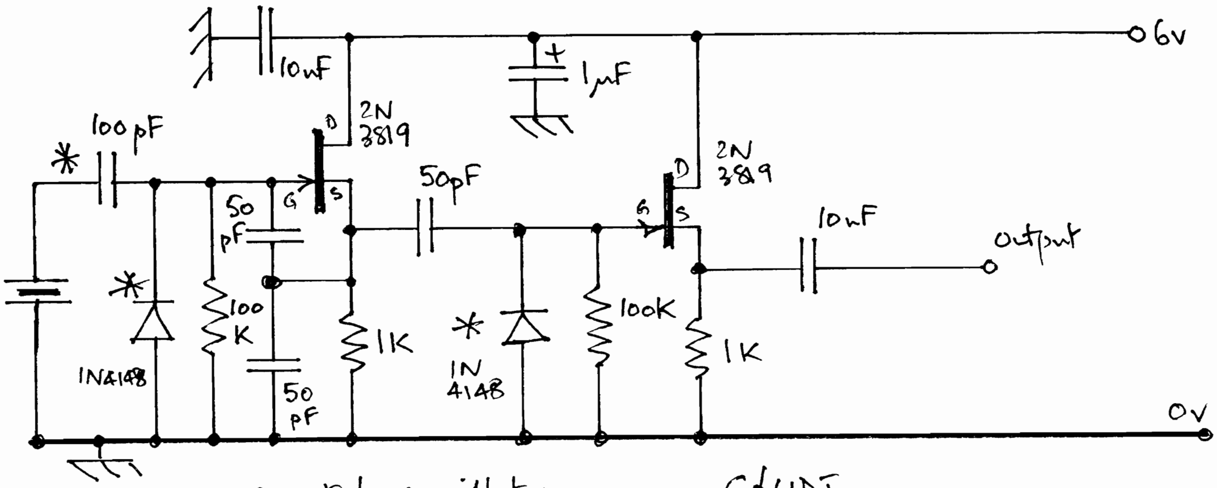
Connectors for RF coaxial cables

I have been trying to decide what type of connectors to use on the new bits of test gear (attenuators, power meter, amplifiers etc) that I have in mind. As you might guess, these will have an 'open' style of construction to reduce their cost, so PCB mounted connector versions are needed! PL259 types are far too clumsy, relatively expensive when new, and I have yet to see PCB mount females. For preference/quality, I would use 50 Ohm BNC types but they are pricey and not too easy to assemble without special tools. I have long used the standard Belling Lee style UK TV 75 Ohm types, although made for 75 Ohms, they are acceptable for 50 Ohm HF work; but being made of aluminium, they eventually corrode.

The only other possibility that I have found so far, are the RCA phono type. They are cheap, have PCB mount females, and appear to use plated steel rather than aluminium. They are partially screened but without a fully symmetrical coaxial form. Originally intended for audio work, no impedance figure is quoted. They should be quite adequate for most HF amateur use and are my current favourites. I shall be glad to have any other suggestions - but quickly please!! Tim G3PCJ

A reluctant oscillator! Prompted by Craig Douglas G0HDJ

Craig explains that he wished to use the crystal oscillator circuit below to set up a receiver on different bands but was puzzled because it 'didn't want to oscillate at the correct frequency on 10m. Perhaps you could comment on this?' Talk about difficult questions!!



Crystal oscillator G0HDJ

From Craig's words I infer that it works as expected on other frequencies but that when he changes to his 10m crystal, something is wrong. I have no information on the crystal but it might be an overtone type since 28 MHz is relatively high for a fundamental type. Fundamental crystals are certainly possible to 40 MHz but are a relatively recent development over about 25 MHz. If it is an overtone type, which means that its fundamental will be near an odd sub-multiple, mostly likely 3 in this case, implying a fundamental of 9.33 MHz or thereabouts. The circuit has no parts to suppress its fundamental oscillation mode so, if it is a third overtone type, it would run at near 9.33 even if marked as 28 MHz. What is its actual fundamental output frequency? Even if the third harmonic is audible at near 28 MHz, it would not be exactly correct since the fundamental of any overtone crystal is always slightly off the exact sub-multiple. (Crystals marked for even higher frequencies might be third, fifth or even seventh overtone occasionally.) Adding a series trap resonant at the fundamental across the crystal should stop it, but would make the circuit useless for a wide range of crystal frequencies!

