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CQ-CQ-CQ

Apologies for the scant Hot Iron; I'm in the throes of moving house, COVID 19 and all the trials and tribulations that family life brings. I've no workbench; my soldering gear is cold, lifeless. No rosin fumes; no swarf or saw shards litter my vice. All is packed away "until further notice", to re-emerge once I'm happily ensconced on Western slopes, overlooking the Irish Sea with County Wicklow in Eire on the horizon.

I take some comfort in my copy of "HF Aerials for all Locations" by that wonderful man, Les Moxon, G6XN, who tells me I'll be moving to a perfect spot for low angle radiation from simple wire antennas - if only I had the garden space to erect something that Les refers to as "simple"! The antenna "rule of three" is as valid now as ever: you can choose two from gain, bandwidth and small size.

I'm sure I'll get *something* up that will radiate; meantime I'm "BRS", and enjoying quietly trawling around the HF bands listening to whatever stations I find. Luckily, I have a very neat and invisible HF receiving antenna: for details, you'll have to peruse the "Antenna Topics" in this edition!

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Credits for some items mentioned in Hot Iron 108, via John Kirk, VK4TJ, to whom I am most grateful.

Mentioned in Hot Iron #108 were the "Wee-ceiver"; this was designed by Weaver, B. WB2HAL, and was featured in CQ Magazine, November, 1967.

The 3A5 Transceiver is credited to JA3TZZ, https://www.asahi-net.or.jp/~ and I'm most grateful to be able to direct Hot Iron readers to his web pages - a plethora of RF design and technology.

I should emphasise that I'm only human, and sometimes I miss references or get them wrong - those who previously copied or used somebody else's work for instance, I might (unknowingly) attribute their work when it should really be the originator's credit. I do check as best I can, and welcome any corrections from Hot Iron readers - as I do ANY feedback or notes from readers.

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Recent OFCOM prognostications in the UK about reducing amateur radio RF power levels, in response to (I assume) their molly-coddling those who believe that all modern ills - including COVID 19 - are caused by G5 mobile phone technology or any other technology that mentions the word "radiation". The depth of misunderstanding of these "foil hatters" is incredible. The more that these folk hear about electromagnetic radiation the more they fear it; "It's RADIATION!!!!", they scream, "IT KILLS YOU!". This weird and wonderful prognostication struck me as odd, but strangely familiar. Let me explain...

In my industrial years I worked for a - shall we say - "seasoned" chief engineer who encouraged me in all things RF; so long as I kept the "amateur" side of my thoughts separated from my "work" tasks! We had many long discussions about RF electro-magnetic radiation and the human body; he emphasises the inverse square law, and oft quoted Pat Hawker, G3VA's notes about this subject, these being the introductory years of popular hand-held ("talky-walky" he irreverently called them) transceivers that the wisest idea was to keep intense RF fields away from the head as par as woas possible and practicable. With modern GHz transmitters in mobile phones, I think this a wise idea; my grey cells are sparse enough without voluntarily knocking off a few more with every phone call.

With that end in mind (or rather, what's left of it in my case) I use the "loudspeaking" function when "dialling"; and switch back to earphone when the call connects. Then I bring to mind the volts per metre my Chief used to tell me about in the transmitter halls at Rugby (60kHz, running C.W. time data) and Droitwich (200kHz / 198kHz Radio 4, long wave A.M., full carrier): the fluorescent overhead lights - that weren't wired into the mains in any way - lit to full brilliance and gave a dazzling indication of the RF output. The RF generators I worked on day in, day out, running between 80kHz and 500kHz up to 500kW would light a 5 foot fluorescent leaning against the wall behind me indicating high energy electric RF fields being present in a very visible way - I limited my time with the covers off at full power to as short as possible; a flashover at those powers is not only visible, it made my ears sing with the noise for a few minutes too!

Best thing to do as amateurs: keep to mind and limit your time exposed to high RF fields, both inside the transmitter and near the antenna(s). But do try to avoid the neighbours seeing you wearing a tin-foil hat; it does upset them!

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That magnificent man, Frank Barnes, W4NPN, has catalogued, sorted and shunted into logical order my ramblings in Hot Iron on his web page, www.w4npn.net, and has done a superb job in splitting out the Technical & Data section: he has set up a separate tab for the information which is usually appended to every edition of Hot Iron.

All our old friends are there; Unobtanium, Obsoletite and valve equivalents, all the favourites. If you have more to offer on these "data" topics please let me know and that section, now available for all, can grow and become a reference for years to come. It will out-survive me, I know that; and that's just how it should be. it's a source of useful information for anybody, anywhere, to access and use - and long live the free dissemination of the basic knowledge of our trade.

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Tim's Topics

I failed to contribute to the last Hot Iron due to a mess-up on my part over Peter's publication dates! Hence two items this time!

Small QRP Matching Bridge and AMU

I frequently need a small unit for all sorts of experiments with a new random 'long wire' aerial that is unlikely to be naturally resonant on any band and a probably dubious RF earth! It had to cover a wide range of feed line impedances – maybe balanced or not – primarily for the main lower HF bands and needed to include some sort of match indicator. The easy bit is the match indicator; for QRP levels a resistive matching bridge has many advantages – simplicity and always being safe for the TX being the most important! When in circuit, the load on the transmitter has to be between 33R and 100R for any antenna line actual impedance (shorts to open circuit) – so this is should not blow the TX output stage! The unit's circuit is given below with the restive bridge in the left half. Such bridges usually feature a double pole switch in the RF path to include the circuit but that is not necessary if you re-arrange the circuit a little! But do keep the second pole of the switch to choose between a red (bad) or green (good) LED to indicate the best match conditions! They can be separate LEDs or a tri-colour one. I have given the RD LED a slight lower series resistor to compensate for the lower RF voltage when the bridge is in circuit, compared to full out output to the antenna when matched with the GN LED. This helps with determining the optimum matching point when the red LED is extinguished! The three 50R bridge arm resistors should be rated to suit the anticipated dissipation over a few seconds while adjustments are made. Six 2W 100R resistors is good for use up to 20W or so if you are quick! Another advantage (maybe) of using LED for the match indication is that you don't need any large meters, or calibration to account for transmitter Pout variations.

