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Hot Iron

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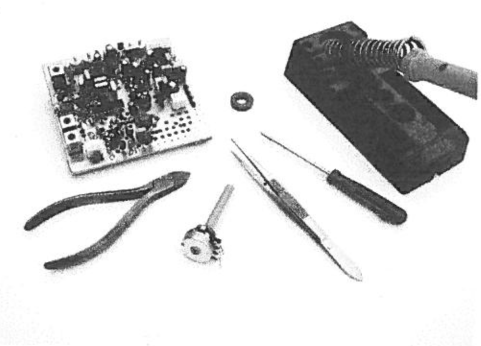
Contents

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

Editorial



Back from work temporally abroad at a farming Conference in Canada (with a little bit of a holiday there as well!), I am finding it very hard to get going again on any serious work! I was not pleased to find that back here, my solar charged batteries were completely flat (due to a light being left on) and not accepting any charge from the panel. After several hours on a powerful mains charger they have crept back to life! It remains to be seen what permanent damage will have been done and if anybody knows about resuscitating deep discharge gel cells I would be pleased to know.

The batteries did however come into their own (powering our AGA cooker) a few days ago, when lightening stuck our local 11 kV overhead lines and took out one phase. All the alarms went off for miles around - I was certainly not going out to turn mine off! Our Post Office still had at least one modem dead 7 days later! We had just had a lightening conductor installed (before the storm) on our 500 year old church, which has never been struck, so perhaps there is a lesson to be learnt there! Tim Walford

Kit Developments

I regret that I have done very little except get the three items of test gear working and written up for PW since I was last typing for Hot Iron! The very next development job is the Brean and then the All Band VFO and Signal Generator. (Please don't give me any more new rig suggestions before Christmas!!) The Test gear items are all for use in 50 Ohm systems - a 20 dB switched Attenuator with 1 dB steps, a Dummy load indicating Power meter (with ranges of 50, 500 mW and 5W FSD), and a PCB with two separate wideband 10 dB RF amps. £19 each or all three for £57 P& P free.

After that I am less certain, as ideas for the Pylle CW TX are beginning to crystallise, possibly using the All band VFO; this might also be a suitable test bed to try out some ideas for the Minster.

Meanwhile the sky is looking distinctly threatening - I ought really to be outside installing some land drains out in the field where a tractor nearly got stuck back in the Spring! Doing a little of Hot Iron looks to be somewhat easier!!

Regards, 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

More Diode Abuse!! by Richard Booth G0TTL

Since the last edition of Hot Iron, my experiments using standard diodes as varactors have continued. Previously I concluded that red LED's and the 1N54 series of rectifier diodes had the best potential for use in VFO circuits. With this in mind the next thing I wanted to look at was the frequency stability of such devices when used in a standard Hartley oscillator.

A well regulated and filtered supply is essential for any kind of frequency stability when working with genuine varactors or substitutes. Being able to deal with temperature changes is the other big problem, luckily though there are quite a few different types of capacitor which can be used in the oscillator to counteract changes in diode capacitance due to temperature fluctuations. The theory is that by using a capacitor with the opposite temperature coefficient to the tuning diode and inductor you can attempt to cancel most of any frequency drift out. Negative coefficient ceramic N150 capacitors, and polystyrene ones are good for counteracting positive drift, which normally occurs in resistors or inductors. COG and NPO ceramics are the other useful types for stabilising oscillators, having negligible changes in value over a wide temperature range.

