HOT IRON

Issue 6 *"Journal of the Constructors Club"* **Winter 1994**

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Hot Iron is a quarterly newsletter for radio amateurs interested in building equipment. It is published by Tim Walford G3PCJ for members of the **Constructors Club**. Articles, suggested topics and questions are always welcome. Please send correspondence and membership inquiries to:-
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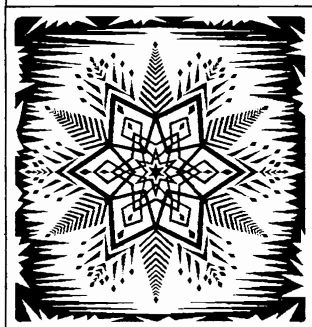


Editorial

First of all may I wish you a slightly early happy Christmas and an excellent New Year building electronic gadgets! I suspect that never before has there been such a selection of projects and equipment that can be built by amateurs; the range widens every year and the performance of things that can be home built steadily increases as integrated circuits are more widely used in equipment. While this may make it slightly harder to understand how a rig works; we have not got to the stage yet in home built gear, where everything is done in a microprocessor with incomprehensible software. The modern technology does undoubtedly produce high performance for cost.

On a sad note, I have to report that David Sugden G4CGS, who contributed an article last time on measuring inductance, never made it to the major operation that he thought he might have to undergo. He suffered a major heart attack and collapsed just outside his own front gate. He will be badly missed by us all since he had already written several notes and had hopes to write more; his wife has kindly agreed that I should print those already completed. I shall particularly miss him as someone who I could bounce technical questions onto and who was also very dependable as my PCB driller. I am pleased to have another new contributor this time with Jim Chick, G4NWJ, adding his experience with a Yeovil. There are also further ideas on IF amps and tuning for the Yeovil. I do urge any of you who have any interesting experience or ideas to share it with others by writing a note for me. It need not concern my kits. Get writing please.

I also pleased to announce that the off air REFERENCE kit is now available with its two optional INPUT kits. The reference part provides highly accurate digital frequencies in the range 1 KHz down to 0.2 Hz with useful intermediate frequencies. It works by phase locking an oscillator to the Radio 4 transmission on 198 Khz and applying this to decade dividers. It can be used on its own or with the normal Walford Electronics counter to achieve very high accuracy and a resolution down to 1 Hz. The optional HF INPUT parts, fitted on the REF PCB, provide a high input impedance amplifier with a voltage gain of x10 and a bandwidth of about 60 Mhz so that the basic counter's input sensitivity can be maintained while using a scope type divide by 10 probe. The other optional INPUT DIVIDER kit is a divide by 10 frequency prescaler which will work to at least 575 MHz. When these four kits are used together, a very high performance counter instrument can be constructed for a fraction of the commercially made cost. The basic REFERENCE kit costs £37 with the two INPUT kits costing £9 for the HF amp and £24 for the UHF prescaler. The basic counter is £49. Further details are available from me.

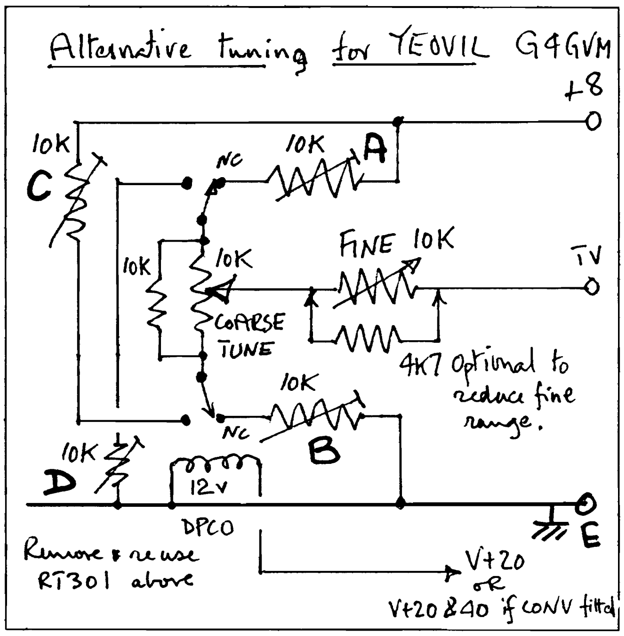
For those of you still searching for small items that might be added to Santa's present list, may I remind Santa of the Coker - a CW transceiver that can easily be packed into large socks hung on the end of the bed. Versions for 80 or 160m, cost £45. Very full instructions and no integrated circuits. 5W output on a 12v sledge supply!

