Hot Iron

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Editorial - The role of Morse - part 2

Contents

I am pleased to say that my comments last time did produce some reaction! Many accepted that morse as a method commercial communication has had its day but that it is still highly sensible for amateur communication. There are many reasons for keeping it as a fundamental part of our hobby - it adds to the variety of modes etc. which are available to us, hence attracting potentially wider participation in the hobby, it can be done with simple equipment, often permitting home building and better understanding of how it works, possibly leading to construction of more complex gear, probably helps to promote good operating practice, provides further contest opportunities, and is historically very important. It is actually still used (and likely to remain so) for certain commercial purposes such as the identification of radio beacons. As a method of controlling access to any particular part of the spectrum, I doubt it has much relevance. Some correspondents made the point that none of the current exams or tests, assess whether the new entrant has been taught how to use his gear to best effect without upsetting others who have an equal entitlement to use their facilities - in short how to behave sensibly in a crowded spectrum. Is this any different from doing a test to check that you can drive without upsetting others? It has little to do with operating on any particular part of the spectrum and not much with the self education, and technical experimentation, that is assessed initially by the various exams, and which differentiate this hobby from other forms of radio usage. Maybe it would be sensible to make all new entrants operate QRP for a period!? The extra sales of relatively simple gear would drive down production costs, reducing the cost of entry to the hobby, encouraging more home construction and hence understanding of the innards. Of course it would be good for kit suppliers!!

Kit Developments

The **Porlock** 6m transverter, from 20m, has now been built by several builders with good results. It produces 5 Watts from a 1 to 5 Watt 20m driving rig. Cost is £44 plus £1 P&P. I fancy this is a cheaper way to get on 6m (with CW or SSB), than via the FM route as suggested by Emma's challenge for a two channel FM TCVR kit, with a target price of under £40. That is a tough target! Most of my development time has been devoted to the **Radstock**. This is an any two band to 10m CW TCVR; on receive it is arranged as a crystal converter ahead of a 6 MHz phasing DC receiver with special narrow audio filters to give sharp single sideband reception. The low frequency VFO gives good stability, with all bands having (very nearly) the same incremental frequency calibration from the lower band edge. On transmit, the receiver mixers become crystal converters so avoiding chirp. Full break-in TR control with sidetone is provided. Available shortly for £79.

Five Questions draw - worth £25 - see back page of last issue of Hot Iron

So few responded that I have decided to extend the closing date to May 17th 1999. Tell me:-

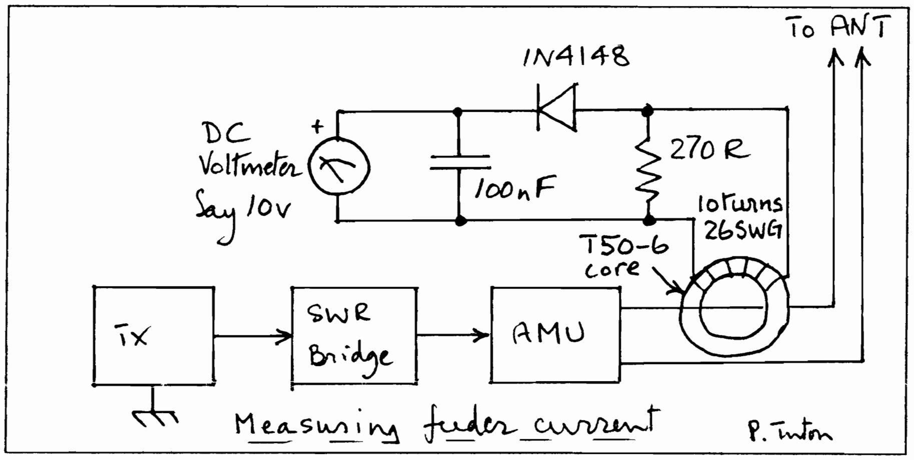
1. What rig you would most like to build and what you think is a realistic price?
2. What is the most complex thing you have built previously?
3. What other topics or material should go into Hot Iron?
4. What is the best aspect of (your?) Somerset Range rigs?
5. What is the least attractive aspect of Somerset Range rigs? (Don't be too coy!)

