# Hot Iron

| Issue 18 | "Journal of the Constructors Club" | Winter 1997 |
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Contents



## Editorial

How I love and hate this computer! I have just spent a good 15 minutes trying to import my normal 'season' picture on the bottom of the page. I know it is somewhere in the machine or on my Publisher CD, but can I find it! I have given up in disgust. Please, one of you, send me something to liven things up a bit! The trouble is that I don't use these slightly unusual features sufficiently often to remember how to do it. At least amateur radio does not have these problems, not at least for most of us using simpler rigs. I suspect those people using packet may feel the same, judging by the long QSOs that one overhears and undoubtedly modern black box rigs do suffer from multiple uses of each control. Thinking of networked computers, I have just linked to the Internet so shall be very pleased to have any future contributions by e mail. I had expected my son to spend all his time surfing at my expense but in fact it is my daughters that use it most for writing to friends etc. I am only just getting used to it and still have some 'local' procedural difficulties but clearly it will become very useful and helpful to all. My address is walfor@globalnet.co.uk. (The missing d is intentional.) My file of articles written by others is a little thin at the moment, so please, when you need some distraction after the festivities of Christmas and the New Year, get your pens out and jot something down. Don't worry about polishing it up etc. for publication - I can alter things easily! (I hesitate to use the word polish as I am conscious of the somewhat informal nature of Hot Iron.) Anyway, all the best of festive greetings for Christmas and the New Year, and may you enjoy good health throughout 1998 and beyond. Tim

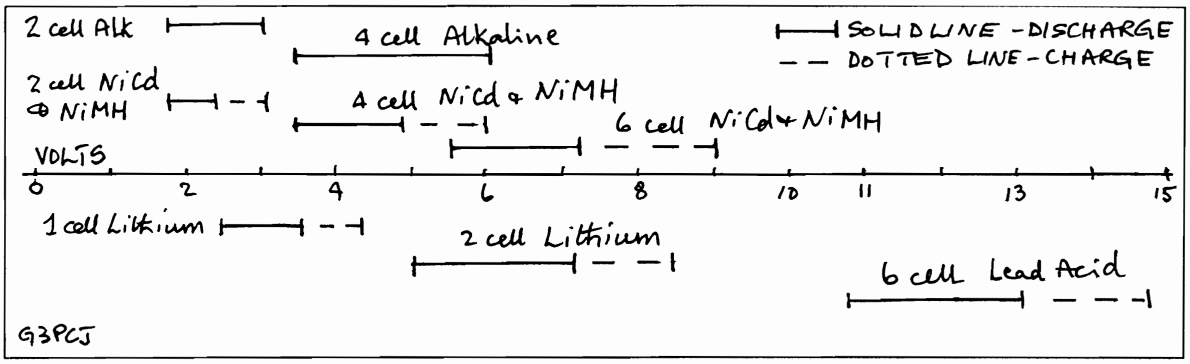
## Kit Developments

The ***Street,*** any single or two band CW and SSB TCVR, is now available. A few are out and no troubles to date - I keep my fingers crossed because 6 metres is a challenge! I have also produced an ***Optional Extras*** kit for the Street and other rigs that have some of the embellishments left out of the basic rig - e.g. AGC, RIT, S meter/output power with matching bridge. There have also been a few inquiries over the months for low pass filters - particularly for the simple broadband CW rigs. I now have available a single kit that contains two relay switched dual half wave ***low pass filters*** for any pair of bands 6 to 160m. Two of these units can also be used for a three band rig like the Godney. I have also completed the kit for a QRP ***Antenna Unit***. This contains a matching unit, based on the low pass L network with variable L and C, together with an optional resistive matching bridge and output meter. L and C switching uses switches as well as a polyvaricon to keep the cost down. For mobile use, it has been squeezed into the small kit format 100x100x65mm high. I have laid out the PCB for the ***Midney*** which is a simple any single band 20 to 160m superhet phone/CW receiver - writing the instructions is the next task after this! The matching CW TX and any two band CW phasing RX are not far behind! I am looking for some prototype builders so let me know if you are interested in any of these. 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  Subscriptions are £6 per year for the UK (£8 overseas) from Sept 1st in each year. June 1st 1996.