Snippets

I am reminded in a note from South Western Electricity that the 50 Hz mains supply is to go down to a nominal voltage of 230 volts on Jan 1st next. They explain that most domestic equipment should be unaffected by this change since it is within the existing allowed tolerance to which most equipment should be designed. Certainly most commercial electronics or appliances, which are likely to have switch mode power supplies, are not likely to be effected. Apart from slightly dimmer incandescent lamps, the main items where performance will be degraded are unregulated power supplies, whose output will drop by 4.3%, and regulated linear power supplies where the decrease in their internal unregulated supply falls below the required input level for the regulator.

Yeovil Transceiver Topics

VFO Tuning Modifications. Derek Alexander G4GVM writes " I have been playing around with the tuning arrangements and you may find this circuit of interest. With the addition of a DPCO relay, 3 extra 10K presets and a couple of resistors it is possible to arrange 1) the frequency will always increase with clockwise rotation of the tuning pot, 2) full rotation of the pot can be adjusted for 320 KHz on 80 and 370 Khz on 20m. (40m still covers the bottom 100 KHz of the 20m scale.) If you can obtain a 10 or 12:1 reduction gear for the main tuning pot, you can dispense with the fine tuning pot by replacing it with a short. See the circuit alongside. Setting up. Set coarse and fine tuning pots and all four presets to mid-position. Adjust Toko slug of L301 to give a VFO reading of 5260 KHz, switch to 80m, then with coarse tuning pot turned fully clockwise set preset A to give 5190 KHz on the VFO (RX frequency 3810 KHz). Set coarse tuning pot fully anticlockwise, & adjust preset B for 5510 KHz on the VFO (RX 3490 KHz); the presets interact so you need to repeat these adjustments till they are both nearly correct. Switch to 20m; set preset C for 5360 KHz at the VFO (RX at 14,360 KHz) with the tuning fully clockwise and then adjust preset D for a VFO frequency of 4990 KHz (RX at 13,990 KHz) with the tuning fully anticlockwise. Repeat the checks and adjustments remembering that if you have to adjust the TOKO slug then all will be affected. Eventually you can obtain the desired full swing on the two main bands and have them both tuning in the same direction.



Mobile Perambulations with the Yeovil by Jim Chick G4NWJ

"Travel, it is said, broadens the mind and expands understanding. This may indeed be true, however, in my case it also means long periods of time in remote and sometimes desolate parts of the world. At such times, having a mobile rig available is a real pleasure and for a while I used my 757GX2 for this purpose and it performed very well although I was always aware of the danger of it being "confiscated" by over zealous custom officials. The turning point came after a trip to Turkey which culminated in my exit visa being withheld for fourteen days and only granted after payment of a large sum of money. I realised that the only equipment which attracted the attention and envious looks were those items in smart cases with lots of knobs, dials and lights and I decided that a home made rig might escape all this unwanted attention. The first approach was to consider a single band design but this was quickly dismissed due to limitations it imposed and after much deliberation I decided to try a Yeovil. The construction was straightforward and I added the 40m converter and the digital frequency readout which in my rig I found necessary to house in a screened box. The completed rig was built into a rugged case suitable for mounting in my Landrover. The antenna I favour is the conventional G whip mounted on the rear of the vehicle with its base about 5 ft from the ground. This is fed via an ATU and SWR meter and I have found this arrangement most successful.

Once the initial trials were underway, a couple of problems became apparent; the audio level was low for use in my type of vehicle and the RF output made life difficult for the receiving station under normal band conditions. The addition of the IF amplifier in the last edition of Hot Iron solved most of the audio problems producing greater signal strength on all bands and I have now built a 120 Watt PA which cured the second difficulty. When using the rig with a conventional wire antenna system or a long wire, the standard version performed very well and I was only aware of the problems I mentioned when using the mobile whip. It can be very difficult to find anything to attach a length of wire to in the middle of the Empty Quarter and most of the time I have to use my vehicle antenna.

In conclusion, I would like to recommend this grand little rig as a reliable mobile unit which has already proven a worthy companion on my travels."