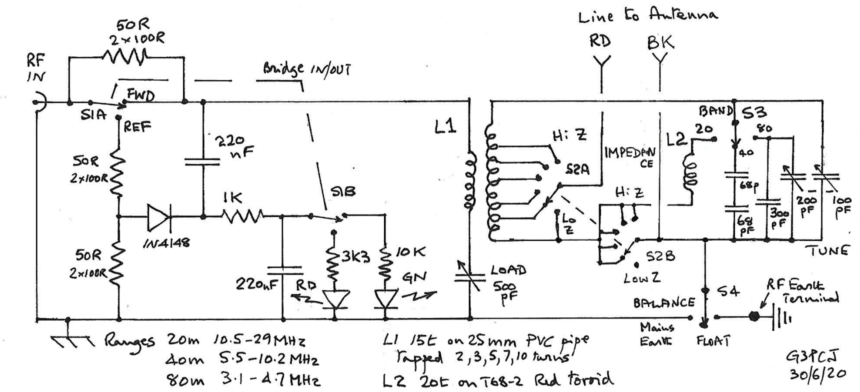
The matching part is a little more complicated – I much prefer a series or parallel resonant circuit because this will help reject out of band signals which can pass through simple L match circuits. I also like the aerial circuit RF 'earth' to be separate from the rigs input 'earth' or 0 volts which is often connected to the electrical mains safety earth – these two aspects lead to a design using a resonant RF transformer with taps for load impedances of a few KOhms down to 10 Ohms; and if isolated from any form of RF earth, it can 'float' to feed a balanced line or aerial despite not actually having a balanced circuit internally. To cover the wide frequency range, the inductor needs to be resonant in the middle of the intended frequency range (say for 40m) with a smallish capacity that can be added to for 80m, and with a lower inductance for 20m by paralleling a smaller inductor, while still allowing the main inductor to remain as a variable turns ratio RF transformer. I had a small air spaced variable capacitor with 100 and 200 pF sections for the main tuning; you should always collect these valuable items! I used another 500 pF variable for the input 'load' one but it is debatable if this is really needed. On 40m I added a fixed 34 pF (2 x 68 in series) across the 100 pF variable to bring the band more to the centre of its rotation; for 80m, the bandswitch connects the 200 pF section with extra fixed capacity to obtain 4 times the capacity on 40m. L1 is wound with 15 turns (tapped at 2, 3, 5, 7, & 10 turns) on a 1 inch plastic water pipe with loads of holes drilled in it to secure the windings; taps are made with a short twisted 'nib' that is soldered down its length to reduce excess winding length/inductance. The primary has 4 turns tight against the low Z end of the secondary. Five positions of S2 give increasingly low tap positions for decreasing impedance loads using parallel tuning; the sixth position alters the circuit to series tuning for very low impedance loads. L2 is a plain winding of 20 turns on a red T68-2 toroid. The last facility is a centre off switch which can connect one side of the antenna feed line to a genuine RF earth or the incoming screen from the TX. With the values shown, the AMU works from 3 to 29 MHz. The picture (below) shows its internal construction. G3PCJ

Stop Press!

I have long been a fan of Regenerative RXs because they can exhibit remarkable performance for simple circuits! My latest is a project called the Bramwell. The prototype (see Photo) has undergone extensive testing here but I need four early builders to help prove it and the instructions for the kit. It has two switch selected bands which are normally set for 40m, with their broadcast stations, and for most of the amateur 80m band. To allow the full beauty of a Regen to be explored it has two large knobbed presets for the frequently used Regen and AF gain controls, with two small presets for the less used RF gain and Oscillation controls – in effect providing coarse and very fine control of the critical oscillation level to suit to AM or CW/SSB reception. The RFG preset is also important to minimise any tendency of strong stations to pull the oscillator frequency which can make the CW beat note sound very rough! After these 'RF' aspects, it has a strong full wave diode amplitude detector with phone bandwidth audio filtering, then the AFG control feeding into a

LM386 power amp that can drive modern 32R phones. The whole is powered from a 9v PP3 battery and will normally be sold for £24 via my website which will automatically add £5 for UK postage. As a special deal for Hot Iron readers, the first four UK orders that come in will be treated as early builders and will qualify for a discount to £22 plus £5 P and P. First come first served so let me know asap if you want to take advantage of this offer BEFORE via my website.

Tim G3PCJ www.walfords.net



SMALL MATCHING BRIDGE and ANTENNA MATCHING UNIT

Test Gear & Maintenance

The Technical Thump

The “Technical thump” - that which cured many a misbehaving valve TV set, and it’s modern brother, the “IC push” - that which sets the wayward little beggars back in their sockets and “wipes” the contact area free of oxide and corrosion are old friends.

Wayward IC’s make a satisfying “crunch” as they reseat. It’s that “crunch” that lets you know the little beggar has been thwarted in it’s efforts to mislead the wayward, and cause untold mayhem and disruption due to intermittent connections.

Before you reach for your meters and tools, , try the IC Push. Works wonders!

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Surface Mount Electrolytics and such

Removing surface mount electrolytics is rendered far easier if you approach the job with a little forethought. Grip the recalcitrant cylinder - after duly noting the correct orientation of polarity - with pliers, and give a firm twist and lift which will peel the stubby leads clean off the pads (with luck). But... beware on cheap pcb’s, you’ll likely lift the pads, so I recommend a touch on one lead with an iron whilst “twisting and lifting” one side at a time.

A dodge to remove those blasted multi-legged flat pack IC’s with more legs than a millipede, is to use children’s modelling clay to make little “coffer dams” all around the flat pack IC, then melting solder inside the barriers to flood the pins with molten solder. With a gentle pry upwards whilst you melt the solder and keep moving round (it’s an “Isle of Man” technique, it needs 3 hands!) you can keep circling the IC with your soldering iron and keep a fair section of solder molten. With patience the IC will gradually lift away clean as a whistle, and the solder can be mopped up with a sucker and fluxed braid to clean up the pcb. I would strongly suggest that a quality temperature controlled iron is used for this job; and don’t take too long or you’ll either fry the pads off or do an “oooh, nasty!” to the IC’s innards. Go forth bravely and without hesitation: all will be well!