# *Battery types and Charging*

Recently several members have had questions about batteries; being not too confident about this topic I was pleased to receive a couple of articles from which much of the following has been culled. There are many different cell chemistries with a wide variety of battery or multiple cell stack voltages; it is not often appreciated just how big the difference actually is between lowest useful cell voltage and that at the end of charging. The chart below shows this for various cells chemistries.

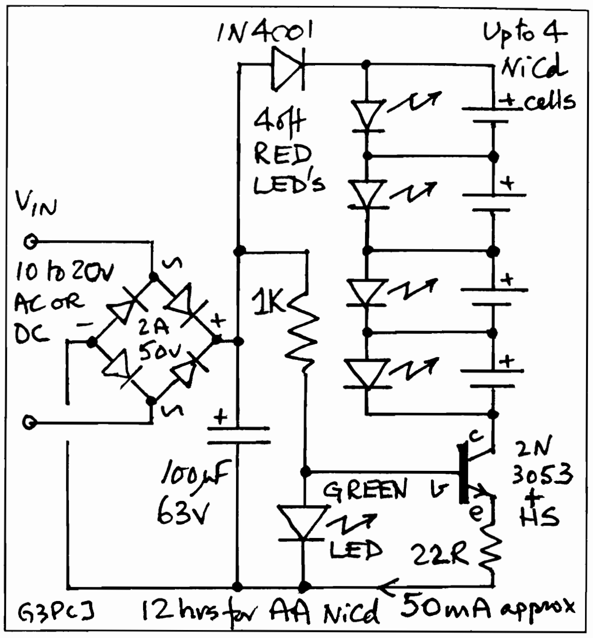



Crucial to charging properly, is knowledge of the cell or battery stack capacity C, measured in ampere-hours. This is literally the product of current and time that the battery can 'normally' supply after being fully charged - a figure which is not dependent on battery voltage. The suggested charging current is often expressed as some fraction or multiple of C; this allows you to estimate the time that it should be on charge - divide the cell capacity by the fraction of C used for charging. (e.g. Charging at half C will need two hours theoretically.) The following table shows some example capacities (in amp-hrs) for typical cell sizes and chemistries. The ordinary carbon-zinc cells are not supposed to be rechargeable but I have seen it suggested that some charge can put back in again shortly after partial discharge - particularly if the DC charge current has a small additional AC component produced by a capacitor across the charger's rectifier. Chargers are commercially available for alkaline cells, I think using the same technique. I have no data, or experience with either, so cannot recommend it!

| CAPACITY Size - AHrs | Primary - Carbon zinc | Alkaline - Copper top | Lithium - | Standard - Ni-Cads | Nickel metal hydride |
|---|---|---|---|---|---|
| AA | 1.5 | 2.5 | 2.3 | 0.6 | 1.1 |
| C | 4 | 7.2 | 8 | 2 | 2.6 |
| D | 10 | 17.5 | 19 | 4 | 5 |
| PP3 | 0.3 | 0.5 | | 0.15 | 1.1 |

There is some debate about the need to discharge cells before recharging - most experts reckon that discharging down to 1 volt per cell (for practically all chemistries!) will reduce dendritic formations which are responsible for the so-called memory effect. Fast discharging, in less than an hour, is not generally recommended unless the cell is specifically designed for such hard work; however it is suggested that any preconditioning discharge take less than 10 hours. Fast charging (as opposed to trickle charging) for *NiCd and NiMH* cells is similar; it can be done at up to twice the one hour rate but it is more usual to use the two hour rate or half the rated ampere-hour figure. A constant current scheme should be used for these two chemistries until the cell voltage ceases to rise any more. For ordinary NiCds a little more charge (5 - 10%) can be put in till the voltage just begins to decline past its peak value. (You will need to measure the cell voltage very carefully to observe this effect so is not done by most amateurs!) Once fully charged the cell temperature will begin to rise more quickly as all the energy is now converted to heat rather than being stored. *Lithium* cells are usually charged with a constant voltage, with initial current limiting to prevent damage, just like the simple chargers for lead acid batteries. Eventually the lithium cell voltage rises to a float voltage of 4.2 volts per cell when charging is complete, so this should be the charging 'voltage'. For lead-acid batteries the charging voltage is not quite so critical, again a current limited supply of about 2.45 volts per cell should be used but the 'float charge' voltage should be lower at 2.2 volts per cell. For Lithium and lead-acid charging, the current limit should be set to about 4C but actual current will fall below this soon after charging is started. After the 'fast' charging as above is complete, an indefinite trickle charge (mainly to counter self discharge) can take over. Self discharge is worst with lead-acid and the articles infer a trickle rate of around 0.1C, that for NiCds should be less at about 0.05C. Trickle charging is not necessary or suggested for NiMH or Lithium cells. With all cells, err on the side of caution by using a low charging current if you don't have any data. If in doubt, use the 5 or 10 hour rate for the cell size and chemistry from the above table. Whatever you do use, it is always sensible to feel the cells a few minutes after starting to charge, then again 15 minutes later, to make sure they are only warm. G3PCJ