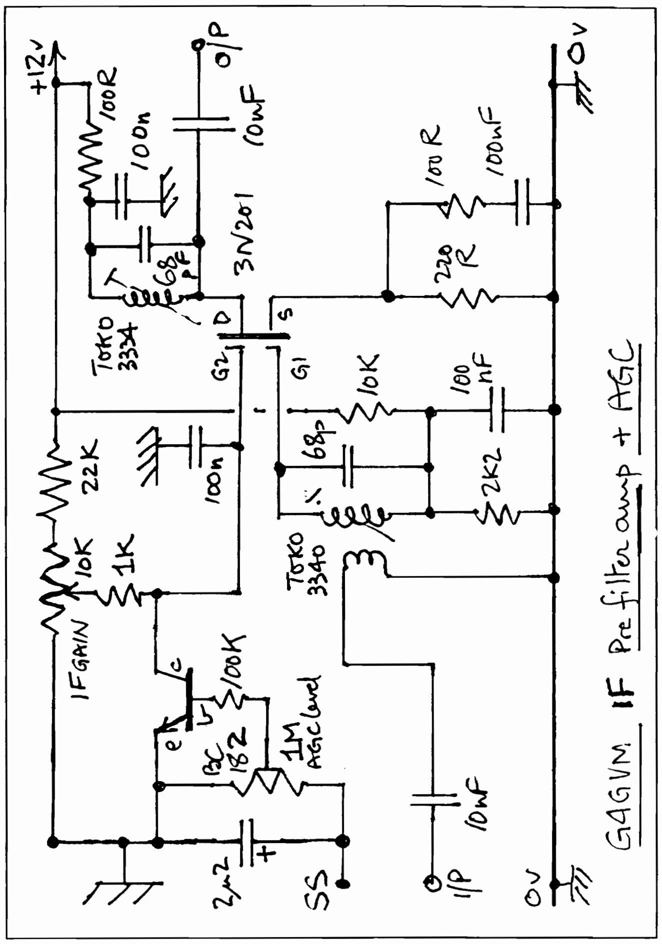
Thank you Jim; in another note he remarks that he found it very stable even under the most arduous conditions and would like to hear of the experiences of any other mobile users. Another has also been used in the Gambia. G3PCJ

Technical matters. I had one Yeovil returned for examination with complaints that it was smelling! It transpired that with mid settings of the audio gain control, the audio output 2030 chip was getting hot and the power supply current was about three times that at low gain control settings. The output chip was oscillating just beyond the audible range with mid gain settings due to feedback from the loudspeaker leads to the gain control leads. Re-routing of these leads so that they were no longer next to each other for a few inches cured it. The same sort of problems can happen at any frequency and is more likely the higher the operating frequency of the stages in between the input and output leads.

The second topic is a little conundrum that I havn't yet solved! Two Yeovil owners observe that while their digital frequency readouts are exactly correct on 20 and 80m, when they switch to 40m they are out by 3 to 5 KHz despite the 11 MHz crystal being set exactly. I think this has to be something to do with a sideband inversion when the 40m converter is in circuit but I am unsure about it. Can anybody offer an explanation? G3PCJ