The next, but much lower probability, is that something in the circuit does not like running at 28 MHz. There are three slightly suspect items. Firstly, if it is supposed to be a parallel resonant sort at 28 MHz, the commonly used load capacitance should be 30 pF in parallel. (It might be a series resonant sort but this should still work but at a slightly off frequency.) The absence of the normal load capacitance does not mean that it will not work, but that it will not run at the plated frequency. In this circuit the load capacitance is 100 pF in series with two 50 pF in series, which if you do the maths, is 20 pF so it would tend to run at a higher frequency than expected. I would suggested omitting the 100 pF in series with the crystal and up the two Collpits capacitors to 56 or 68 pF. The next oddity is the diode across the crystal - it is there to help stabilise the oscillation amplitude but I think it's the wrong way round! Its presence, when the right way, should be fine. (You could try omitting it to see if it then runs.) The other suspect item is the second diode on the gate of the buffer stage. I cannot see any reason for including it! I doubt that its presence will prevent the oscillator from running! All it does is alter the buffer stage bias when the oscillator is running.

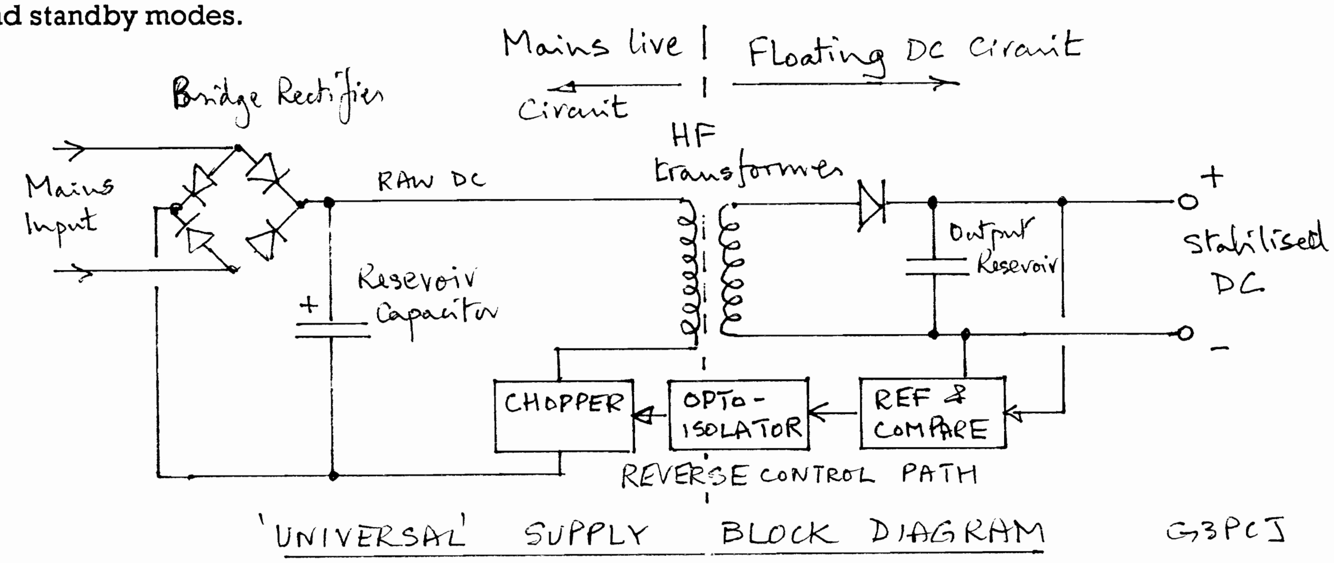
Just to fill the page, I recall that somebody has suggested using low voltage valves as the way to make very stable oscillators - on the basis that there is very little change in inter-electrode capacitance with temperature. The electrode capacitance is of course part of the tuned circuit and would influence frequency. This is a valid comment but usually the amplifying device is loosely coupled to the tuned circuit in any oscillator so the effect of its capacity changing will be diminished. In my opinion it is far more important to make certain that the main tuned circuit L and C are really high quality low temperature coefficient items. That means ceramic formers and air variables! Both are becoming increasingly rare and or expensive! Tim G3PCJ