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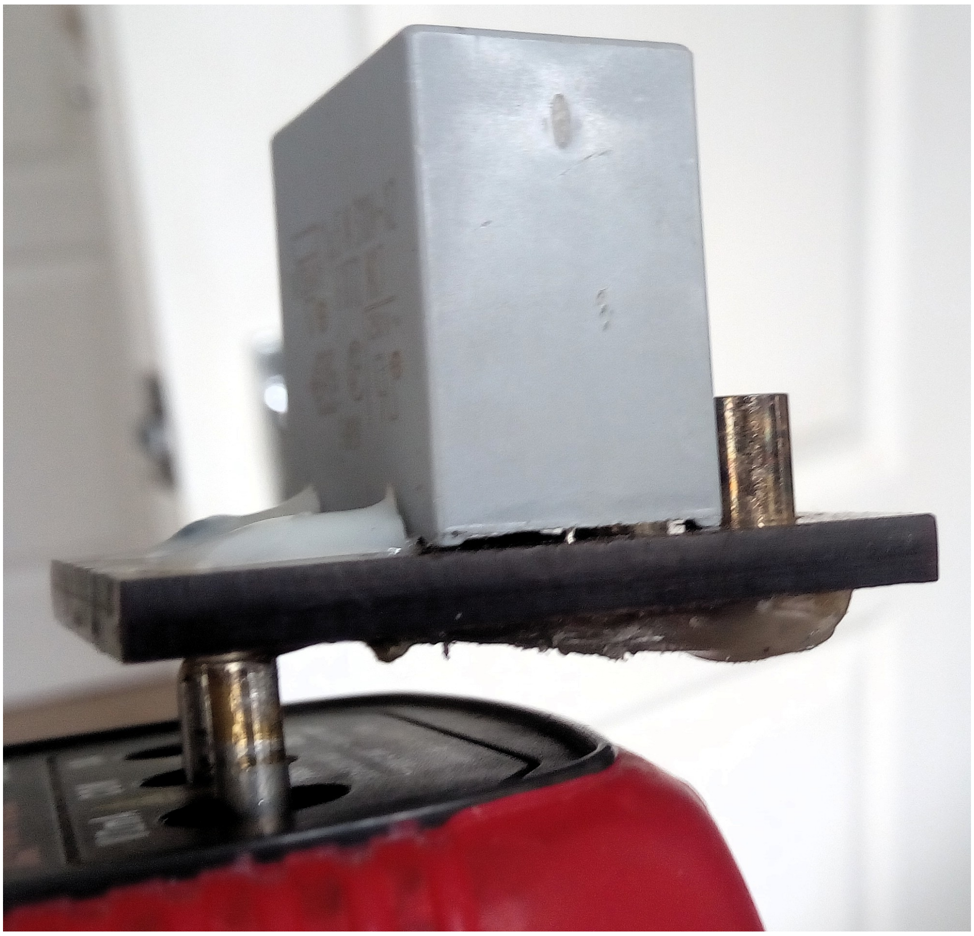
Low Pass Filter for DVM’s

Below is a picture of the low pass filter for my digital multimeter to “average out” rapidly varying signals to kill the “dancing digits” I mentioned in Hot Iron #108. You can see the 4mm plugs partially inserted into my DVM beneath the 3mm thick Tufnol base plate, and the stubby 4mm sockets immediately to the right of the capacitor for my probe’s 4mm plugs - a 1.5 µF, 650v (NON-POLARISED) polypropylene, fed by a 680k-ohm 1kV rated resistor is buried in the epoxy resin covering insulation from one 4mm socket (it doesn’t matter which). I always secure my DVM to an insulating board (elastic bands are ideal) when using it on 50 volts AC/DC or more, and NEVER touch the DVM (or change range) whilst connected to ANY voltage.

This RC combination is ideal for most of my jobs, slowing down those dithering digits and settling quickly to a steady(ish) reading.

I ALWAYS wait a few minutes before unplugging the LPF module from my DVM; the 10 Meg-ohm DVM input resistance forms the bleed resistor for any charge left in the 1.5 µF capacitor once the measurements have been made, and I ALWAYS short my probes together. Why? A 1.5 µF capacitor charged to 600v gives a fair bite! YOU HAVE BEEN WARNED....!



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Audio matters...

Tuning Headphones & Select-o-Ject
During WW2, Tuning high impedance headphones for added weak signal clarity was a dodge used in some of those mysterious huts at Bletchley Park. The basic idea was to add non-polarised capacitors in parallel (or series...?) across the voice coils of each individual ‘phone, to get resonance at the frequency the operator preferred - nominally 800 Hz, but everyone has different preferences.
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The capacitor resonates with the voice coil inductance, giving a useful boost to the signal and simultaneously reducing extraneous noise, it's a simple band pass filter.

An interesting thought is why resonate in parallel; a series resonant circuit would give the same "Q" and peak the current through the voice coils. Or, of course, resonate one phone slightly higher than the other: then you'd get a bin-aural "peaks" so receiver tuning wouldn't be over critical, and you'll have a spatial awareness of the received signal if it drifts.

A modern equivalent for low resistance headphones could be an add-on audio "select-o-ject" circuit, beloved of valve days - an audio notch / boost filter of adjustable Q and centre frequency, applied just after the audio pre-amp and before the power amp stage. The original select-o-ject from RCA is shown at: https://www.w7ekb.com/glowbugs/rx/SOJ/soj.htm ; and some very tasty other projects and designs on his web page are well worth looking at.

You'll find a simple solid state design, aimed at radio reception, at https://www.electroschematics.com/dx-audio-filter/ . This is a simple design, but I can't comment on it's performance as I haven't built it; but it follows the accepted style of these things so should give a good account of itself if built carefully - and as always with these things, quality components of tight tolerances are used.

If I need audio designs my immediate "go to" resource is Rod Elliott's web pages; you'll get the truth, the whole truth and nothing but! Take a look at the magnum opus of variable state filtering at https://sound-au.com/project75.htm or any other of Rod's filtering / crossover / notch / peak projects. If it's audio you're after, you'll find all you'd ever need in Rod's pages, believe me!

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Sliding Bias audio output stages

The principle of "sliding bias" isn't new. It's been around for many years in one form or another; the general idea being that for low level outputs, Class A is for best quality, the superb audio enriching any low level signal and making copy easier. Once the signal has risen in magnitude (maybe due to less fading or shifting ionosphere) then the amplifier "slides" into class AB then straight into Class B on high level signals. This saves power supply watts, and gives a much more comfortable listening experience. It's akin to Auto Volume Control; it makes the listening far more comfortable.

You can find more about "Sliding bias" class A amplifiers on page 53 of https://nvhrbiblio.nl/biblio/boek/The-Transistor-Radio-Handbook-Donald-Stoner.pdf

and it reminds me of Tim's method in some of his designs for biasing the gates of RF power mosfets. The forward bias of the mosfet is derived from the input signal: if the drive fails, the bias shuts off, but under normal drive conditions the gate is biased to bring the mosfet into conduction at the appropriate bias point.