Further thoughts on IF amps and AGC for the Yeovil

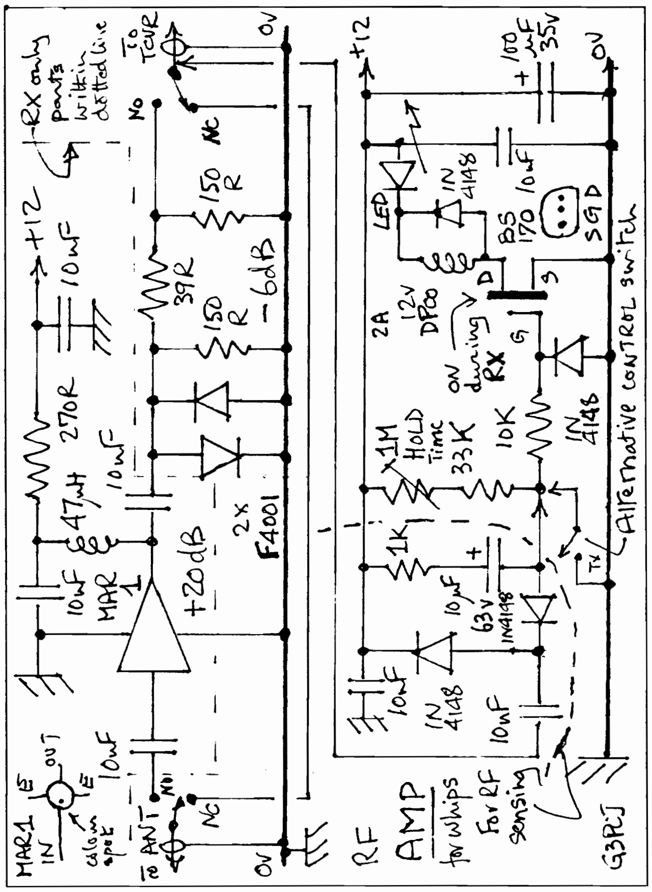
Derek, G4GVM, has sent along more on his experiences and comments that he finds his IF amp scheme rather better than that which I suggested in the last Hot Iron! He has made extensive trials on at least three versions and ,while I think most builders will find that the circuit in Hot Iron 5 is the best balance between complexity and performance, I include his final version for the more adventurous since it has a second level of AGC. He finds that it gives a marked increase in signal to noise/hiss ratio allowing the gain control to be kept low and the AGC parts can be adjusted to give further attenuation of really strong signals. This circuit is intended to be placed in the receive path after the first mixer IC201/202 and before the 9 MHz IF filter. Although this is not the ideal position he finds it best and it is ignored on transmit. To connect it to the rig, cut track to isolate pin 9 IC202. IF amp input goes to pin 9 IC202 and the amp output to pin 10 IC202. SS is connected to the drain of TR101 and 12 volts is found from any convenient point. His circuit was on a small board which was mounted by the earth connections. The BC182 is needed to invert the AGC signal for control of the 3N201 and the extra 2,u2 on the point SS restores the hang time which would be decreased by the addition of the 1M preset. He found that R110 needed to be reduced to 47K to prevent the main AGC operating on noise and, with a little advice from me, improved the strong signal handling of the main audio amplifier by adding 2M2 from pin 1 of IC103 to earth which shifts the DC output level to 6 volts which is better for 12 volt operation.



IF Amp for Tiny Tim. I am pleased to report the circuit that I sketched out in the last Hot Iron, which was untried at that time, does indeed work well and gives a useful improvement in sensitivity. Care is needed to fit it in! G3PCJ