Universal Mains Supplies

Many modern mains powered electrical gadgets can be used on 'any' type of mains supply! No longer do you have to adjust the tapings on a transformer to cater for American or European voltages, or even frequencies. These items are designed to run on anything between 110 and 250 volts with either 50 or 60 Hz! I suspect they are also quite able to use 400 Hz which is sometimes used on aircraft or ships! They might even be able to use the old 16.67 Hz standard that was used in much of Europe in the 1930's but that is less likely! How do they cater for such a wide input range!

The key is that they generate a high voltage DC supply direct off the incoming mains, without any mains transformer, consequently this voltage might be anywhere between about 150 to 350 VDC. They have a reservoir capacitor large enough to cater for the lowest input frequency without excessive ripple. This DC supply is then chopped at a much higher frequency, often in the tens to hundreds of KHz range, and applied to a small high frequency transformer. The output of the secondary winding(s) are then rectified and smoothed for the desired output supply rails. Clearly without further clever circuits it would have very poor regulation! So the output voltage is compared to a reference and a control signal fed back to modify the chopping process feeding the high frequency transformer. If the output voltage is too high, the chopper is stopped until it gets too low, when it is restarted etc.

Unlike the old valve radios that did not have a mains transformer, with the supply neutral connected directly to the radio's chassis (with potential safety issues), the modern unit depends on the small high frequency transformer for mains safety isolation of the forward power path. The reverse control low power path has its mains safety isolation provided by an optically coupled isolator. In consequence, be very careful when investigating faults in modern PSUs because most of the circuitry is at mains voltages, and with high DC values on top! Furthermore their control loops make it very difficult to decide what stage is faulty - so often the most sensible approach is to buy a new one! The block diagram below shows the principle elements; in reality they are often somewhat more complicated to provide extra facilities such as input power factor correction, shutdown and standby modes.



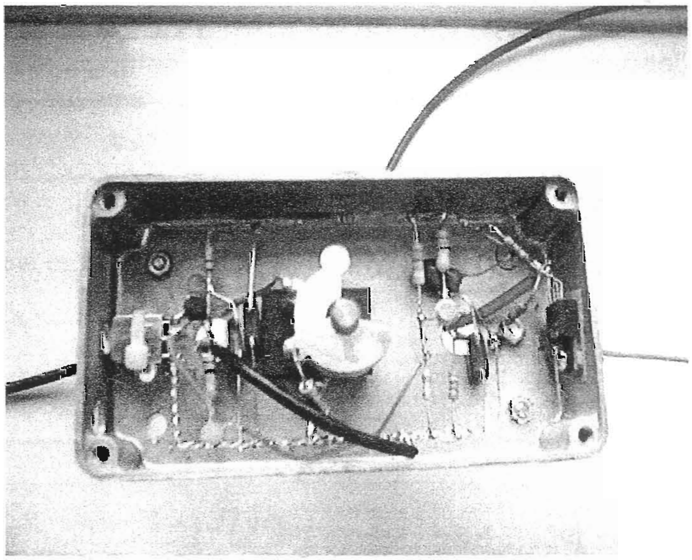
Interestingly, the approach of high frequency chopping an incoming DC supply to generate a much higher DC voltage is widely used in static inverters. The internal high voltage lines are + and - 350v (for a nominal 250v RMS output), which is then chopped at 50 Hz into a pseudo sine wave output - actually positive and negative rectangular pulses with gaps between them so that the RMS voltage is similar to a genuine sine wave but without excessive harmonic content.

In pondering how to better utilise my free solar power (at 12v DC), I contemplate stepping this up to 250v RMS at some much higher frequency than 50 Hz to minimise the transformer size. Ordinary incandescent light bulbs could use this direct but conventional fluorescent lights would not like the higher frequency. I am not sure what the modern long life miniature bulbs would do with a MF input! If they have chokes to limit their current, there is an obvious problem; but they would be alright if the incoming supply is rectified first to generate a high voltage.