Tim Walford G3PCJ

Antenna Matching Unit efficiency by Paul Tuton

I've built quite a few QRP / physically small transmitters and receivers over the years, and it's always an irritation when the only ATU that seems to tune them effectively is the size of a large cornflakes box. It's also a pretty effective deterrent to /P working if you have to lug it around. So Tim Walford's miniature Antenna Unit and Matching Bridge looked particularly attractive. But would it be efficient? I suspect most of us have fallen into the SWR trap at some time - the ATU that shows a perfect 1:1 match, but somehow, results are disappointing. The fact is, that ATUs both home built and commercial, vary between excellent and dreadful, and a 1:1 SWR is no guarantee of good performance. The question is, how can you measure the efficiency of various ATUs, and even different configurations of the same ATU?

There is one sure measurement of how much RF is going up your antenna, and that's the current flowing in the feeder. Regardless of anything else, given a constant transmitter output power and frequency, more current up the spout means more signal is radiating. In the valve PA days most of us had never heard of SWR - today, we need to be concerned mainly because of 50 ohm output solid state PA stages, but RF current is still the ultimate measurement of the power in the antenna. RF ammeters are hard to come by these days, but there's a simple alternative that can be made in a few minutes - a current transformer wound on a toroid and slipped over the feeder:



The components are totally non-critical and I claim no originality for this circuit - I've seen similar ones in many places over the years. It works well with open wire or ladder line feeders, slipped over one leg. If your output from the ATU is coax, you should wangle some way to slip the toroid over the centre conductor at the outlet of the ATU. I use an AVO and 2 or 3 watts output is enough to give a 3 or 4 volt reading though this will vary with the band you tune on, and your own particular antenna. The point is, you don't need much power to show a reading. Connect up the TX and set it to the band you want to tune up on. Find a clear frequency and transmit 2 or 3 watts of carrier. Adjust the power and multimeter range to give a reading around mid-scale. Now the interesting part, adjusting the ATU. I could write pages but I'll summarise the key points to keep it brief:

· You might find several settings of the ATU's capacitors and inductors that show a 1:1 SWR, but there could be large variations in the antenna current. Find the setting that gives a low SWR and maximum current.

· If you can configure your ATU in different ways e.g. T or L format, try different combinations and observe the result on the antenna current.

· If you are using a doublet type antenna, try "floating" the ATU on a current balun - typically a sizeable handful of ferrite rods with 30 / 40 turns of coax wound on them, between the TX and ATU (ATU side of SWR bridge). Don't connect the ATU to earth! If the ATU has a metal case, it will be at RF potential so beware - keep to QRP. I've known this to produce spectacular results - particularly on 160 and 80 metres. This whole subject actually needs more explanation - maybe in a future Hot Iron.

· Many of the popular commercial ATUs in neat metal cases appear to be very effective dummy loads, showing a 1:1 SWR but expending most of the RF energy in heating up the innards. I had one where part of the case got too hot to touch with 20 watts continuous for about 2 minutes.

· Metal cases are generally not good news - particularly when inductors are mounted close to them.

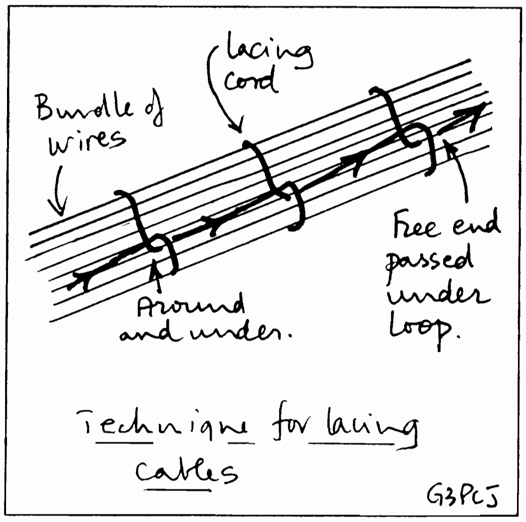
· Baluns (usually toroidal) on the OUTPUT of the ATU are a great way to choke off your RF before it reaches the feeder, and at higher power levels, to start exciting fires in your shack. This is not

Cabling - some suggestions for you to consider!