## *Charger for 4 AA NiCd cells*




This circuit was designed for use off a car battery (or 12 volt AC) in the dark so had to have polarity protection! It depends on the green LED acting as a 1.4 volt zener diode to define the voltage between the transistor's base and bottom of the emitter resistor, hence defining the constant charging current through the cell string. As each cell becomes charged, the cell voltage approaches the 1.4 volt 'on' voltage of the red LED across it causing the LED to light up because it is now passing the current instead of the cell. This also allows charging without having to have a full string of cells. I used to use this on holiday for the kid's Walkman batteries with the charger under the bonnet - I found out the hard way that it is advisable to do the charging while driving with the unit visible when leaving the car! G3PCJ

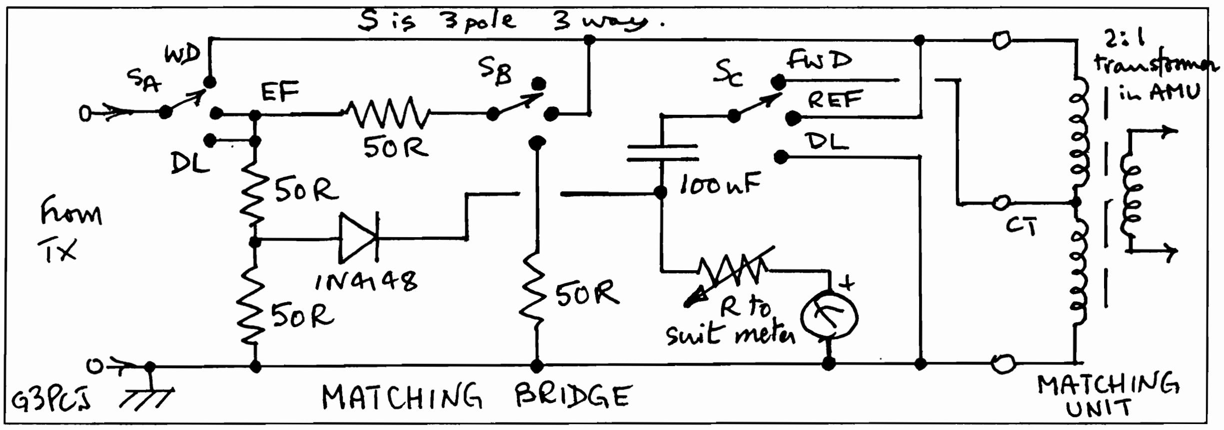
## *Rig Updates*

Bruton and Taunton AGC    A few builders, have reported difficulties with the audio AGC system of the SL6270 VOGAD chip oscillating at about 1 Hz or less having the effect that sensitivity pumps up and down at this slow rate. I used to think that it was associated with too high DC resistance to ground on the unused audio input. (The chip is designed for a balanced input from a mike transformer etc..) However I now think that this instability is caused by a too high supply voltage impedance - over 10 Ohms or so leading to possible problems. Both rigs have precautionary supply voltage dropping resistors with decoupling to prevent audio feedback from the output stage to the VOGAD chip. The chip can take the full 8 volt supply voltage so the easiest modification is to short out these resistors, R112 in the Bruton and R121 in the Taunton, if your rig is affected.