Anybody know what is inside a modern long life bulb? Tim G3PCJ

Stable VFO for 20/30/40m By David Proctor G0UTF

For years, I built and used VFOs usually for one band at a time. They worked fine, but going above 7 MHz was rather dicey as they were not too stable. After many years I went to crystals and was amazed at their stability. More recently, frustrated by their lack of range, I set my mind back on building a VFO that didn't drift "too much". This effort consists of a 2.0 - 2.2 MHz VFO mixed with 5, 8 & 12 MHz crystals via a Walford mixer to give 7, 10 &14 MHz. Of course you can do other bands with more crystals & filters. The VFO result is quite pleasing, drifting less than 10 Hz in ½ an hour. The VFO circuit is shown below – I haven't got round to the rest yet! Some will say it is too complex but I had all the bits in the junk box, and I don't intend building lots of them. Using a small die cast box there should be few hot spots, and even the KANK coil is strapped to the metal. The total power dissipated is 130 mW and this could be reduced by a remote regulator. The whole transmitter is as yet incomplete but it may sow a few ideas in readers minds. With better components, it could be more stable.



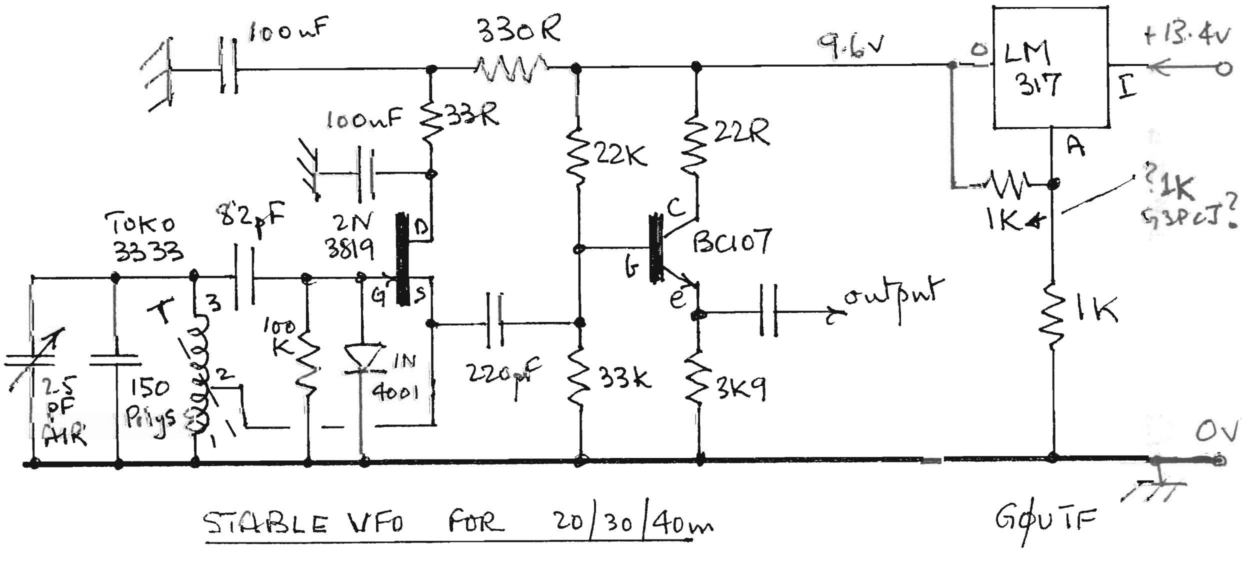
Run 1

Mins after on	5	10	15	20	25	30	45	60
Drift (Hz)	0	-5	-2	-6	-1	-9	-9	-4

Run 2

Mins after on	5	10	15	20	25	30	35	40	60
Drift (Hz)	0	10	17	23	28	33	36	39	43

(David explained that both these sets of figures were taken with an initial 5 min warm up period during which drift was ignored. Run 1 was done in a stable temperature condition. Run 2 was done as his central heating was coming on and has convinced him that he should have a water cooled VFO to keep it at constant temperature! Even so, these are good figures! Tim)