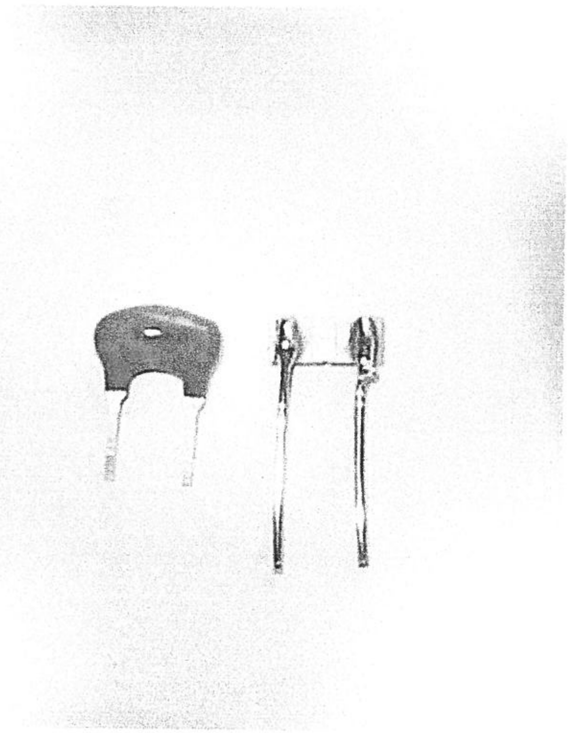
My latest project which is half built now, is a direct conversion receiver that uses a varactor tuned oscillator running at 6 MHz, this in turn is mixed with cheap ready cut computer crystals and filtered to generate the local oscillator frequency. This scheme covers all the traditional HF bands and a couple of the WARC allocations too. The prototype hopefully will cover 4 bands. More on this later! My specifications were a 6 MHz VFO with a minimum 300 KHz bandwidth. Using much the same circuit as described last time for test purposes, I constructed another oscillator complete with the extra supply filter and regulating components. Fourteen turns on a T68-2 toroid makes up the oscillator coil together with a tap at three turns from earth. This had it running at 6 MHz in no time at all. For starters I used a 5 mm red LED as the tuning diode. It turned out to be a good choice as I managed to get about 300 KHz swing out of the circuit without too many capacitor value changes. Using a combination of COG and N150 ceramics as the VFO resonators I was surprised just how stable this little circuit could be. After allowing the board to settle down for a few hours any drift, according to my counter, was in the region of 10's of hertz! From switch on as expected the oscillator drifted about 2.5 KHz over the first few minutes, after being on for 15 minutes you could adjust the frequency and after a moment settling down a high level of stability was achieved. The acid test that I like to perform is to listen to the output on a good communications receiver. Over a one hour period once tuned in I did not have to adjust the tuning control on the RX at all - to my ears listening in CW mode I didn't notice any change in pitch either, which backs up the previous findings of the frequency counter. Blowing on the tuning LED caused the output frequency to increase slightly - this is quite an extreme test though! The experiment was then repeated using a 1N5406 diode which I had to hand. This produced a wider frequency swing than the LED, although slightly less linear at the extremes of tuning. To keep things comparative I used exactly the same resonating components. The results here were not quite as impressive as the LED, however still quite acceptable. Initial drift at switch on was about 4 KHz. After 15 minutes this settled down to around 400 Hz over a 10 minute period, and much the same after changing frequency. After 1 hour of operation this improved to around 150 Hz over 10 minutes. Blowing on the diode made a big shift though, I think possibly due to the physical size of the component more than anything else.

The construction of LED's makes them almost double glazed and quite well thermally protected. Based on these tests I've built my 6 MHz VFO using standard high efficiency red LED from Maplin. It's working a treat - more on this project next time.

Richard, that looks very promising and we look forward to hearing more. Could you also see what the oscillator does when you change the supply voltage, and or change the load on the regulated supply line due to some other circuit that might be sharing the regulated supply? My experience suggests, that for an ambitious project like yours, you need better regulators than the 78L0X series - something like the 317L. Tim G3PCJ