Wedmore    While the ceramic resonator VFO has many benefits, it does have a reputation for not being quite as stable as one would like! With helpful experiments by a number of builders, it now appears that part of the blame can be attributed to using plain ceramic coupling capacitors to the varactor diode(s). The ordinary 10 nF ceramic disc capacitors have a large positive temperature coefficient which I thought would not be important in their role as a coupling capacitor; however changing one to a 4n7 COG type (with nominally zero tempco) has made a marked improvement in most of those rigs which were suffering drift. Changing both C27 and C28 in my own Wedmore overcorrected the drift so I suggest you only change one (either) of them. Not all Wedmores drift and in one case changing the ceramic resonator effected a cure. Send me a stamp with a stamped envelope if you wish to try a 4n7 COG capacitor or another ceramic resonator. G3PCJ

## *Versatile Resistive Matching Bridge*

The circuit shown below is an extension of the simple resistive matching bridge which normally uses a DPCO switch to insert the bridge in circuit and to make the meter show either full output when the bridge is out, or reflected voltage when the bridge is in circuit. A minor irritation is that, with the simple circuit, the meter will never show more than half-scale on the reflected position. If the bridge is used with an antenna matching unit that has a 2:1 input transformer, having a centre tap, then the meter can show full scale on all switch positions including the extra dummy load position. You have probably guessed correctly that the CT is available in my new Antenna Unit kit!



# *Measuring Your Aerial Impedance* by Eric Godfrey G3GC

Many of us at some time or other have wanted to resonate our aerial system for use on the particular band on which we wished to operate. It is not uncommon for this to be attempted using a grid dip oscillator (GDO) or using a noise bridge. However neither of these in my opinion is particularly satisfactory and the object of this note is to put forward another method which is not only capable of indicating resonance, or lack of it, but also able to measure both the resistive and reactive components of the impedance of the system.

The method is to make use of the fact that an aerial which is resonant at a particular frequency has no reactive component but behaves like a pure resistance. If such an aerial is connected across a circuit tuned to resonance then, since its impedance of the aerial has no reactive component, there will not be any change in the tuning of the tuned circuit which will still be at resonance but will now be loaded by the resistive component of the aerial impedance. It is possible, by substitution, to be able to measure this resistive component of the aerial impedance. Figs 1 and 2 show such a system connected to a low impedance source such as an oscillator.

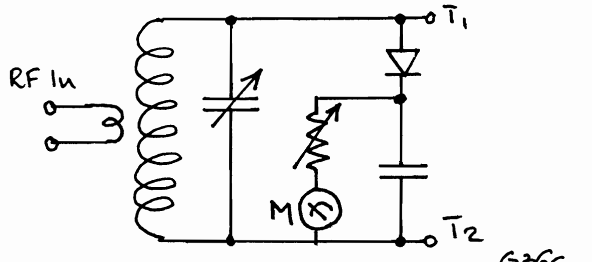



Fig 1 Balanced

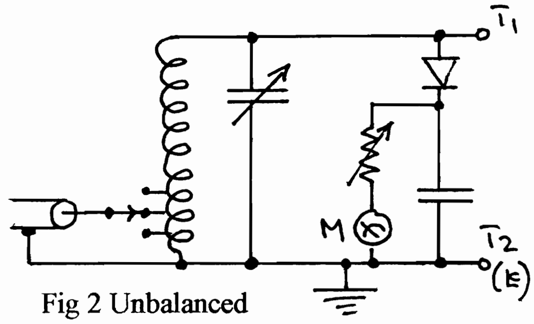



Fig 2 Unbalanced

Preferably the source of RF should be at a low impedance and this has to be connected to the tuned circuit by loop coupling which should be at the centre of the coil to maintain balance assuming that one is going to measure a balanced system such as a dipole (Fig 1). If some form of monopole aerial, such as a vertical quarter wave, is to be measured then the loop should be at the earthy end of the coil. In fact if one wished the coil could have taps at its earthy end thus avoiding the need of loop coupling (Fig 2). It does not matter which method is used and is simply a matter of personal convenience. The diagrams show a peak voltmeter across the coil and resonance will be indicated by the maximum voltage across the coil. This peak voltmeter does not have to be calibrated since it is only used as an indicator but it is worth having as sensitive a meter as possible with a nicely calibrated scale. It does not matter in what the scale is calibrated, it is simply for re-setting purposes. A variable resistor is included in the meter circuit to adjust the sensitivity as required.