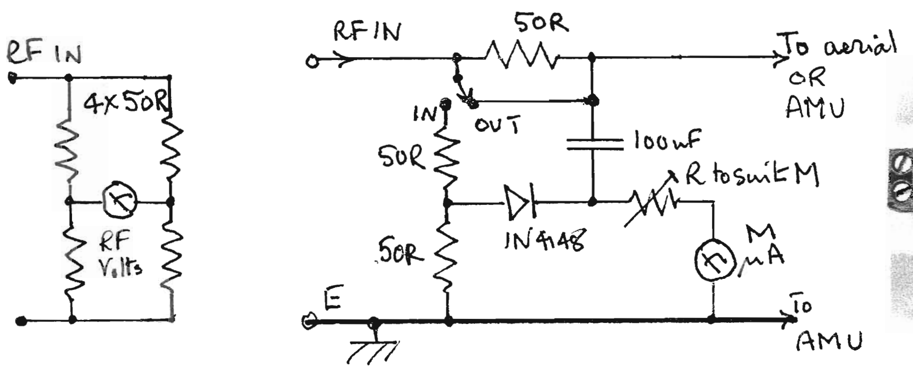
CW and VFOs

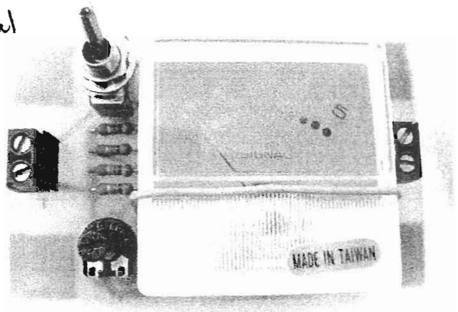
For direct conversion CW rigs, the receive and transmit frequencies of the VFO need to be different in order to generate a received audio beat note. Hence there is usually some form of automatic tuning offset for reception only (RIT). Arranging this tends to degrade the intrinsic stability of the VFO and is seldom compatible with a simple Huff and Puff stabiliser - if one is contemplated. Using a single sideband 'phone' type TX superhet with an injected CW tone overcomes the Huff & Puff incompatibility because the VFO frequency does not change. Its no longer essential to have RIT but it's a useful feature in any rig! You can Huff & Puff stability, or RIT, but seldom both! G3PCJ

Mini Bridge

The kit designs below are derivatives of the standard AMU. I have split it into two units (matching indicator and antenna matching circuit) so that each fits onto a 50 x 80 mm PCB, to match the **Kilve/Kilmot/Kilton** single band rigs. Each is £19 + £2 P & P, or both £38 inc P & P.

The Mini Bridge is a 50 Ohm resistive bridge where the antenna is connected instead of one of 'four' bridge resistors. If all four were exactly 50R, the bridge is said to be balanced and the voltage across the mid points (as shown left below) would be zero - hence we need a circuit that detects when there is least voltage between these mid points. This can be done with a simple RF voltmeter. After the bridge has been used to indicate the best match obtained by adjusting the AMU controls, the bridge circuit is switched out, but the detector remains connected to the antenna thus showing output RF voltage, or power with a square law scale. The preset is adjusted for full scale deflection with the bridge out of circuit while feeding rated TX power into a 50R dummy load; then with the bridge in circuit, the maximum reading will be half scale for an extreme open or short circuit antenna load. The load on the driving TX has to be between 33R and 100R, so will always be a safe load, irrespective of the actual AMU settings. With the bridge in circuit, you adjust the AMU controls for the lowest indication, (all four 'resistors' equal 50R), and then switch the bridge out. G3PCJ