Ceramic Resonators for 80M Phone

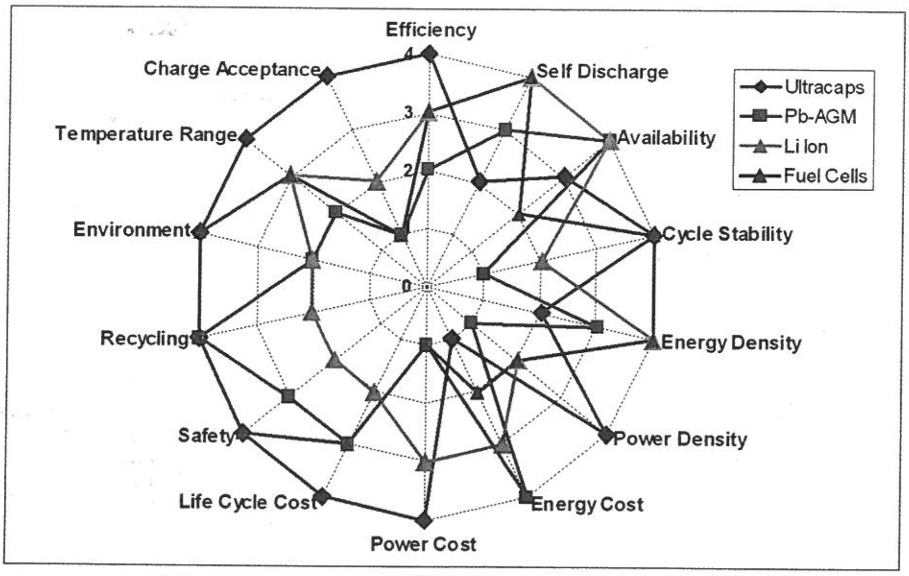
Whilst doing some component research I've come across a useful ceramic resonator available from Farnell. It's nominal frequency is 3.840 MHz however using a 150 pF variable capacitor it will pull right down to 3.710 MHz without any problems at all. I've tested this component in both the Sutton and Compton kits with superb results. The only slight snag is that it's a surface mount part, however it's actually the same size as the standard component - minus it's resin dip coating. It has three pads which are all plenty big enough to solder wires to, the two outer pads being the ones to use. Ignore the centre pad. I bought quite a lot in to get the overall cost down so if anyone would like one to try out then please send 5 second class stamps to Richard Booth, School House, Old School Lane, Wadworth, Doncaster, DN11 9BW and I will pop you one well packed in the post by return. I'm more than happy to solder you on a pair of legs for PCB mounting - just ask. The FEC part code is 117-0427



High Integrity Supplies

Where it is essential to maintain mains supplies, such as to emergency operating equipment in hospitals etc, the available solutions are becoming more high tech! Often a standby diesel engine powered alternator is provided to carry the main load some minutes after the normal mains fails but what is best to keep the gear going during that transition? Traditionally the load would have been powered by a bank of lead acid batteries feeding a rotary, or nowadays, a static inverter. This might have been kept on line all the time, ready to supply power instantly, with the batteries being trickle charged from the mains. But lead acid batteries are bulky and not very friendly items in our environmentally concerned world! Super-capacitors, featuring many Farads (yes - whole farads!) of capacity are now available and are used in all sorts of applications where high integrity short term supplies or energy storage are needed. They can be used as direct replacements for the lead acid battery in standby supplies to bridge the gap while an engine is started.

I read that fuel cells are another technology that is also a candidate but it is totally outside my experience and I cant make any sensible observations! However I did see this diagram right in a power systems magazine which compares the different technologies. Its an interesting format! Although not explained, I assume that the points with the longest radius are deemed to be the best! Study the shapes for each technology carefully! Tim G3PCJ



Resistor selection for the Home Constructor by Gerald Stancey G3MCK

Resistors come in many forms but for the home constructor there are really only two characteristics that matter; these are resistance and wattage. Lets look at each in turn.

The resistance is usually written on the resistor or coded onto it by different coloured bands. The former method of identification usually gives very few problems but the latter can cause difficulty, For example which end of the resistor do you start to read the bands and what are the colours - not just what do they mean but can you tell the red from brown in any light? Apart from enabling you to determine its resistance the colour coding may also give data such as the tolerance. Oh for the old days when the body, tip spot system was used and life was simpler.

Tolerance means how close to the marked value the resistance will be. In general modern resistors are usually within 5% of their marked value and a good circuit diagram should give the tolerance of the resistors that are used.

I find that the best way of handling resistors is to measure their value on my DVM (digital voltmeter). This avoids having to decide whether it is a brown or red band and from which end to start. Lets look at a practical example, the circuit diagram specifies a 47K 20% resistor. This means that any value between 37.6K and 56.4K can be used. Hence all you have to do is to look in the junk box for a resistor in that range. A word of caution, resistors can change their value with age/use so it may be a little 'iffy' if the marking says that it is 33K and measures 38K, but for the junk box king taking risks like that is part of life's rich tapestry.