The method of operation is to first set the RF source to the frequency required and then to adjust the tuned circuit to resonance, indicated by a maximum reading on the meter. It should be noted that some modern transmitters on high power may not like this and turn the power output down. The meter reading may be set with the variable resistor for full scale deflection on the meter (FSD). Then attach the aerial to the terminals $T_1$ and $T_2$ which more than likely will reduce the meter reading. This can be re-adjusted to FSD by the variable resistor (it is possible, depending on the amount of power and meter sensitivity, that you may not get FSD but adjust for a maximum). If the aerial is resonant then there will be no change required to the setting of the tuning capacitor for a maximum reading. If more capacity is required the aerial must have some inductive reactance and is therefore too long. If less capacity is required then the aerial is capacitive and is too short. Reduce or increase (much more difficult) the length of the aerial as required until there is no change to the tuning of the tuned circuit when your aerial is connected and Eureka you will have an aerial resonant at the measuring frequency. You may calibrate your variable capacitor by connecting different known values across the terminals without an aerial connected and retuning the capacitor. The RF source frequency for this operation should be adjusted so that resonance is achieved when the vanes are fully meshed. A calibration chart of capacity against capacitor rotation can then be drawn and from this, the capacitive or inductive (negative capacitance) component of the aerial impedance may be deduced. You will have noticed that the meter reading tends to be less with the aerial connected which is due to the resistive loading on the tuned circuit. However this gives a way of finding the resistive component of the aerial impedance. All one has to do is to make a note of the meter reading, remove the aerial and replace it with a suitable non-inductive resistance until one is found that gives the same meter reading as there was when the aerial was connected. It is worth keeping a series of resistors specifically for this purpose.

The problem of using this gear is how do you get it, and for that matter yourself, up some 30 ft in the air or do you lower the aerial which will then affect the impedance and give false readings. Well the answer is you do neither. You measure the aerial through a length of twin feeder connected to the centre of the aerial which is any number of electrical half waves long at the desired frequency (the smaller the number of half waves the better). The input impedance to a half wave feeder is the same as its terminating impedance irrespective of its own impedance (Fig 3) and therefore the aerial impedance is transferred to the input which can be connected to the measuring gear situated on the ground with the aerial still at its operational height. It is essential that a balanced aerial is measured through balanced feeders. The monopole should use unbalanced coaxial feeders.

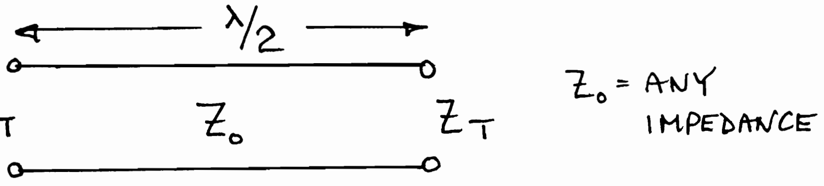
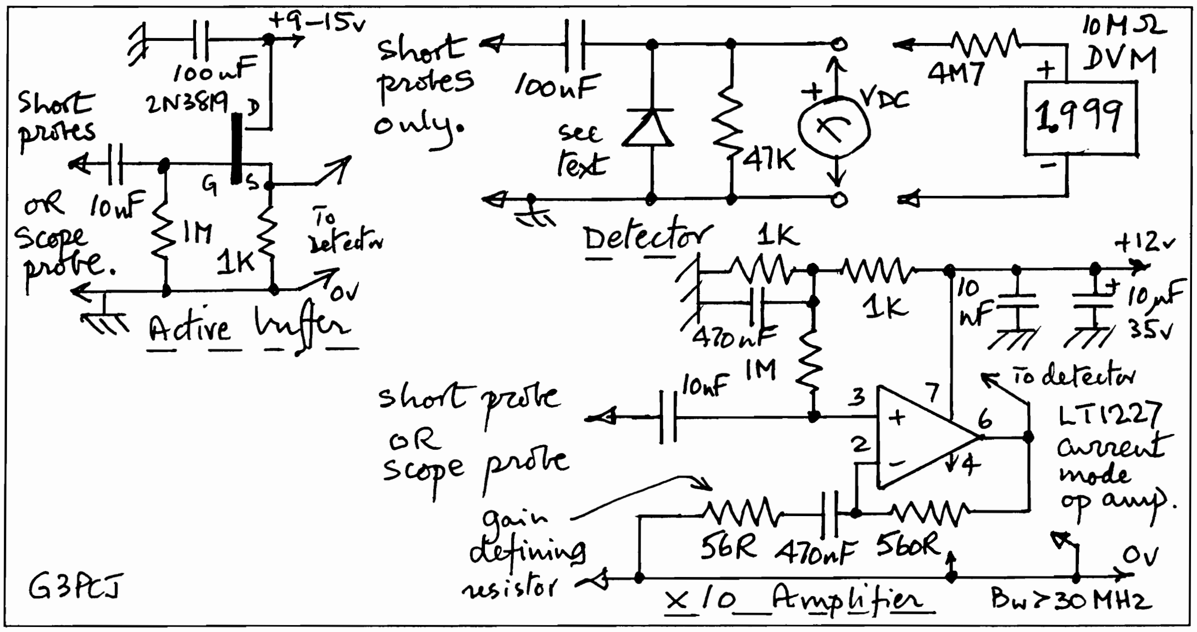