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Components

The "Earthy" foil of capacitors

When you're building sensitive or critical audio amplifier chains - typically Direct Conversion receivers, for instance - it pays to note the "earthy" foil of a rolled film type capacitor. Yes, those ubiquitous epoxy coated chunky capacitors beloved by audio designers! In fact, any capacitor of "rolled up" construction - polystyrene types are another instance - the "earthy" foil is the outermost foil of the "rolled up" construction. The outer foil should ideally be the "earthy" foil to avoid pick up, hum, and undesired feedback, often attributed to poor layout but perhaps because the outer foil in the capacitor is the signal foil and thus unshielded by an "earthy" foil.

The easiest way to find which foil is outermost is to couple one lead of the capacitor to your scope probe, the earth clip going to the other capacitor lead. Then grip with your fingers the capacitor on test: note the "pick up" volts displayed on the scope. Reverse the capacitor connections and repeat; the outer foil will pick up more "hum" from your fingers, as seen on the scope.

For those without a scope, an audio amplifier can be used: earth one capacitor lead, and connect the other to the amp input. Now grip the capacitor in your fingers, and note the "hum". Reverse the capacitor connections and compare the "hum" level - if you earthed the outer foil the "hum" picked up should be notably less.

Of course, not every circuit will need such esoteric thoughts - but at least, now you know the score and can save it for the times you might need it.

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LED photodiodes

LED's make very good photodiodes; and so do 1N4148 or other glass body diodes, where stray light can get in and illuminate the junction. If your design has an incurable "hum" problem, try shading it and mounting it in a die-cast box. That way you'll guarantee no external pick up from RF interference OR light - if your die-cast box is earthed properly, that is! Keep to mind too, if your design proves light sensitive, you can get problems from fluorescent and LED lamps, as they flash at a rate faster than your eye's response time - in my day, this was known as the "fluorescent buzz", the stray light from the overhead fluorescents getting into the glass diodes and injecting a nice little "untraceable" signal which mysteriously stopped when the circuitry was shadowed or in darkness.

You'll find this phenomenon multiplied nowadays when working near mains driven LED's: these not only flicker at odd frequencies, but spit out plenty of RFI too, just to make life even more interesting! If earthing and all the other conventional "cures" don't help, look for light ingress.

A reference to all this is at: https://www.analog.com/en/analog-dialogue/raqs/raq-issue-108.html#

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Modern single rail op-amps

Thinking of light and photo-diodes, optical comms links using silicon photodiodes (or LED's) often call for single rail op-amps to create current to voltage converters which are often required for optical comms experiments in the receivers. The tiny currents generated by silicon (or LED) photo devices are fed into the summing junction at the inverting input of a very high input impedance op-amp; thus the feedback resistor from the op-amp output to the summing junction defines the "volts per µA". The photo junction effectively runs it's tiny current into a virtual earth resulting in minimal loss that the usual resistor load creates. For instance, if the feedback resistor is 1 meg-ohm, you'll see 1 volt per µA at the op-amp output: 1mV output therefore is equivalent to 1nA photo current, without having to resort to a 10 meg-ohm load resistor.

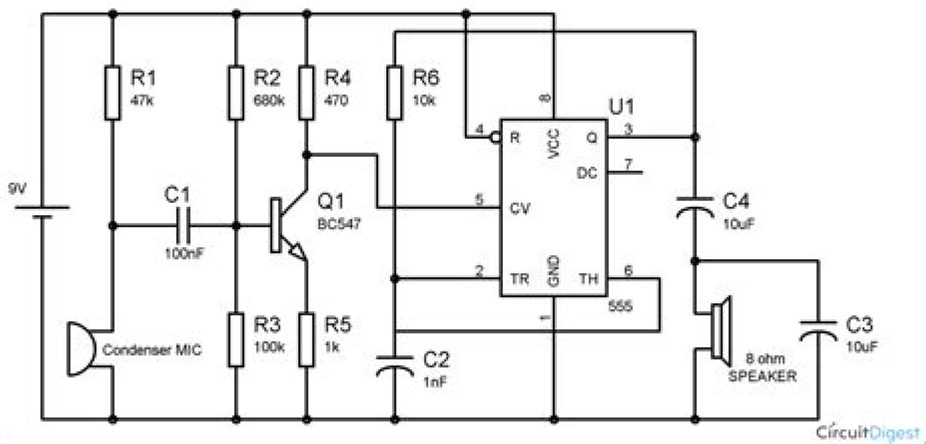
Take a look at page 4 of http://ww1.microchip.com/downloads/en/appnotes/00682c.pdf These modern op-amps are superb performers, require low supply current to run to full spec. and often only require single rails so the circuitry is simplified; a real boon for the "field" operation optical comms almost always demand.

Magnificent experiments set up by Roger Lapthorn, G3XBM, using "cloud bounce" and powerful LED's running pulse modulation has shown significant distances can be achieved - and those 4 inch / 100mm lenses from bench magnifiers are excellent for these jobs, as well as A4 sized Fresnel lenses. They are optical Yagi antennas!

Roger's page at https://sites.google.com/site/g3xbmqrp3/optical shows a very straightforward transmitter using a K1EL code generator; I've always hankered after trying a 555 with audio applied (suitably scaled and processed to get 50/50 mark space with no audio input) to pin 5 in a circuit like this. It should work a treat, and follows a proven design which you can see on pages 30 and 31 of the Radio Shack book, "Engineer's Mini Notebook, Communications Projects" by Forrest M. Mims III and would form the basis of a quite sophisticated comms link if modern components were used and high power LED's for the Tx with substantial optics as per G3XBM.

The basic 555 LED driver shown in the article could be improved by using the 555 to drive the gate of a power mosfet; this then switching the LED would allow significantly more powerful LED's to be driven, but the power supply will need to be beefed up a bit!

A typical circuit for a 555 pulse width modulation audio amplifier is below. This circuit has appeared in many web pages and articles; I believe it was from a Signetics application note back in the 1970's, but if anyone knows more about this reference I'd be glad to know and happy to publish any further information. My personal interest stems from efficient modulated output stages for A.M.; the audio modulator being a "high side" HV mosfet feeding the Class C / D / E stage via a low pass filter.