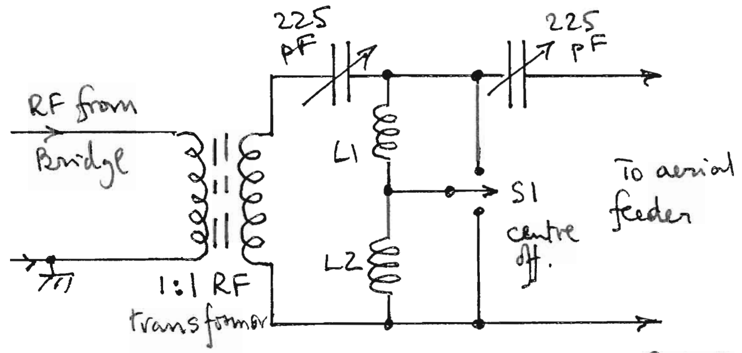


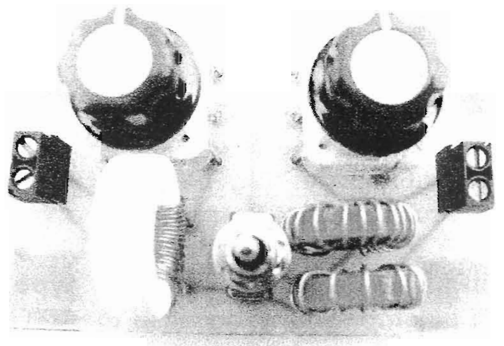


OUTLINE OF BRIDGE CIRCUIT G3PCJ

Mini Matcher

This is a simplified version of the T match part of the AMU, with a restricted inductance range to cater for a single band. The two inductors are wound to suit the chosen band and probable feeder impedance. The standard capacitors should suit all bands 10 to 80m; 160m might need extra fixed C. The T circuit can cope with a wide range of loads, and although not fully balanced, it can drive a balanced feeder/aerial system because the input RF transformer 'isolates' it from the usual unbalanced output of a transmitter. If the aerial is genuinely unbalanced, e.g. quarter wave vertical against RF ground, then the input 1:1 transformer can be omitted. (Beware mains/RF earth isolation aspects.) Because the complete circuit is bi-directional, you can reverse the signal flow through the unit, with the RF transformer on the output driving a genuinely balanced feeder. However, this is not really recommended because the transformer will work better if it has a resistive load - this is less likely with a reversed signal flow unless the *antenna* is actually matched to the *feeder* impedance properly (which is seldom the case!), to prevent there being any reactive component being passed through the RF transformer. The normal, and preferred, signal flow from transmitter through RF transformer to matching circuit, does have the transformer working with a resistive load. The radiation pattern is likely to be disturbed by other metalwork in the near field anyway!