Fig 3 G3GC

It may be that you do not know the velocity ratio of the measuring feeder but this is no problem since all one does is to cut a piece of feeder about a half wave long in air (velocity ratio of 1) and then connect it across the terminals of the tuned circuit. It will then exhibit an inductive reactance and the tuning capacity would have to be increased for resonance. However what one does is to reduce the feeder length until there is no detuning on connection. This length divided by the length in air is the velocity ratio of that feeder expressed as a decimal. This technique may be applied to any feeder whose velocity factor is unknown. (The tuned circuits can be home brew using plug-in coils which should be of such an inductance so as to require the tuning capacitor to be set around mid-capacity.)

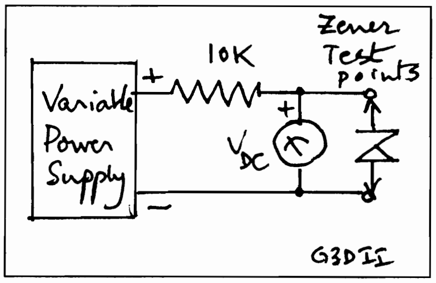
## ***High Impedance RF voltmeters***

Assuming that a DC multimeter is the indicating instrument, some form of rectification has to take place. Silicon diodes (1N914, 1N4148 etc) should not be used in simple circuits as the input voltage has to exceed 0.65 before they begin to conduct, instead germanium (OA90, OA91 etc) conducts over about 0.1v but they are too slow for HF circuits; the best are Schottky silicon diodes like the BAT85 which conduct over about 0.35 volts and are good to VHF. For the simple circuit shown below, the input impedance is of the order of 47K and the series 4M7 should make a 10 MOhm DC voltmeter read the RMS value. Be careful not to apply too much RF voltage (from a transmitter) as the PIV rating of the BAT85 is only 35 volts! The next step up in complexity is to add an active buffer stage to further increase the input impedance by mainly raising the input resistance, to 1 MOhm in the Left circuit. Note there is no increase in sensitivity and there is still a few pF of input capacity. With both of these circuits, they need to be very close to the point being measured and must not be connected by screened lead - its capacity will heavily load the circuit under test. However the nominal 1 MOhm input impedance of the active buffer does allow a 10:1 scope type probe to be used. This will attenuate the signal by a factor of ten, but it does allow the cable (of the probe) to connect to the buffer amplifier. Finally, the operational amplifier circuit will allow the scope probe to be used and regain the full sensitivity of the detector. This circuit has the 1 MOhm input impedance required for a scope probe and should be useable to at least 30 MHz when a good layout and short lead lengths are employed. It should feed the detector direct. The circuit gain can be increased but bandwidth will suffer. The chip is a current mode op-amp with a limited range of feedback resistors; gain alterations are made by changing the other gain defining resistor between negative input and earth. G3PCJ

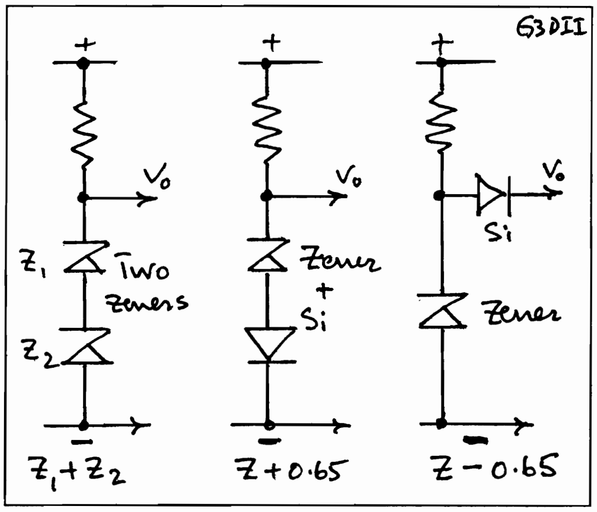


## ***Testing Zener diodes*** by Joseph Bell G3DII

Zener diodes are often used in ham radio equipment and can commonly be obtained with voltages in the range 2.7 to 200 volts. Typical maximum dissipation is in the range 300/500 mW for the smallest glass bead type, 1.3 W for more solid black 'slugs' and 5 Watt for the top hat shape. In circuit, the actual dissipation is easily worked out as the product of zener voltage multiplied by the current through the zener.