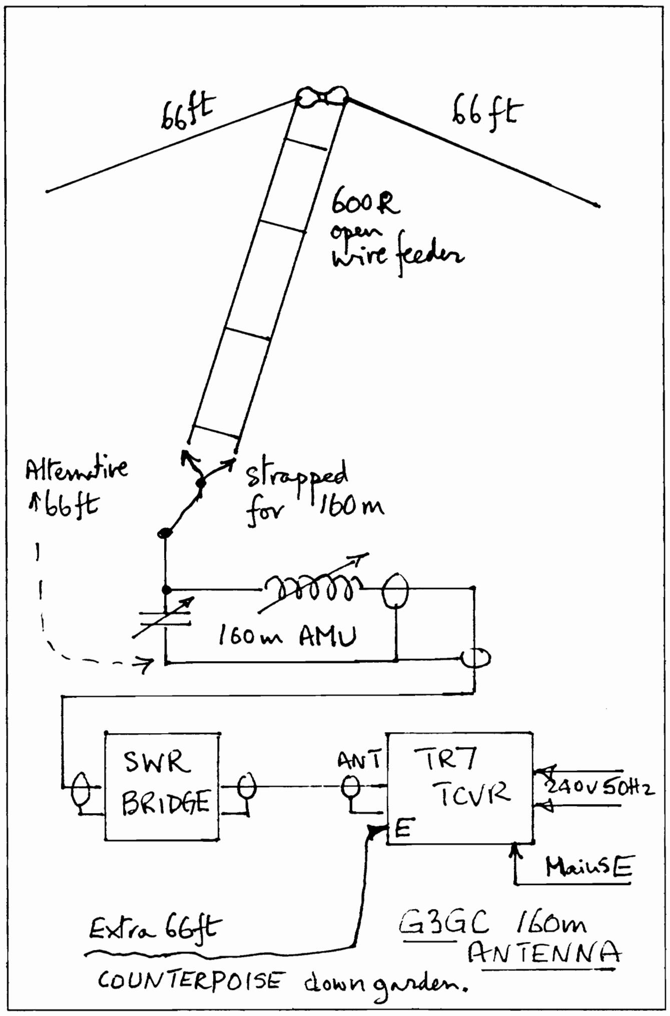
RF Amps for small antennas

Readers may recall an earlier comment that an additional wideband RF amp for the Yeovil was not recommended when it is used with normal sized antennas due to overloading by out of band broadcast stations; however I have found it to be a most useful addition when giving demonstrations with my 0.5m square portable loop antenna made of 15 mm copper pipe and which can also be used for transmission. It will also be suitable for those using whips like G4NWJ where overloading is unlikely. If its to be only used with a short antenna, then the amplifier part of the circuit can be inserted in the receive path around the transmit amplifier. The circuit is broadband with 14 dB gain. It is important that there be some good selectivity in the antenna matching unit to reject the broadcast stations just outside the 40m band. I have the full circuit shown alongside mounted in a separate box which can be left in circuit continuously as its bypassed with no power applied. The attenuator/diodes on the amplifier output protect it when the rig transmits during the short time that the RF sensed relay takes to turn off on transmit. It can be controlled with a hard wired transmit contact switch as shown which avoids the hold time delay associated with RF sensing (needed to avoid it dropping out between words). This circuit can be used in any low powered 50 Ohm antenna line and is a handy "extra" for more sensitivity - fast power diodes must be used. G3PCJ



More on End Fed Aerials by Eric Godfrey G3GC

My aerial system for HF is a half wave dipole on 80 metres (132 ft overall) centre fed with home brew 600 Ohm open wire feeder. The centre is supported by a pole in a sycamore tree lopped off to stop it growing further and each Spring it is pruned back to the trunk to avoid the new growth interfering with either the dipole elements or the 600 Ohm feeders. This also has the advantage that there are no flowers and hence no helicopter seed pods to germinate all over the garden. On 40m and the lower harmonically related bands, the 600 Ohm feeder sees a high impedance at the centre of the dipole but on 80m, where the length is a half wave, it is low impedance. In the shack, the open wire feeders are connected to a KW (E-ZEE) MATCH which in turn connects to a Drake TR7 transceiver via a 50 Ohm coaxial feeder. This all works satisfactorily on all bands (including the WARC bands) from 80m to 10m but the KW (E-ZEE) MATCH is not designed for use on 160m.



I needed to use the aerial in the Edgware and District Radio Society's Activity Period last October and decided to strap the feeders together in the shack and connect them to the TR7 via a simple LC matching unit comprising a variable capacitance to earth from the aerial and a variable inductance in series with the inner of the coaxial feeder to the TR7 (see sketch). I then tried to match the system on a frequency of 1.950 KHz and found that although I could get an apparently good match by adjusting the inductance and capacity, I could not wind the power up properly on the TR7. I was at a loss to understand this at first; it was not until I discussed it with our Editor and he suggested that I read my own article in Issue 4 of Hot Iron that I realised that it was of course due to the problems which I discussed in that Issue. Here was I, caught with my own RF trying to go into places that it should not have been and not practising what I preach!