It's easy to see from the above diagram how a power mosfet could be uses to replace the speaker. The 555 is a meaty little chip, it's bipolar version easily capable of 300mA output current at nigh on TTL edge speeds, so driving the gate charge demand of a power mosfet shouldn't be to tricky.

The Rx features a threshold discriminator (a "bit slicer" as it was called in my day) which improves the S/N ratio and acts as squelch; the use of a 741 as the photo-diode high gain pre-amplifier could be improved by employing a current to voltage converter (as discussed previously) and would probably improve the S/N dramatically by removing high value resistors from the signal path.

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Inductors for free

Relay coils culled from burned out relays - whose contacts are shot but all else otherwise OK - make good substitute A.F. chokes. The astute will note that the magnetic circuit in an de-energised relay has an air gap, when the relay armature is away from the coil core: this gives a clue as to increasing the inductance of the coil dramatically, by wedging or otherwise closing the armature onto the coil core. This closes the air gap and the inductance rises significantly.

With a spring or something similar to push the armature away from the core, and apply pressure via a simple screw mechanism to vary the air gap, and le voila! An adjustable inductor.

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Transformers and all that...

Transformers, 50 / 60 Hz, and such... a note from Ross Whenmouth, ZL2WRW and most gratefully accepted! Ross comments:

"Hi Peter,

Re: USA vs. European Mains transformers

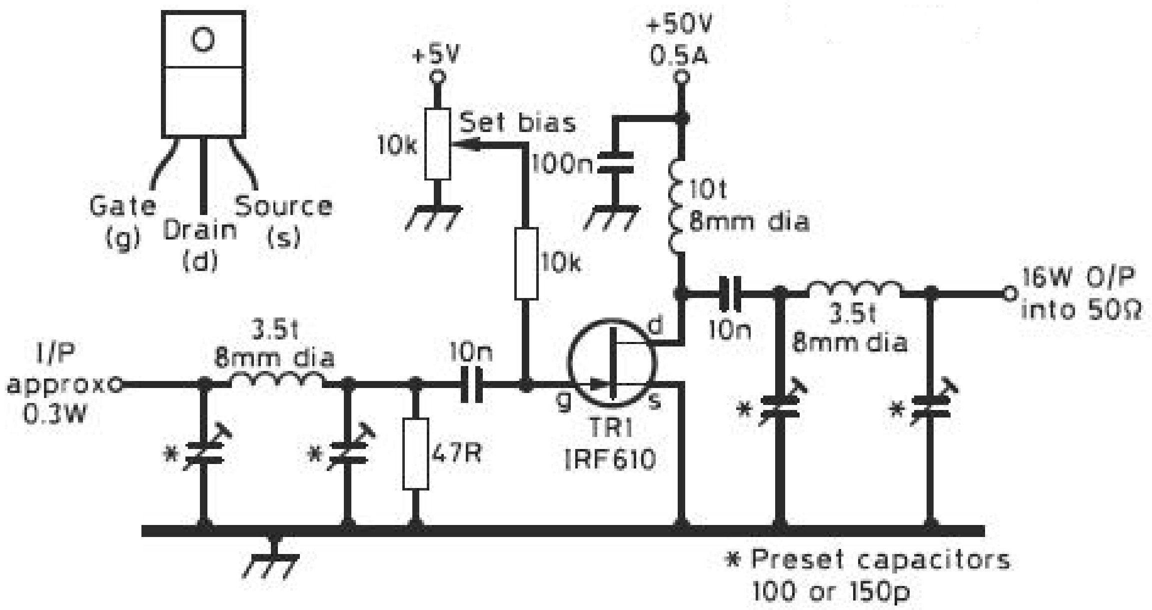
In response to Martin Boardman's article on page 23 of Hot Iron #104:
I understand that a common industrial voltage in North America is 480V 3-phase 60Hz with 277V line-neutral voltage. A transformer with a winding rated 277V 60Hz should be quite happy with 230V 50Hz energisation because both the voltage and frequency are reduced by ~ 20% - thus the core flux density will be same as when energised with 277V 60Hz. However, the output voltage will unavoidably be reduced by 20% (but maybe you can get lucky and source a 277V to [desired output + 20%] transformer ?)

73 ZL2WRW
Ross Whenmouth"

Many thanks Ross for your contribution. This is exactly what Hot Iron is all about: open knowledge sharing and helping constructors get "junk" working in a useful scenario. Many transformers (and what other components?) from industrial control panels and other commercial electrical / electronic equipment - which probably cost an arm and a leg brand new - turn up in the most unusual places, and can be adapted into good service rather than cluttering up land fill or otherwise dumped.

For our thermionic aficionados, UK 415v to 230v control panel transformers make superb HV supplies, run backwards; and with a voltage doubler - another use for those microwave oven HV capacitors paralleled for some serious high voltage µFreds! - will make some hefty 1kV rail power amplifiers.

Or 230v to 32v transformers beloved by stepper motor drive designers for MOSFET PA's running a 48 volt rail? You would be well on the way to very simple mosfet linear amplifiers; the higher supply radically improving the linearity and gain, as per the schematic below by VA3IUL:



Just a matter of keeping an open mind and lateral thinking. It's tempting to start a radio constructor's junk yard, concentrating on stripping all the useful parts from failed projects and old control cabinets and the like - a collection of old, non-functional radio gear for spares or repairs? Got a empty barn for me to rent, Tim? Hah!

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"Dull Lamp" Test for unknown Txfmrs

Trying to identify and test unknown, unmarked transformers can be made much easier (and with less blown fuses) with a "Dull Lamp" test set. The gist of a dull lamp test set is a 40 or 60 watt lamp wired in series with the live feed; any disastrous shorts or crossed wire / windings cause a bright lamp; a correctly wired "tranny" will show little or no glow when the secondary winding is
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disconnected from the load - al the primary side draws is the magnetising current and in a decent tranny, that’s just a few mA’s.

A good start identification is to measure the DC resistance of the windings. Not only can you pair off the wires and windings this way, and you get a good idea of which winding is the primary. On a step down transformer it will probably have the highest resistance of all the windings; the logic being the high voltage winding will have many turns of fine wire which reads high resistance, whereas a secondary of lower voltage has much thicker wire hence reads significantly lower resistance.

Energize the each winding identified with your Dull Lamp test set. The voltage across the winding is (approximately) the rated voltage of the winding. What's happening is that when the applied voltage is higher than the rated voltage of the winding, the core saturates, and its impedance drops, which tends to clamp the voltage across the winding. If you read full line voltage, you’ve got either the primary winding or an HV secondary; the lamp won’t light, because the (unloaded) primary or HV winding inductance is usually a good few Henries, thus the magnetizing current is tiny and the light bulb barely glimmers.