Many hams have a bench variable PSU covering 0 to 20 or 30 volts; if such a DC source is available then all we need to test the zener is a 10K resistor and a DC voltmeter, preferably high impedance. The 10K resistor is placed in positive leg of the PSU as shown alongside with the zener placed between the other end of the resistor and the PSU negative terminal. Start by setting the PSU to some convenient value near 15 volts and measure the voltage across the zener. If the zener voltage is under 15 volts this will be shown; if the voltage is 0.6 volts the zener is connected the wrong way round and is showing the voltage drop of an ordinary silicon diode. This is also a way of testing whether you have selected a zener or an ordinary diode from the junk box. If it is an ordinary diode it will show about 0.65 volts when connected one way and the supply voltage when connected the other way. If you have a short circuited zener or diode it will show zero when connected both ways; if open circuit, it will show supply voltage both ways unless it is zener with a voltage higher than your supply voltage. In this case slowly increase the supply voltage and see if the meter reading fails to increase with the supply voltage - in which case you have now found the zener voltage.




You may have a zener whose voltage is a bit high or low for your need but all right on probable power rating. You can increase the zener voltage by connecting two, or more, zeners in series (the same way round) or by adding ordinary silicone diodes between anode of the zener and earth. They need to be able to handle the maximum zener current. If you need to reduce the voltage, add silicon diodes between the junction of the resistor/ zener diode and the load. In both cases, each silicon diode will add or subtract about 0.6 volts from the zener voltage. As a rough guide, for circuit design purposes, the zener voltage should be limited to not more than about ¾ of the lowest available supply voltage. If the load current is fixed, then the current through the series resistor should be about 1.25 times the load current so that ¼ goes through the zener. If the load current varies, then use the maximum load current so that 1.25 times it flows through the resistor BUT remember all that current will go through the zener when the load current is zero, so do check that the zener power rating is adequate! The series resistor value is (supply voltage less zener voltage) divided by 1.25 load current. Do also check the resistor's dissipation. The slope impedance of small zeners is around 5 Ohms so changes in load current will have a small but definite effect on voltage (5R x change in load current.). (If you need better stability use a fixed voltage regulator of the 78XX series - XX is voltage - 05, 08, 09, 12 & 15v are available; the TO220 devices have a 1 Amp rating. The 78LXX has a 100 mAmp rating. Neither is good enough for varactor tuning diode voltages - use a 317 series regulator.)

There are many other diode tricks - do a little experimenting - send the results in to Tim!

## ***14th Yeovil QRP Convention***

The date is earlier next year, ***April 19th*** at Sherborne as before. Star attraction is the Rev George Dobbs G3RJV. All the usual attractions - traders, bring and buy, food, talks, demonstrations and Construction Challenge. This is to produce the most power efficient 20m QRP transmitter. Details from Peter Burridge G3CQR, QTHR or Tel 01935 813054.

## ***Signal Generator Tuning Label***

Craig Douglas G0HDJ found that printing a small adhesive label, fitted beside the tuning knob, with the adjacent signal generator coverage table saved getting out the instructions each time. The 3 digit counter is even better!

| | |
|---|---|
| 1. 26 - 55 MHz | 7. 2.6 - 5.1 MHz |
| 2. 17 - 38 MHz | 8. 1.7 - 3.3 MHz |
| 3. 12 - 26 MHz | 9. 1.1 - 2.1 MHz |
| 4. 8.5 - 17.9 MHz | 10. 807 - 1900 KHz |
| 5. 5.7 - 11.5 MHz | 11. 543 - 944 KHz |
| 6. 3.8 - 7.5 MHz | 12. 395 - 616 KHz |

***Happy constructing in 1998!*** ***Tim G3PCJ***