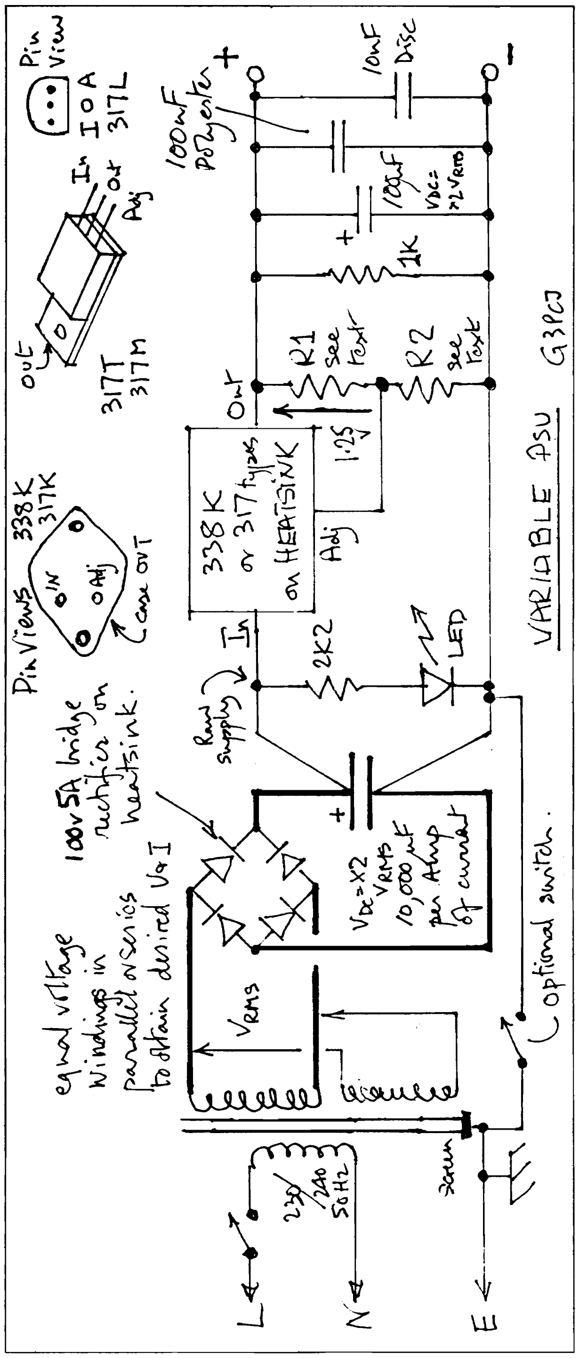
The obvious thing to do was to add a quarter wave counterpoise to the earth terminal of the TR7. This I did using 66 ft of ordinary connecting wire thrown out of the window and just tied to a garden cane down the bottom of the garden somewhere nearly underneath one leg of the aerial. The LC matching unit was again adjusted for minimum SWR and this time I could get full power into the system. I think that what was happening in the first case, was that although I had a reasonable SWR in the coax from the TR7 into the elevated wires which formed one leg of the whole aerial system, the other leg was formed by the mains earth wire, and this was causing the transceiver as a whole to receive a lot of return (backward) power and its self preservation circuits were limiting its power output.

This, I think, goes to confirm that no end fed aerial system should ever be contemplated without some form of earthing system. It might be worth adding that, if you ever have the transmitter near ground such as on a table at field days, then a low impedance earth wire (thick coax with inner and outer joined is very satisfactory) connected to a good long earth rod driven well into the ground may replace the counterpoise provided the earth is moist (water if necessary). If in any doubt have an earth rod and a counterpoise!

Comment if allowed! Eric first advised me of this problem in some rather boring part of a Committee meeting with a cryptic diagram saying "what's going on?" Answer-RF shooting down the mains earth wire! My own preference would be to connect the counterpoise to the coax screen at the matching unit but Eric comments that his SWR bridge would not be affected by any RF on the outside of the coax cables going in & out of the bridge. The full evidence also suggested the possibility that his mains earth system might be resonant (with the quite high Q of 8) at 1.95 MHz since tuning to 1.83 MHz cured the problem completely. I wonder if it is OK to live in the middle of a 160m loop?! G3PCJ

Variable Output Linear Power Supplies

I apologise for returning to the subject of power supplies but they are a frequent source of inquiry! There are two common variable types, those based on the 317 chip and the very similar 338K type. The 317 can provide outputs up to 37 volts; it is available in the 100 mA L version and the 1.5 Amp T version which needs a heatsink. The TO-5 338K can handle 5 Amps and needs lots of metalwork! The output of the 317s can be from 3 to 37 volts and the 338 from 3 to 32 volt. The input voltage must be at least 2 volts more than the maximum output but beware that the device dissipation will be highest on low output voltage at high current. Devising a power supply to give say 5 Amps continuously over the range 3 to 32 volts is a severe electrical challenge and also a mechanical one as it might have to dissipate nearly 150 watts and will need a transformer weighing about 3 Kg. The first problem is that the input to these regulators must not exceed 35 volts for the 338 and 40 volts for the 317s; the transformer on load secondary AC peak voltage needs to be a minimum of about 5 volts higher than the desired maximum DC output (2 for the bridge rectifier, 1 for ripple and 2 volts for the regulator) - this usually means a nominal transformer secondary RMS voltage of at least the maximum DC output voltage. The off load raw DC voltage will at least 1.4 times the nominal RMS secondary voltage and perhaps up to 8% higher if the mains is high. For our notional 32 v PSU, a simple arrangement of transformer, bridge rectifier and smoothing capacitor combination might generate a no load voltage of perhaps 50 volts - none of these regulators will tolerate this! Either the regulator has to have a permanent load, or some form of pre-regulation, or the secondary RMS voltage be lowered to about 25 volts in order to keep within the permitted off load maximum input voltage. The probable upper full load output DC voltage will then be around 24 . At high output currents, even the bridge rectifier will get warm and need bolting to the metalwork since it might dissipate 8 Watts. The smoothing capacitors should have a working voltage about twice the transformer open circuit RMS voltage and as a guide, their value should be about 10,000 µF for every Amp of output current, if the ripple on the raw supply is to be below 1 volt at full output. The smoothing capacitors should always be fitted with a bleed resistor which can also be used for a LED Power ON indicator. The notional 32 volt 5 Amp continuous supply would need a 150 VA transformer and capacitors of 50,000 µF rated at about 60 volts DC - they will be BIG and EXPENSIVE if bought new! All of this points to an impractical design requirement! A further practical point is that for a 5 Amp supply, the peak current in the rectifier will be around 50 Amps so you need to use thick wires in the transformer, rectifier and smoothing capacitor part of the circuit. Incidentally, soon all commercially made supplies whose power output is over 50 Watts will have to meet difficult requirements about not reflecting harmonics back into the mains due to these very large and spiky rectifier currents. The above list of snags explains why switch mode power supplies are so attractive as all these problems are much reduced and nowadays the problem of electrical switching noise is well under control. Many of these problems can be much reduced by designing for as small a range of output voltage and low current as is possible. I have sketched in some suggestions alongside.