Wattage is a difficult parameter to establish. I know of no way that this can be established by visual inspection or non-destructive testing. You may be able to get an indication by comparing it with contemporary resistors of a known wattage. If you know anything better then please tell me. Happily needing to know the wattage is a problem that does not often arise for the modern home constructor. The reason for this is as follows. For the modern constructor the highest voltage that he is likely to encounter will be 13.8 volts. The lowest wattage resistor that you are likely to come across is 1/8 Watt. Now let us look at Ohm's Law and similar things. The wattage dissipated by a resistor can be written as:-

$$W = \frac{V^2}{R}$$

Substituting V = 13.8, and W = 1/8, allowing a 50% safety factor and rounding shows that resistors greater than 3K3 need not have a wattage greater than 1/8 Watt. For resistors of less than 3K3 you will have to do a little circuit analysis to see if 1/8 Watt will be enough. Lets look at a 100 Ohm resistor that is used as part of a decoupling circuit in a 13.8 volt feed line. If this resistor is to dissipate 1/16 W (note the 50% safety factor) then it will pass 25 mA of current so if the stage is drawing less than 25 mA it will be suitable for use. Other examples can easily be calculated.

In the above examples, I have left you to do the detailed calculations for practice. Don't worry if if you do not get exactly the same values as me, remember that I have rounded and used a safety factor of about 50% and then chosen a close preferred value. For those who wish to have more rules of thumb, the following table maybe helpful:-

Wattage	Ohms
1/8	3K3
1/4	1K6
1/2	1K
1	470R

This shows that all 1/2 Watt resistors whose values are greater than 1K can be safely used in 13.8 volt circuits.

Tolerance and how many resistor bands?!!

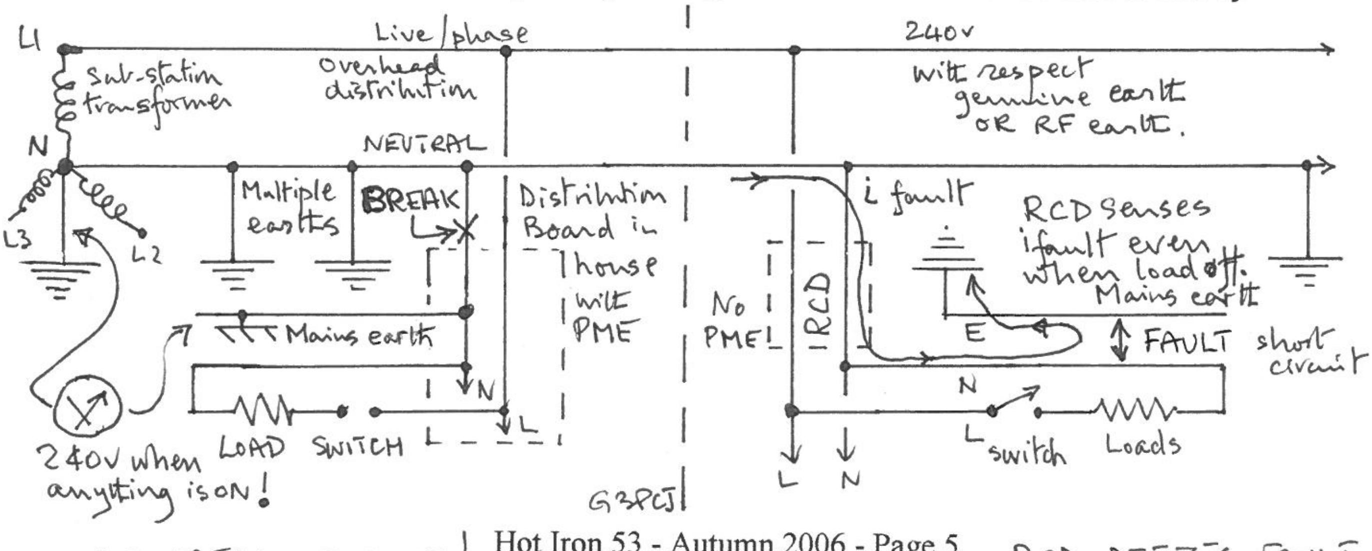
Modern resistors with only **four** colour bands will probably have a tolerance of at least 5% whose value will be in the sequence 1, 1.2, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.6, 10 ..... etc. Starting from the colour ring nearest one end, the ring sequence will equate to body, tip, and spot - the value is a.b times 10^c with the fourth ring signifying the actual tolerance. If it has **five** colour bands then it is likely to be 1% tolerance with markings that mean a value of ab.c times 10^d plus the fifth ring for tolerance which is very confusing! I try to avoid five ring types!! G3PCJ

Another reason for using RCDs!