This is a safe test for the primary; if the bulb doesn’t light, then there will be minimal current drawn when that winding (all other windings unloaded) is connected to the line. Beware though a transformer with higher voltage (than the line) windings: this test can’t discriminate the high voltage winding(s) from the primary. Again, resistance checks will help; a txfmr with (say) 230v primary and 350-0-350 secondary will show significantly more resistance in each of the secondaries than the primary winding, and you’ll have a clue from the overall resistance (350 to 350) resistance. You’ll only struggle when the primary and secondary windings have similar voltage ratings.

Once the primary is located, then you can apply line voltage to the primary and measure the secondaries, with the Dull Lamp tester. If you’ve confused an HV winding with the primary, the resultant voltages measured on the previously paired windings will usually show odd values, so try the other HV windings as the primary to see if the paired windings now produce more sensible voltage readings.

Weigh the transformer, then reckon 20VA per lb weight or 45VA/ kg. You won’t be far off.

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Transformer Calculations

The whole skedaddle of designing transformers is a mystery to many - and I'm one of 'em! I can work my way through the basic calculations, but one we get into the "magnetic circuit", reluctance, remanence, and a host of other weird and often unknown variables ("Oersteds", anyone?) we're in weird and wonderful surroundings.

I worked alongside some magnetic designers, whose expertise was in 3-dimensional magnetic field analysis for Cathode Ray Tube deflection coils, saturable reactors and voltage stabilising transformers, amongst many other strange devices of unknown utility. These people were so far out, they were very close to coming back in by the back door! They worked in the midst of 200kV AC / DC power supplies, insulators the size of small pine trees, coils, cores, copper wire by the mile, flashes, bangs and clouds of smoke that had to be witnessed to be believed. I was immensely impressed!

This is not to encourage you to follow these wonderful displays, but below is some sound basics from the wonderful world of the magnetic masterminds:

https://ludens.cl/Electron/Magnet.html

(yes, he of the capacitor ESR instrument design). This will tell you all you could possibly want to know (if you value your sanity) and I can recommend reading it thoroughly!

Replacing Ge transistors with Si PNP's

From https://forum.allaboutcircuits.com/threads/looking-to-replace-hard-to-get-germanium-transistors-with-silicon-ones-is-this-possible-please.160821/

Quoth the author of the article - "*I worked for a famous Hi.Fi amplifier company that produced a stereo 30 watt amplifier. The noise level of the pre-amp transistors was quite high so they re-called many of them and replaced the original germanium transistors with silicon and simply doubled the emitter resistors. After this, the noise level was very much lower.*

Back in the day when silicon started taking the place of germanium, there was a generally accepted rule that ***doubling the value of the emitter resistor was way to obtain the correct bias conditions, (within limits) In a great number of cases with old radios and amplifiers etc. this worked. whilst not absolutely theoretically correct, it is worth trying****. As most germanium transistors where PNP, be sure to select the correct type of silicon replacements as some of those in your schematic are NPN, substitute one at a time and check operation before going on to the next stage."*

The OC71 is being used to set the bias for the output transistors with temperature compensation, is it mounted on a heatsink with them? If you change the output transistors to silicon, you will need to use a silicon transistor (or diode, Ed.) *here to and re-set the bias to reduce crossover distortion".*

Of course, sourcing Germanium transistors held as "New Old Stock" would help...

https://www.utsource.net/sch/AC176?link=OC21%7CAC128%7CAC176

Notes from: https://www.vintage-radio.com/repair-restore-information/transistor_transistor-faults.html

Or make your own Ge transistors (Hah! Now there's an idea - I knew all those years working in a wafer fab. would come in useful one day!). See:

http://www.thevalvepage.com/trans/manufac/manufac1.htm

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Asian pet Rocks
From John Kirk, VK4TJ - with many thanks!

I've always had an infantile fascination with crystals – probably because most of my crystal-controlled projects WORKED, and virtually none of my VFO projects ever did. You buy a capacitor, and you are lucky if you know where you are within 10%. You buy a surplus rock out of the far east for pennies, and you get what – a few PPM? This led me to peruse Aliexpress, to see what, if any projects employing cheap rocks might suggest themselves. What a mess! These vendors clearly don't know what is in the bins. Sometimes, you can weasel a frequency out of them by hovering over the "extended" product description, but more often than not, you must drill down right into the item. Do that a few hundred times, and you'd happily hire someone to do the rest for you! A bit of COVID-inspired boredom inspired me to spreadsheet the lot, which I am happy to share with you here:

https://vk4tj.blogspot.com/

You will note on arrival, that I have also categorised clock oscillators and ceramic resonators, though I am less certain that I have captured 100% of either.

I have only listed one vendor for each frequency, even though virtually all the listed frequencies are available from multiple vendors, so, once you have worked out a suitable search term, shop around! Some offer pretty good quantity breaks. Others are happy to pony up for free freight.

Getting started: Cut and paste this URL into your browser:

https://aliexpress.com/store/624531

This will bring you to the "Hengdashengdianzi Store", one of the more prolific sellers of surplus rocks. Search WITHIN his store for the desired frequency. If Mr Hengdashengdianzi cannot help you, edit the above URL with another store number from the right-hand column of the list. Lift a suitable search term for the wider Aliexpress pedler community from Mr Hengdashengdianzi, as plagiarism is rampant amongst Alibaba's 40 million thieves.

Try to fix in your head the difference between "Search In This Store" and the more global Aliexpress search, or you'll spend fruitless hours wading through crystal pendant necklaces that will cure psoriasis, gain you financial independence, and ensure you never sleep alone, all in one go! (Now there's an added attraction for Amateur Radio aficionados! Ed.)
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Cut to the chase: Yeah, there are some promising crystals available, like 10.111, 7.159 & 7.200 etc. Years babysitting the VK QRP Club's crystal stash have revealed that most of us have, in fact, moved on from simple MOPA rigs, however, so "out of band" rocks suitable for ladder network filters etc. are often the new "movers". I was delighted to find both 6.4 & 3.2 MHz rocks, as my old Yaesu FT-7 need a new 12.8 MHz crystal for the 100 kHz marker generator. A straight swap for 6.4 MHz yielded 50 kHz markers, and 3.2 MHz, 25 kHz markers.