Audio stages Probably the most common deficiency that I see on returned rigs, concerns the 0 volt or ground connections to the loudspeaker socket and the AF gain control. These should NOT share the same thin common wire because there is a fair chance it will make the AF output stage will actually oscillate (at AF) or scream, or with a tendency to oscillate, leading to a rather harsh sound quality. The LS socket 0 volt/earth lead should be either directly connected to the front panel ground plane, which itself should be connected electrically to the main PCB ground plane at several points, or the LS socket earth tag should be connected by a thick wire to the main PCB ground plane close to the audio output stage. The earth lead of the AF gain control should be either connected directly to the ground plane of a PCB front panel or, by a separate wire (as short as reasonably possible) to the main PCB ground plane midway between the audio pre-amplifier feeding the AF pot and the input to the output AF stage. The LM380 series of audio power amplifiers do have a tendency to self oscillate at near 2 MHz which may well be aggravated by failure to observe these precautions. The 1 Ohm in series with a few hundred nanofarad across the output are essential to stop this mode of oscillation.

Supplies Another frequently seen weakness is thin supply leads. Do make certain that your incoming leads, and those within the rig, are not causing the loss of say 0.5 volts when the rig is drawing maximum current. This can lead to the internal regulator not having sufficient supply voltage headroom to function properly with again the possibility of instability. Often it causes a sort of squeeging RF instability as the bias voltage to the RF output stage falls when the supply droops, TX output falls, volts recover, bias recovers, output rises and volts collapse again. The LM317 series of regulators need at least 2 volts between the regulated output and the incoming supply. The LM2930T8 is a LDO type (low drop out) regulator which will work with around 0.2 to 0.4 volt difference but they are more sensitive to the decoupling capacitance on the regulated line - they must have at least 10µF - use 22µF because the tolerance on electrolytics is huge. Without this capacitance, they will oscillate!

Controls etc. For other wiring, which is often DC tuning or control signals, one should generally route them away from sensitive areas such as RF oscillators which might have their stability impaired, from the input stages of (receiver or transmitter) RF amplifiers, and away from the transmitter output networks. It is also important to make certain that, for example, a relay control signal does not loop from a relay selecting the receiver RF band pass filter onto a transmitter relay selecting the output matching network, because in a bi-directional superhet , this can be an RF feedback path - both relays should be fed separately from the control switch to increase the RF impedance between the two sensitive areas. I prefer to see wires laid in a rectangular grid across the main PCB (and behind the control panel) with them pressed down tight against the ground plane - threading or routing them through the gaps between components. Where a wire connects to the PCB, you can fit pins in the PCB to form little vertical tag posts or solder the wire in directly. When fitting wires direct to the PCB, always make the PCB joint first before the control panel end. Tin the pad first (without blocking the hole) and keep the wire at right angles to the board while applying the iron and gently pushing the wire against the board till the insulation is just within the hole's countersinking. Hold the wire until the solder has solidified and allow the insulating plastic to cool fully before bending the wire to shape to reach the other attachment point. Cut off any excess wire which is projecting below the solder joint of the PCB. If extra anchoring points are needed, solder small bare wire hoops (before threading the wires through) to the ground plane in suitable places. This style of wiring imparts a tidy look and keeps the leads secure. Another approach is to lift them off the PCB and route them in a bundle (with branches) down the centre of the rig about an inch above the parts. The wires are then laced together to keep them rigid. Special lacing 'string' is available - it has a central core with an outside cover which collapses slightly when tied tightly so that it jams and keeps the knots tight. Use the 'around and under' style of lacing knot so that it stays tight as you progress along the bundle of wires - see alongside. If you feel that screened wire is advisable for RF or audio signals, generally it is best to connect the screen to 0 volts/gound plane at both ends near to the signal connection points. For test points, use pins or short stiff wires - do not fit wires with long dangling tails! G3PCJ

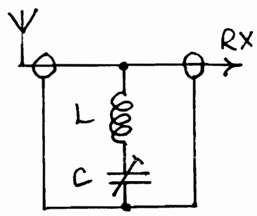


always the case - it depends on whether or not the feed impedance of the antenna falls within the limits of the balun on the chosen frequency. In my experience, it rarely does. (Note that Tim's ATU has the toroidal transformer BEFORE the tuned circuits which is a totally different matter. It always sees an impedance in its design range).

My favourite main station ATU is an elderly Capco Transmatch in a plastic case, fed via a large choke balun. A couple of years ago, I spent several weeks of evenings experimenting with different settings, configurations and balun types until I could get no further improvement. In that time, I doubled the current on top band - and as power is proportional to the current squared, that was effectively a 4 times power increase. My antenna's only a 2x50' doublet, but it now works well around the UK on top band. So how does Tim's ATU compare? My current meter shows identical performance on 160 and 80, and better performance on 40. I've not yet compared it carefully on the higher bands, but quick comparisons suggest it will be at least as good as the Capco. It works on 6 metres as well. Not bad for something small enough to sit in the palm of your hand. Power handling? Well, 10 watts SSB or CW seems fine with no discernible heating. But 5 Watts is probably more sensible. When's Spring coming? Time for some /P working.