Members may recall that I have long advocated the use of Residual Current Devices on your incoming main 50 Hz distribution board, especially where the mains earthing is provided by PME (protective multiple earthing). This is especially important for installations with radio equipment that have genuine low impedance connections to the real earth through the radio installation 'earths'. Using a RCD, which detects small differences between the current in the live/phase wire and the return neutral wire, allows the mains earth to be provided by a suitable local earthing rod or spike. Under normal circumstances, the phase and neutral currents are equal so that the RCD is unable to detect any difference and the circuit stays powered. If there is a small difference, due to poor insulation/leakage or short to something else, then the RCD turns off the circuit. RCDs are available to detect differences of 30 mA where there is a risk of electrocution — typically on 13A socket outlets, or of 100 mA where the concern is fire. 300 mA RCDs (often with delayed tripping characteristics) are used to give further protection to a whole 3 phase installation. Using a RCD, with the mains earth provided by a suitable spike, means that there is unlikely to be any chance of a significant 50 Hz voltage being developed between the enclosures of mains earthed equipment and anything connected to the genuine earth via the station's RF earth system. However it is advisable to not directly connect RF and mains earths even if an RCD is used.

Where PME mains earthing is used, the mains earth is provided by a direct connection of the house earth wires to the incoming neutral, on the assumption that this is very unlikely to ever become 'live' (due to its multiple actual earthing). It is normal practice anyway to bond all metalwork that might become live (through a breakdown of insulation, eg in a central heating pump) to the mains earth terminal block; the purpose of this is to ensure that all exposed metal work in the house will be at the same potential and hence there is a much reduced risk if a person touches a mains earthed cabinet and the central heating pipes. The drawback to this scheme is what happens if the incoming neutral, that is providing the PME earth, happens to get broken or is accidentally switched with the live phase wire! The consequence is that everything becomes live with respect to genuine or RF earth!! Hence the warning that one should not be able to simultaneously touch mains earth and RF earths in a PME installation!! Failure of the incoming neutral is not unknown (especially with overhead rural distribution) and I have had direct experience of the incoming neutral/phase live line being reversed (thankfully there was a spike and RCD protection)! If you are unsure what sort of mains protection you have, make certain that mains and RF earths are separate and well insulated! This is a point for Antenna Matching Units!! The diagram left shows how things can go wrong! Take care and consult a good electrician if in any doubt!

After the recent thunder and lightening, in one local property the RCD would NOT switch on even when all the individual circuit breakers were off! Previous experience told me this would be due to a short between an un-switched, or not isolated, neutral wire somewhere in the whole installation and the mains earth . Disconnecting the neutral leads of all circuits together then allowed the RCD to stay on (but with northing working!). Only disconnecting and testing the circuits one by one eventually revealed which had the neutral to earth fault - in fact the lightening had caused an insulation failure in old hidden perished rubber covered wires which had 'fused' together - see right. Without the RCD, this short caused by the lightening would not have been detected! G3PCJ



DANGERS OF PME!

RCD DETECTS FAULT

Alderney's Electrics and Communications by Chris Rees GU3TUX

Living on a small island emphasizes one's reliance on effective communications. Barring some dairy products, Alderney imports all of its needs by sea and air. Not infrequent fog can disrupt flights and the flow of mail, newspapers and perishables. Prolonged gales can delay delivery by sea of just about everything else. A well stocked larder is reassuring when the weather turns nasty.

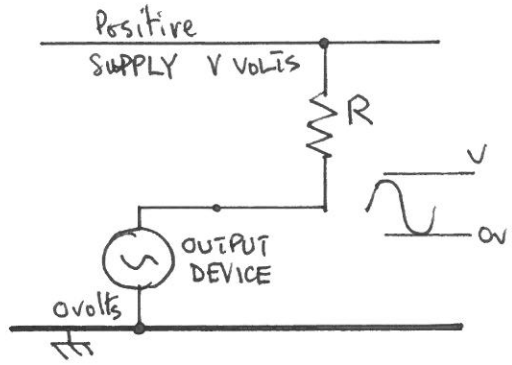
Moving on to the sort of communications which interest readers of 'Hot Iron', we start with the electricity supply. This is locally generated by diesel driven alternators. The price reflects movements in the cost of oil and is currently around 18p per kWh. QRP operation definitely pays! There is a long term project to harness the power of the strong local tides, but in the meantime I use solar where I can and have invested in low energy lighting. Mains voltage routinely fluctuates +/- 5V from nominal 235V – I discovered this when investigating the reason for my FT817 constantly switching to half power TX, which was due to lack of volts from a poorly regulated DC supply. Mains frequency can also vary as witnessed by poor timekeeping of mains-locked clocks. Supply interruptions are, thankfully, rare.