Both the 338 and 317 series of regulators work by developing a controlled 1.25 volts across a resistor R1 placed between the output and the adjust pin. The current, which this causes in R1, then flows on through a second resistor R2 from the adjust pin down to zero volts developing the control voltage. The maths of this is:-

$V_{out} = 1.25 + (1.25 \times R2 / R1)$

The current which flows in the adjust pin is around 50 µAmps and can usually be ignored. Typical values are 220R for R1 with R2 to suit the desired voltage if the output is fixed. Alternatively R2 maybe variable but if it goes open circuit (with a noisy pot) then the output will rise to the raw supply probably wrecking connected circuits. A better approach is to make R1 variable and fix R2 at about 2K2. If R1 is a variable of 1K in series with 82R the output range should be about 4 to 35 volts if the raw supply will allow it. The current in R1 and R2 should really be at least 0.5 mAmp but this is difficult to arrange with a wide single output range. It is quite a good thing to put a load resistor of 1K or so permanently across the output and to decouple the output with 100 µF (V DC same as smoothing caps) in parallel with a 100 nF polyester and 10 nF disc ceramic on the output terminals. It is also worth noting that the line and load regulation of these regulators is appreciably better than the common fixed voltage types; this is why I use them for internal stabilised supplies for varactor diode tuning voltages. **ALWAYS** fully try out a PSU on a dummy load first! G3PCJ

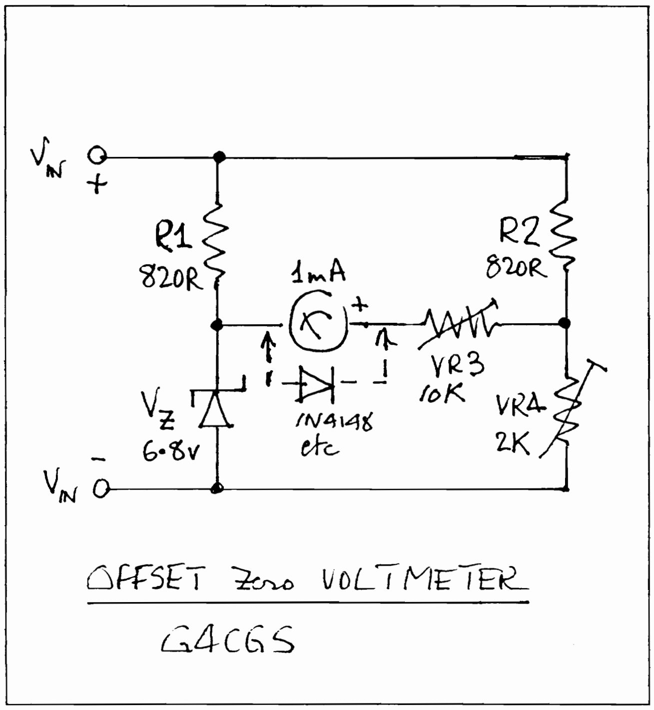
Offset Zero DC voltmeter by David Sugden, G4CGS