Designing series resonant RF traps

Jim Gearey asked me to suggest some values for a 100 MHz trap because he had a local transmitter that was causing interference which might be cured by placing a trap across the receiver input. The technique can be used for any band but it is necessary to know the frequency of the offending transmitter. At VHF, it is easier to use capacitors for the variable element necessary to adjust for best attenuation. Start by using a capacitor value of say 20 pF; this might actually be a part 'closed' 65 pF trimmer and would be appropriate for say 30 to 100 MHz. You then need to work out the required inductance to achieve series resonance using the well known formula:-



$$f = \frac{1}{2\pi\sqrt{LC}}$$

Hence

$$L = \frac{1}{(2\pi f)^2 \times C} \quad \text{or} \quad C = \frac{1}{(2\pi f)^2 \times L}$$

For 100 MHz, $f = 1 \times 10^8$ Hz

Guess $C = 20\,pF = 20 \times 10^{-12}$ Farad

Makes $L = 1{\cdot}26 \times 10^{-7}$ Henry

$L = 0{\cdot}126\,\mu$Henry

G3PCJ

Inductors wound on powdered iron toroidal cores are easiest to make. The first number is the core diameter in hundredths of an inch; the second number indicates the core material mix which have recommended frequency ranges. You need to know how much inductance each turn contributes, which is indicated by their A_L value. The values for common cores are given in the next box together with the formula for working out the number of turns required. For the 30 to 100 MHz range, a green/white (number 10 mix) or yellow (number 6 mix) core is required, so that a T50-10 would need 8 turns.

Core	Colour	Size	f Range MHz	A_L (μH/100t)
T68-2	Red	68/100 inch	1-30	57
T50-2	Red	1/2 inch	1-30	49
T50-6	Yellow	1/2 inch	10-90	40
T50-10	Green/White	1/2 inch	100-200 MHz	18

No of turns $= 100\sqrt{\frac{L(\mu H)}{A_L}}$

For $0{\cdot}126\,\mu H$ on T50-10 where $A_L = 18$

$n = 100\sqrt{\frac{0{\cdot}126}{18}} = 8{\cdot}37$ turns

G3PCJ

For HF offending transmitters, use a fixed capacitor and a TOKO variable coil. First select a coil, with the higher inductance ones for LF work, and then use the formula to work out the required capacitor. Use the nearest available value. Note that if the offending signal is near to a wanted frequency, then tune the trap on far side (in frequency sense) of the offending transmitter, so that it just gives sufficient attenuation to cure the BCI etc. with the minimum attenuation of the wanted signal.

freq Range	TOKO Coil	Inductance Pins 1-3
1 to 5 MHz	3333	45 μH
3 to 15 MHz	3334	5.5 μH
10 to 30 MHz	3335	1.2 μH

G3PCJ

Example: $f = 7\,MHz = 7 \times 10^6\,Hz$

Choose 3334, $L = 5{\cdot}5\,\mu H = 5{\cdot}5 \times 10^{-6}\,H$

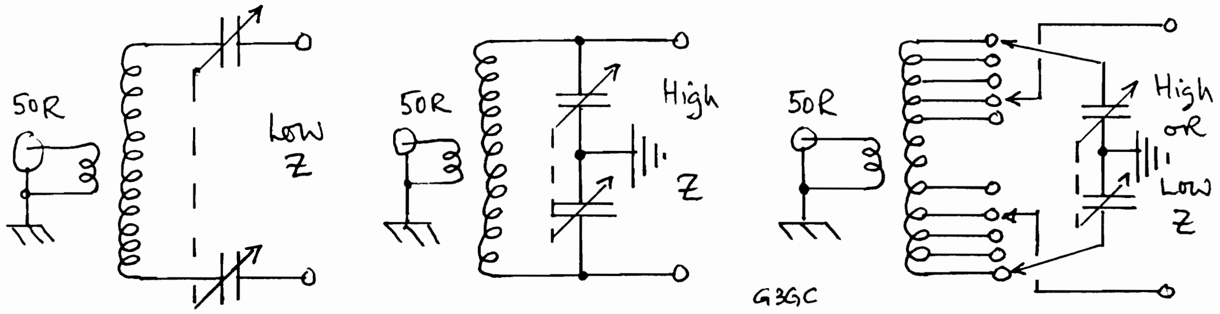
$C = \frac{1}{(2 \times \pi \times 7 \times 10^6)^2 \times 5{\cdot}5 \times 10^{-6}} = 9{\cdot}4 \times 10^{-11}\,F$

$= 94\,pF$ Use 100pF + adjust L.