Being surrounded by the sea, the island is particularly subject to disturbances to VHF and UHF propagation. I'm no more than a mile or so from the local TV repeater and Band 2 BBC Radio Guernsey TX, but both are often subject to severe co-channel interference from French mainland stations. Best band 2 FM reception is usually had from West Country transmitters, rather than Jersey. 'Sky' satellite installations seem to be favoured by the majority of the viewing population. Interestingly, on 2m, the GB3ANG Dundee beacon is frequently a better signal than GB3VHF in Kent.

The telephone service is supplied by Cable and Wireless based in Guernsey. The link is by microwaves to that island and thence by undersea cable to the UK mainland. Alderney has broadband, most likely driven by the presence on the island of several on-line gaming operations which benefit from the favourable tax regime. 2.5G mobile phone coverage is offered by both C&W and Jersey Telecom (Wave). The only hiccough here is that at certain points on the island my mobile finds a stronger signal from France and QSYs accordingly! Unless you pay attention, you can end up inadvertently paying roaming charges for local calls.

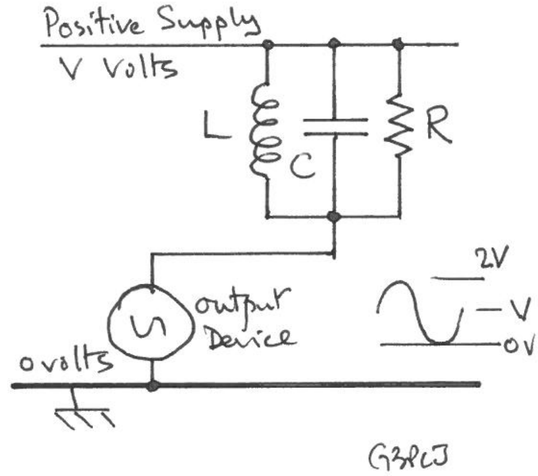
Before the microwave telephone link was installed, an 80 MHz system was in use. This used 4 stacked wire rhombic aerials of multiple wavelengths. The gain must have been pretty staggering. I've recently rented the old equipment hut as an alternative shack for my VHF/UHF operations. The site is excellent with a sea path to everywhere except the South West.

Theory - Rig Output Power



A customer recently commented (before purchase!) that the Brent, with its 1.5 Watt twin BS170 output stage, would be a good candidate for an upgrade with much higher output, by changing to an IRF510. So what determines a rig's maximum output?

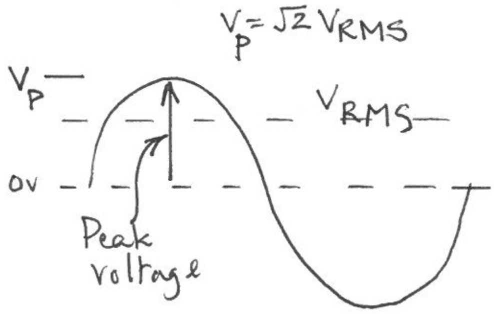
Consider the simple circuit top right. An output device, bipolar or MOS is driving a plain resistive load R Ohms in series with the positive supply of V volts. The lowest voltage that the output can achieve is 0 volts when the device is hard on; the highest output voltage is just V when the device is turned fully off.



What happens if we now add a parallel tuned circuit across the load resistor as shown in the next circuit? If the signal from the driving device is turned off quickly, the presence of the inductance will cause the output circuit to ring at its resonant frequency. In a practical transmitter output stage the driver will operate at the desired radio frequency; and the tuned circuit will usually be resonant at the same frequency. At maximum output, the device will cause the output voltage to just reach 0 volts on each half cycle, and on the other half of the cycle the voltage will go above the supply rail by the same extent as it went below. The output voltage thus swings actually between 0 volts and twice the supply rail, so that it has a peak ac output voltage equal to the supply voltage V, which is sitting on a DC pedestal of V volts also! Practical output networks remove the DC aspect by capacitive coupling so that the we are now only concerned with an ac signal of amplitude V volts peak into the load resistance R.