There are times when it maybe desired to more or less permanently monitor a DC power source without tying up the shack multimeter all the time. Usually the voltage range required is restricted and so a form of scale expansion by using an offset zero will enable accurate readings to be made. A typical example might be to monitor the terminal voltage of your car battery whilst working DX from the top of a hill. The battery voltage may, dependent on charge state, be between 10.8 volts fully discharged and 14.5 when fully charged on float. Since for this purpose we are not interested in readings outside this range, it would be appropriate for it to be scaled 10 to 15 volts. With care, readings to plus or minus 0.1 volts are possible. The circuit can be easily adapted to other voltages and meter sensitivities. It is essentially a bridge arranged so that, at the minimum input voltage, the bridge is balanced and no current flows in the meter. As higher voltages are applied it becomes unbalanced and the meter reads up the scale. It will read backwards for inputs below the minimum and you might wish to add the diode to protect the movement if this is likely. Select a zener whose voltage V_Z is about 60 to 80% of the V_{min}.

The $R1 = R2 = (V_{max} - V_Z)/10 \times I_m$ KOhm

and $VR3 = (V_{max}/V_{min} - 1) \times 1.5 \times V_Z/I_m$ KOhm

and $VR4 = V_Z/(7 \times I_M)$ KOhm



These theoretical values for VR3 and VR4 are the minimum and you should use the next available higher value. The circuit gives some typical values. The setting up procedure is to set VR3 to maximum resistance and apply V_{min} from a variable PSU - 10 volts in this case. Adjust VR4 till the meter reads 10 volts at its normal zero position. Then apply V_{max} and adjust VR3 for full scale indication - 15 volts in this example. Repeat these two adjustments as there is interaction between the presets. To complete the job, assuming you can dismantle the meter, remove the old scale calibration numbers carefully by scrapping or snowpake etc., then carefully add the new numbers with a fine tipped pen; the intermediate values should be reasonably linear but its worth checking them with your variable PSU.

Tail enders

Further to my note about Blu-Tack, Peter Barville G3XJS, writes "It is useful for a wide variety of jobs including temporary (or not so temporary!) mounting of finished PCBs in confined spaces (e.g. mounting a small extra board above or on an existing panel). I even admit to using it as quick and easy method of securing a battery, without having to drill holes for securing a battery clip. It is also ideal for sealing connectors and soldered joints exposed to the elements. In my experience, copper cable, chrome nuts and bolts etc stay shiny and bright so long as they are protected within Blu-Tack used as a sealant. There appears to be no problem of corrosive action, as is the case with normal bathroom (and exterior) type sealants. Blu-Tack doesn't harden, can be easily removed, and then replaced if necessary, and is cheap and readily available. Every shack should have some!" To think I have been chucking it away! G3PCJ

Pat King, G4GFY, who I frequently hear using his Tiny Tim, found that he had a bit of a problem with audio breakthrough on transmit. He cured this by an extra relay operated by the PTT switch which disconnected the LS.

Some while back, Stewart Sims G3WQW, suggested a note on temperature compensating capacitors for VFOs etc. This is big topic but I think there are some general observations that can be useful. I find that when the inductor of a HF VFO is a TOKO style coil and it is used in conjunction with a combination of NP0 and N150 capacitors, then drift is seldom a problem. The characteristic of the N150 roughly matches that of the inductance so that with increasing temperature, as the inductance goes up, the capacity goes down. Both the NP0 and N150 capacitors are low K ceramic discs which usally have small rectangular grey bodies and coloured tips; the NP0 sort have black tips and the N150 types have orange tips. The NPO (black tip) ones have a nominal zero temp coefficient and are supposed not to change as temperature alters; the orange tipped have a -150 parts per million per degree Centigrade characteristic. The other violet tipped disc ceramics (- 750 ppm) should not be used in VFOs. Medium and high K disc ceramic types (often with round yellow bodies) are not suitable for VFOs either since their temperature coeffecients are even larger and more unpredictable. As it is difficult for most people to tell the difference between the low K and other ceramic types with certainty when they are presented unlabelled at a rally; my advice is don't use them for a VFO unless you have confidence that the supplier is certain of what they are and write the details down at the time. Chance it if you wish, but at least silver mica (if you can find them) and polystyrene types are far less confusing and nearly as good for VFOs!

And finally, I thought you might be amused to know that one of my Booster linear amplifiers is doing service at Malin Head Radio Station ! I have to admit it is with EI0CF and not with the Irish Authorities! G3PCJ