Mini Matcher circuit G3PCJ

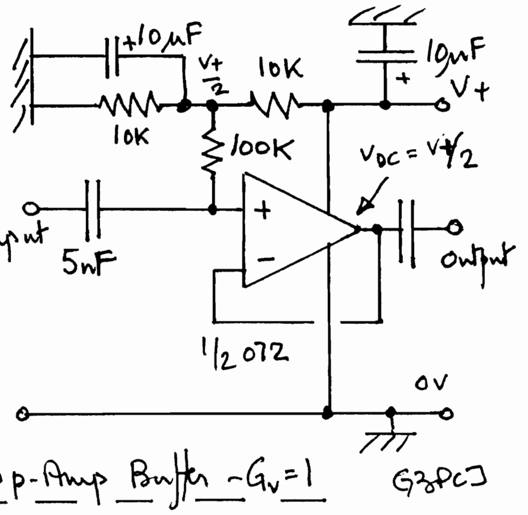
Theory - Using Op amps

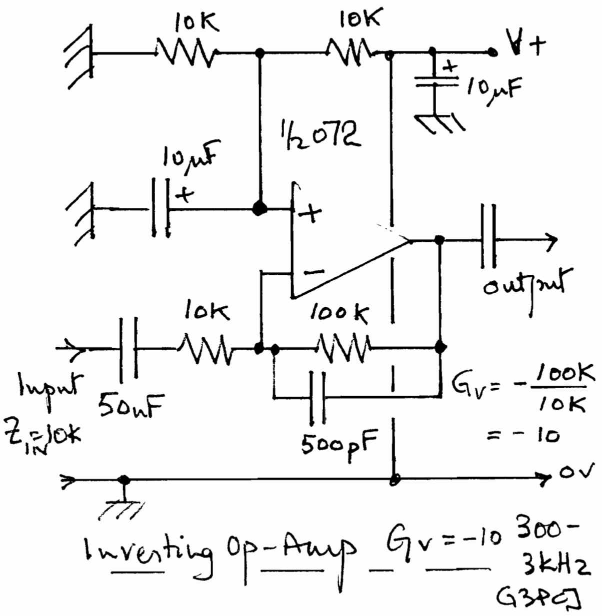
The first thing is to select one that is designed for the anticipated supply voltage. The common TL072 type that I use liberally, is a dual low noise type suited to audio applications and comes in a plastic package with a supply range of about 5 volts to 30 volts. The next point to consider is the biasing, to make the output settle at the desired DC output voltage - often half way between the supply rails. The device will usually have both positive and a negative signal input terminals. A positive going signal on the positive input will make the output go positive; a positive going signal on the negative input will make the output go negative. The actual input bias currents are often so small that they can be ignored. A convenient approach to biasing is to feed the negative input in a DC sense (but not necessarily AC) direct from the output without any form of attenuation; the DC output voltage will then directly follow that applied to the positive input. Where 0 volts is the negative supply rail, then a 'pseudo' mid rail supply is often used to set the out put voltage by applying this mid rail value to the positive input. This leads directly to the very useful *buffer* circuit shown top right. This has a high input impedance and a low output impedance with unity voltage gain. The upper bandwidth limit is hundreds of KHz. The low frequency limit is determined by the input coupling capacitor and the bias resistor - about 300 Hz for the example values shown.

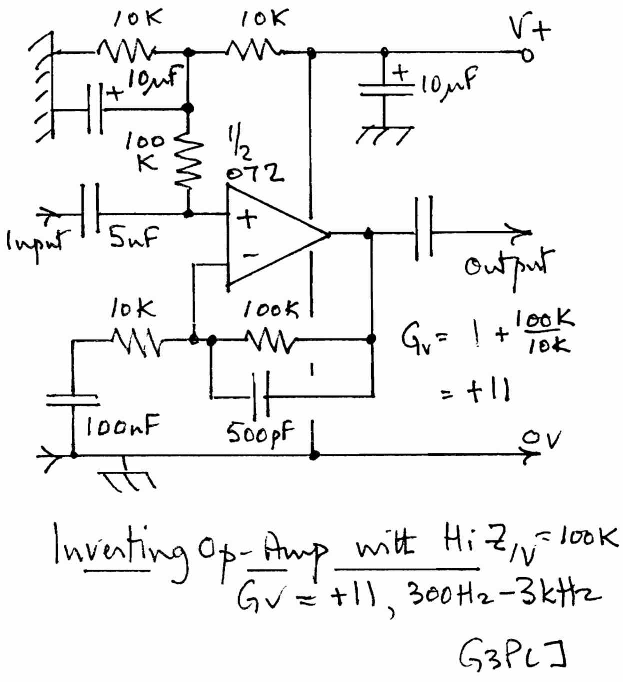
The middle diagram shows a typical AC coupled audio inverting amplifier. It actually has a voltage gain of 10 and a bandwidth of 300 Hz to 3 KHz. The gain is defined by the ratio of the two resistors, literally the feedback one divided by the input one! The output impedance is low (often less than 100 Ohms) and the input impedance is the value of the input resistor! This is because the junction of the resistors at the negative input is a virtual earth, having negligibly small audio signals owing to the very high gain of the internal amplifier. The low end response is determined by the input CR and the upper response by the feedback CR. The negative sign means in and out are out of phase.

The final circuit is a variant of the middle one above, where a higher input impedance is required and it is acceptable for the input and output to be in phase. The gain is now still highly dependent on the resistors at the negative input but to their ratio you must add one! The lower end bandwidth is now dependent on both the negative 'input' decoupling cap and the positive input coupling. (Think about the very first circuit above without negative input resistors, so their ratio was zero but adding 1 for the use of the positive input gave the correct gain of +1. The plus meaning that in and out signals are in phase.)