We all know (or should!) that the power dissipated in a resistor is the product of the voltage times the current, but the current is voltage divided by the load resistance so that the power can alternatively be expressed as voltage squared divided by the load resistance.

In an ac circuit, one uses the RMS values of current and voltage to work out power, so what is the RMS voltage for our signal whose peak voltage is V? The peak voltage of a sinusoid is square root of 2 times the RMS value (see right), so the RMS figure is the peak divided by root 2. Substituting, the power then becomes the peak voltage squared divided by (load resistance times root 2 squared). This of course simplifies down to the well known formula:-



$$P = \frac{(V_{RMS})^2}{R} = \left(\frac{V_p}{\sqrt{2}}\right)^2 \times \frac{1}{R} = \frac{V_p^2}{2R} = \frac{V^2}{2R}$$

where the supply is V volts. G3PCJ

What this tells us is that the maximum output from any particular stage is highly dependent on the supply voltage, and to a lesser extent on load resistance. The device power rating does NOT have a direct effect as long as it can make the signal swing to the full extent of the supply voltage. Thus just changing the device to a beefier type will NOT alter the output, unless you also either increase the supply voltage or reduce the effective load resistance! If you put the actual numbers into the above expression you will find that any suitable device(s) with a 50 Ohm direct antenna load on a 12.5 volt supply will produce about 1.5 Watts, or that a beefier device on 12 volts will need a 12.5 Ohm load to produce 5 Watts of output. This lower load can be achieved by using a 1:2 RF transformer or a tuned matching network like the LCC one used in most of my 5 Watt rigs. (While the above is written in terms of a resonant circuit at the output stage, the ringing effect is equally true when a broad-band stage directly drives a low pass filter which is intended to remove harmonics.)

So the conclusion is that just changing the Brent output to an IRF510 will not increase its output, even if all the other considerations like bias conditions had been catered for! Tim G3PCJ

Snippets

Coherers The Yeovil ARC has long had an interest in very simple rigs that go with QRP activity generally; and this has included simple diode type detectors. At a recent crystal set event, I recently inquired of one of our elder members about the rectification characteristics of coherers. He wasn't too sure but thought they might just begin to turn on when the applied voltage was over a volt. No wonder radio communication distances were so short in the early days! Even now actually getting over a volt out of your receiver antenna system, and through a tuned circuit, into any form of detector is quite an achievement! And that's with transmitters that might actually be putting a steady carrier of hundreds of kW or even a Megawatt of RF into their aerial, as opposed to a spark making an RF circuit oscillate! So does anybody know what actually are the characteristics of iron filings as rectifiers? Their ears or actual signal low frequency information detectors must have been seriously sensitive! Of course that is why mirror galvanometers were invented (actually a lot earlier than radio) because of the high sensitivity that could be obtained by a very long projection distance for the light beam, between the mirror/magnet hanging on the pivot threat and the scale on which the reading was observed. Anybody fancy making a coherer and measuring it?! Tim G3PCJ

Design Challenge! From Chris Rees GU3TUX

I've recently been coerced into joining the Alderney Railway Society and have even driven the train up and down the line a couple of times, complete with passengers on board! The loco does have dual controls, though. The operation is push-pull with a guard in the leading coach when the loco is pushing the coaches. The guard has control of the brakes which he can apply in emergencies. There are several un-gated level crossings at which the guard uses a bell communication system to signal to the driver when it is safe to cross. There used to be loco to guard telephone communication, but this failed and the 3 wires of this system are now used for the bell circuit.

The Problem. They'd like to restore guard to loco cab voice communications whilst retaining the bell signalling system. This has to be achieved with the existing three conductors (no earth return available), including powering the loco end of the circuit from a 12V battery located in the guard's compartment. The battery is solar charged and the system should not consume any power when inactive. The bells operate satisfactorily from the 12V battery supply - they are (and need to be) loud! It should also be capable of construction by yours truly. PMR radio is not a viable option.

Chris offers an appropriate prize of railway related items - tickets, first day stamp covers etc. I have copied Chris's words direct from his e mail so I can't directly answer any questions; however it seems to me that the key is to somehow liberate one of the conductors from the present 3 wire bell circuit. So Chris, we all need to know how these bells are connected and used. I also wonder why a return path (perhaps of poor quality but good enough for fail safe bells) is not available through the engine/carriage wheels and track/couplings? Tim G3PCJ

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