Cast your mind over Alibaba's trove of treasures – hopefully the fruits of your labours will turn into projects to grace the pages of this journal….

VK4TJ

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Construction Notes

Stainless Steel Soldering

Soldering stainless can be a daunting task: the trick is to pre-coat the stainless with a wetting agent that can break through the ultra tough oxide layer on the surface - it's that (amongst other things) that gives stainless it's wonderful properties. A mixture of phosphoric and hydrochloric acid was one flux I've used previously; but in this "Elf-N-Safety" age I can't honestly recommend you mix your own.

In the UK we have https://www.cupalloys.co.uk/soft-solder-fluxes/; I have seen similar products on various on-line market places based in the USA and Canada. I'd suppose similar are available in the Antipodes, too.

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Q-max cutters

The circular hole wonder tool (and other profiles are available, too)

Grease is the word! Apologies for reminding you of John Revolta and Olivia Neutron-Bomb in that 1978 insult to music lovers, but all those who have used Q-Max cutters in anger will know the score - grease and plenty of it makes for an easier life.

These wonderful time savers cut perfect holes in aluminium chassis oh so easily; so long as you don't rush, or try to cut anything on the really "beefy" scale. I once had to cut 64 off 20mm holes in a stainless steel cabinet as air holes for cooling; it took all day and the screw in the Q-Max had to be replaced several time. That's because 18 SWG stainless is near the limit of a Q-Max cutter's capabilities, though the cutter die and stock were well up to the job, the compression bolt gradually stretched until the thread pitch changed and the consequent friction became intolerable.

The answer, as I was taught all those years ago, when cutting anything beefy with a Q-Max, is to go s-l-o-w-l-y, and on bigger diameters (say 1½" and up) use a ring of small holes just inside the finished hole periphery to reduce the strain on the cutter. You can get roller bearings instead of washers to reduce the compression screw's friction, and to help the standard steel washers liberal applications of pencil lead or locksmith's graphite powder lubricant as well as conventional grease and oil really helps. Pete Insley - an old pal of mine who worked in the Maintenance crew in the CRT Department - had phosphor bronze “Oilite” washers he kept specially for beefy Q-Max-ing; and he had a small squirt bottle of white spirit (turps sub) mixed 50-50 with red diesel and this, he said, really did the trick.

Whilst working for Stone-Platt Industries in St. Louis I was introduced to a solvent based cutting fluid called “Relton TAPTITE” which proved very efficacious in any cutting, drilling or tapping operation in stainless steel; I guess in chunky mild steel chassis bashing for Octal, B9A or B7G valve holder holes that TAPTITE would work well too. I never found out what the actual TAPTITE fluid was; but it was very effective in any stainless cutting. Perhaps one of our US readers could shed some light on TAPTITE?

I kept a short length of ½” stainless gas pipe in my tool box; not for extra leverage, but to make turning a hex Allen key a bit more comfortable. In theory a hex Allen key (“Unbrako” in Scandinavia) is an “easy on the hands” tool - but once you’ve done an hour or two with a Q-Max cutting hefty steel you’ll appreciate any bit of help!

Where you will need every ounce of subtle attack and leverage is getting the disc of waste metal out of the stock part of the cutter once the hole is cut. The metal disc is distorted; any attempt to bash it out will result in the disc becoming solidly jammed in the stock. Use gentle persuasion with a drill shank in the hole left by the compression bolt and waggle the waste piece out. Patience is the key; don’t ever try to cut another hole until you’ve cleared the waste from the last hole. The two pieces will unite in sympathy against you, and defeat your best efforts to shift ‘em: the combined outward pressure will lock them in solid and it’s a blacksmith’s job (i.e. big hammer, punch and anvil with Hardie hole) to get the damn things out.

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Tank Cutters

These I will warn you about - the use of “tank cutters” (sometimes called “fly cutters”) for chassis holes. These are Devices of the Devil and will have your fingers a’fore you know it. They comprise a cutter mounted on the end of a bar, set into a mandrel that fits into a power tool. Fine if your slicing a 3” hole in a large water tank or other heavy and solidly mounted sheet metal object; but woe betide you if you try it on a small sheet of steel or aluminium hand held in a small drill press. If the metal job isn’t secured with multiple clamps, the moment the cutter breaks through the back surface, the job will be ripped off the drill press table and whizz at great speed across the room akin to a flying guillotine blade. You MUST use plenty of hefty bolts / clamps / TEE nuts, whatever - don’t underestimate the forces involved. They will rip to pieces anything not 100% secured down, and have absolutely no respect for human flesh. Don’t chance it unless you’re well versed with machine tools and the forces involved.
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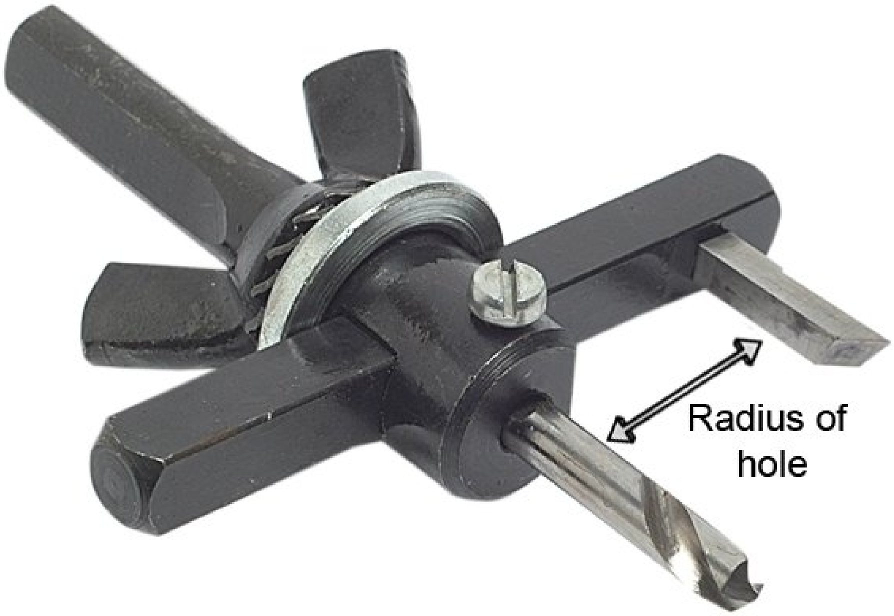

Image from: https://www.wonkeedonkeetools.co.uk/media/wysiwyg/TC-Tank-Cutters-Jenna/TC1/TC-1-6.jpg

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Hole Saws

A slightly different Spawn of Beelzebub live in the hole saws much beloved of our "sparks" electrician compatriots: these are marginally safer than Tank Cutters, but you'll be finding razor sharp bits of swarf under your finger nails, down your shirt, up your sleeves and stuck in any soft skin you let them near. And that's not mentioning the racket these hole saws make when cutting: infuriated banshees, they rip and scream through mild steel; on stainless they fling red-hot swarf everywhere you really don't want it - and generally after cutting one or two holes all the teeth have gone anyway. They don't like stainless! Aluminium is fine, as is FR4 pcb material, but go easy, take your time - it's NOT a race. And you'll have the now familiar job of getting the waste out of the cutter, too....