Not really much need for fancy maths or the calculator to work out the gains! Bandwidths are all the usual CR sums! Tim G3PCJ







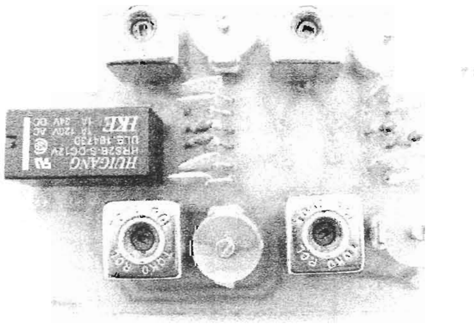
Snippets

Lithium batteries Dave Buddery passes on a tip from his son who is in the oil industry, and hence rather conscious of safety matters, that these batteries are prone to self igniting if allowed to discharge too quickly. I hazard a guess that discharging should be limited to their 1 hour rate max. This would imply a current numerically no greater than their storage capacity in Amp-hrs.

Huff and Puff stabilisers David Proctor asks if I ever contemplate a stabiliser kit that could be added to a builder's VFO to improve its frequency stability. This is a project that I have often considered but never tried. An early customer, who is not any longer a member of the Construction Club - otherwise I would get him to write something on it, spent many hours trying to stabilise a varactor tuned VFO and eventually gave up. I think this was because his particular VFO design was prone to small jumps or changes in frequency (but not sufficiently large to hear), due to temp, supply or other variations affecting the tuning diode, which were comparable to the finite size of the control steps of that particular stabiliser design. Since large capacity varactor diodes have become like hen's teeth, leading to the use of PolyVaricon tuning capacitors, I will re-examine this topic.

40m phone crystals Several of the new simpler transmitters require an actual crystal for the oscillator on bands above 80m, this is because ceramic resonators are not stable enough as frequency rises. Luckily I have found a low cost source of 'standard' value 7159 KHz crystals so that you can now use them in the extended phone part of the 40m band. £2 +£1 P and P.

Lead free solder A messy situation! Many components are going extinct as manufacturers change their processes to cater for the desired abolition of lead products in electronic goods from about now. Solder is the main concern. There are plenty of substitutes but they nearly all require higher temperature soldering irons for the making of satisfactory joints. Interestingly, the military and certain other organisations have obtained exemptions where extreme reliability is demanded. It is also permissible to use normal 60:40 tin-lead solder to repair equipment which was made with that material. It seems likely that 60:40 solder should be available for some time to come.



The photo is a relay selected dual bandpass filter, this one has a 20m filter on the right and an 80m one on the left. The inclusion of trimmers makes adjustment slightly easier and will also allow for toroidal cores when eventually TOKO 333X series are extinct! The relay has two alternative positions, for nominal 50R in & out, OR nominal 1K5 in & 50R out for the in/out impedance of 612 mixers. The filters are actually bi-directional so it can be 50R in and 1K5 out OR 1K5 in and 50R out. Both bands have to use the same impedance setting of the relay. A single set of parts is supplied for the normal amateur bands 20 to 80m but it can do others with alternative parts. G3PCJ

The Somerset Supper and Yeovil QRP Convention

REMINDER for those who have not yet booked!

I am planning the second supper to be held on April 8th 2006 in Sherborne for locals and those staying overnight. This is the evening before the Yeovil QRP Convention scheduled for April 9th in the Digby Hall. The convention will have the usual array of interesting talks, trade stands, bring and buy stalls etc., so is well worth while coming - why not make it a weekend! As before there will be a small display of items from each diner's home built radio equipment! Your entry must be different from last years ticket! (Please also bring a QSL card or label.) This will qualify you for a *free* place at the supper table! The competition will this year be judged by Steve Hartley, the well known author of many amateur radio books who writes the Newcomers column for Radcom. He will decide how to judge it and his decision is final! You buy your own drinks. I do plan to a take a photo or two for publicity purposes but this will not intrude into this *social* event where all (including XYLs) will be very welcome. A minimum of formality! Places by advance booking **only** by Mar 28th so please get in touch soonest via walfor@globalnet.co.uk letting me know names. Places are limited - first booked secures their place! Hope to see it and you! Tim G3PCJ