Aerial Impedance Matching Networks - Part 1 - by Eric Godfrey G3GC

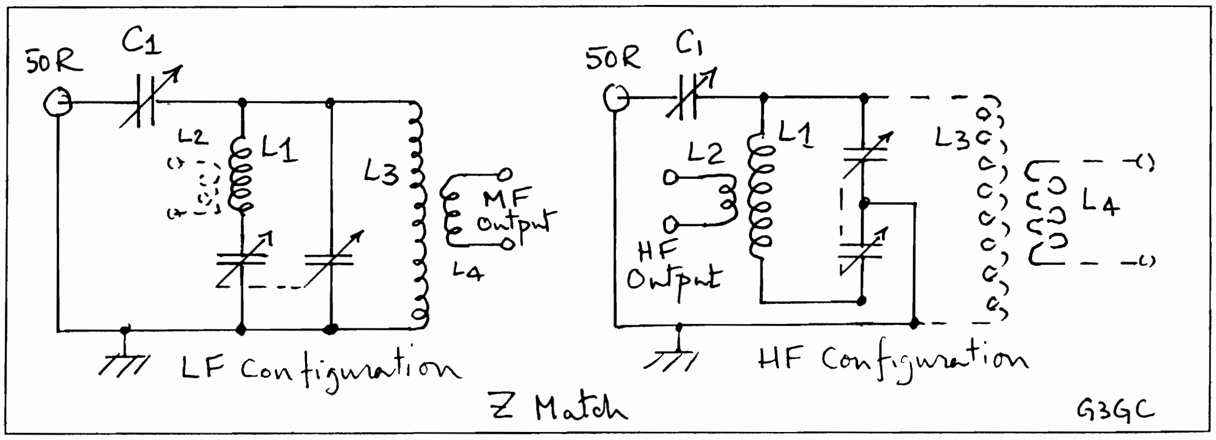
Impedance matching (transforming) networks are used for matching devices or circuits of differing impedances together to ensure their correct and most efficient operation. Probably the most common use in amateur radio is for matching an aerial to the transmitter, commonly but incorrectly called an aerial tuning unit. The one thing the unit does not do is to alter the tuning of the aerial, this is determined by its physical configuration, but it does ensure that the transmitter is presented with the correct load impedance, usually 50 Ohms. This note covers various matching circuits for balanced aerial systems with a variety of impedances. Part 2 will cover unbalanced systems.

The two main categories of matching networks are 1) Resonant and 2) Non-resonant, both of which may be a balanced or a non-balanced arrangement. Although it may not be possible or convenient to use the resonant network, it is always preferable, since it will reduce any possible break-through from broadcast stations and also reduce the radiation of any harmonics that may be generated in the transmitter. This is particularly important if simple equipment is being used.



The diagrams above show examples of a balanced aerial system connected to a resonant circuit which may be either parallel or series tuned depending on the impedances to be matched. The inductance of the tuned circuit is in turn coupled to the receiver by link coupling. The advantage of this circuit is that by changing the configuration of the coil and condensers for either parallel or series tuning, virtually any impedance at the input to the feeder can be matched to the transmitter's low impedance. However there are a number of practical disadvantages with this arrangement: 1) The need to be able to switch from a parallel tuned circuit for high feeder input impedances, to a series one for low feeder input impedances by either the use of a switch or with "Banana" type plugs and sockets: 2) If a number of bands are to be covered with one matching unit then this will require a tapped coil which again will require either a switch or "Banana" plugs and sockets; 3) The link coupling should be located at the centre of the main inductance thus precluding the use of a "Roller Coaster Coil" instead of a tapped coil, unless arrangements are made to move the link coupling as well. Remember that all parts must be suitable for the power being used.

A more convenient arrangement using two tuned circuits is the Z Match or "E-ZEE Match" circuit which is very popular and available commercially. Two balanced outputs are provided from the matching unit; one is normally used for 3.5 and 7 MHz and the other for the HF bands 14 to 30 MHz. On the LF bands it operates as shown on the left below, the split stator capacitor working with both sections in parallel with L3, except that the small inductance of L1 slightly reduces the effectiveness of one section. On the HF bands, the unit operates as shown right. Here the inductance L1 is tuned by the split stator capacitor working normally but there is the large inductance L3 in parallel with L1 which will slightly reduce the effective value of L1. C1 has to be fully insulated from the chassis.



There may be occasions when, due to an unusual feeder input impedance, a match may only be achieved using the "wrong" output. If this is necessary there is nothing wrong with doing this to provide a match. If a match cannot be obtained then another trick is to increase the length of the feeder to change the impedance presented to the matching circuit, the length being found experimentally. My own aerial is a half wave on 80 Metres, which is low impedance at the centre, fed with about 60 feet of 600 Ohm twin feeder. In order to be able to get a 1:1 SWR on 80 Metres using my E-ZEE Match I have to switch in (using "Banana" plugs and sockets) about an additional 50 feet of twin 300 Ohm ribbon feeder strung back and forth along the ceiling of my shack. On all other bands, where the impedance at the centre of the aerial is high, the unit is used without any extra feeder.

Another problem which amateurs encounter, is using of unbalanced feeder to feed a balanced aerial, such as a coaxial feeder connected directly to a dipole. This is bad engineering practice but is commonly done although a balun of some form should be used. We now have a coaxial feeder to connect to the balanced output of the E-ZEE Match. The solution, although not sound engineering, is to connect the coax screen side of the E-ZEE Match output to the chassis.

Somerset Homebrew Contest

Don't forget this event on March 27th from 1700z onwards. Either, or both, the TX or RX must be home made. Any mode - 80m only. First prize is a £50 voucher - full details in Winter 98/9 Spratt!

Yeovil QRP Convention

Make a note of the date, April 18th in the Digby Hall in Sherborne. A must for homebrewers!

Tips from Joseph Bell G3DII

Coaxial Switch A very useful piece of equipment to have in the shack! Commercial switches are not cheap but there is a method of constructing one at minimum cost and do the same job. The components needed are die-cast box, a rugged ceramic wafer switch and as many sockets as you require, SO239 or BNC or whatever. Mount the switch on the lid of the box and position each socket so that its central connection is immediately next door to the switch tags. A short piece of 16 gauge wire can then be used to bridge the gap between centre pin of the socket and the switch wafer tag. If this type of construction is used it will be found that there is negligible effect on the SWR when inserted in a coaxial line operating at its nominal impedance. The more robust the switch the better, even if you are using QRP, as such a component will stand up well to continuous use.

Dental tools For many years I have used these useful tools in and around the shack. The ones with a hook on the end, which the dentist uses to clean cavities after drilling, are the most versatile. Even if the end of the hook has snapped off, it can be reground. Other 'unhooked' tools can be made into fine centre punches. Hooked tools can be used to retrieve inaccessible spots of solder or to check the number of turns of fine wire on a coil. Next time you visit the dentist, ask him if he has any broken or unserviceable instruments. Modern ones are made of stainless steel which does not take solder.

Emergency coax connectors Recently I wanted to join two PL259 plugs together using the threaded barrel double ended type of double socket. The junk box let me down and I hit on the idea of using two SO239 sockets. I had two of the bulkhead mounting four bolt type. I put the two back to back and soldered the central pins together with a short wire. To join the bodies together, I used some copper flashing (brass or tin plate would do) formed into a cylinder to enclose the central part of the sockets just inside the bolt holes of their flanges. I then soldered along the cylinder long joint and around each flange where it abutted the cylinder. Perfectly satisfactory and much cheaper than buying one!

Preserving the stability of pulse generators

The 555 timer IC has excellent frequency stability against supply and temperature variations for square wave outputs. If two diodes are added to permit separate resistors controlling the charge & discharge of the timing capacitor, then the stability is badly spoilt. Adding two more diodes as shown right will restore the stability without upsetting the timing. The circuit is drawn for the general case of a bistable with set and clear thresholds at one third and two thirds of the supply voltage. (Eg. Schmit trigger circuit.) It can also be arranged to give independent pulse repetition rate & width controls. G3PCJ