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Terminal rail construction

Making life easier is always thought a good thing at G6NGR. If you look at a well designed electrical control cabinet, you'll see the power supplies, signal wiring and other (non-RF) wiring set out for easy test and isolation purposes, and amateur radio gear can well follow suit, albeit in the power lines and control signals, if not the RF connections. In valve days tag strips and solder tags were commonplace; nowadays it's a good idea to use screw terminals for power and control signal wiring - you can slip the wire out and isolate for fault finding a "suspected-of-instability" or other misbehaving section.

The easiest way to do this is to use the brass innards of “choc-bloc” connectors, cut in half, and soldered down the the PCB “islands” used for Manhattan construction or pcb strip power “rails”. Unscrew and remove the screws from a section of choc-bloc (your side cutters are ideal for this to chop off the plastic shroud that contains the screws) and release the brass tube that connects the wire cores. Cut the tube in half. Solder one half section down on the “Manhattan” islands, and use as the power supply connection to that stage; you can clamp a resistor or RFC “leg” (or whatever feeds power to that stage) in one end of the clamp tube and PVC equipment wire carrying the DC supply / control signal in t’other.

Voila! Now you can isolate each stage, easily and safely with little fear of a short to ground.

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Strange QRM?
Most amateur radio constructors will have heard a strange high pitched whining noise, that comes after spending hours messing about with bits of home made radio gear on the kitchen table (or wherever you pursue your RF). This whine is ubiquitous; it’s whenever your XYL sees your lovely metal chassis sat on the polished table top, worktop or chair. The whining goes on, and on, AND ON... no amount of filtering, audio processing (though I did know one deaf amateur who switched his hearing aid off) or other solution will be found.

Well, help is to hand to stop this “worse-than-heterodyne” whining: search on your favourite online auction site for “Rubber Bumpons”, and you’ll find some these wonderful self-adhesive rubber domes stuck on the bottom of our magnificent creations will quench the QRM whine in a jiffy.

They have other excellent properties too: for paddles, keys and anything else that wants to stick where you put it, they are made of a “grabby” rubber, so once placed, they tend to stay put.

No more scratched table tops. No more whining. All is tranquil, all is peace. For a few minutes, at any rate... until the inevitable “you’ve been at that for 3 hours now, when are you going to.... (fill in as appropriate)”. That is the ultimate QRM, believe me!

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R&D Dept.

“Share the love”
John Kirk, VK4TJ, suggested, in a fine example of lateral thinking, using multiple crystals of identical frequencies as a means of increasing the allowable dissipation of our beloved crystals. “Share the love” as John put it, by assembling multiple crystals in series / parallel. This sounds a good idea to me if we happen to have a good few identical crystals on the frequency we want; not always possible as the calling frequencies on each HF band tend to be non-standard frequencies as far as crystal manufacturers are concerned. But if you’ve a good few crystals on the frequency you want, why not?

I’ve long had ideas about using some sort of amplifier stage to “beef up” crystals, so modern micro crystals can be used in much more demanding circuits: typically those “MOPA” valve circuits that can give crystals a fair hammering. My idea is to put the crystal between the collector and base of an HV NPN transistor, shunted by a meg-ohm bias resistor. When placed in circuit, as a two terminal device, the transistor does the bulk of the work, the crystal only running the base current and thus “sharing the love”, giving the crystal a far lower power dissipation.

Doug DeMaw, W1FB, used a trick to clean crystal oscillator outputs up - another crystal of identical frequency in the output, acting as a band pass filter to remove harmonics the oscillator created (and Pierce oscillators a very good at crunching waveforms). This prompted the G6NGR grey cells to wonder... what happens if the output filter crystal is radically *different* in frequency? This led me down the rabbit hole into a Carrollian “wonderland”, where all sorts of abstruse ideas float around. Read on, and see what you think.

Think of a simple Pierce transistor oscillator, or, if you prefer, a CMOS gate biased into linear with a 1 meg-ohm feedback resistor. Now let us place a crystal in parallel with the feedback resistor. Voila! A crystal oscillator, well known to most. Now here come the first twist: in parallel with the first crystal, put another crystal of *different frequency*. What frequencies will we see now at the output? Just one, that of the most “lively” crystal? Two, perhaps, distinct frequencies, one from each crystal? A “sum and difference” product(s) of multiple frequencies?
So we now throw in a third crystal in parallel, of different frequency than the first two. What output do we see now?
If the crystal frequencies are harmonically related I’d guess a dominant frequency that “fits” all three would appear; depends on each crystal’s activity and the harmonic relations - as overtones in crystals (depending on cut) tend only to run on odd frequencies.

Now, let’s put the crystals in series; the CMOS gate is biased linear as before. They are (for instance) harmonically related - let’s say 1 MHz, 2MHz and 4MHz. What output will I see? (if any?) And... what happens if we now add parallel crystals - a veritable field of crystals - of different, non-harmonically related frequencies?
I leave this experiment to you to put together and see - as this particular Mad Hatter’s Tea Party has no references I can find in any of our usual amateur radio literature , or, come to it, my professional RF literature either. Just where would this multiple crystal approach lead? An oscillator which

simultaneously runs on 80m, 40m, and 20m? Am I glimpsing spread spectrum, or similar? Chaotic oscillators? Over to you, readers! Let me know what you find, please!

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Ft measurements for amateur purposes

As amateurs we often find ourselves without the data and information the professional designer has to hand - our salvaged components, unmarked, or just plain unknown, mean we often give it a go without knowing the full characteristics of a transistor. The responses I got about transistor Ft measurements in a recent Hot Iron prompted me to dig out an amateur approach I saw used many years ago for approximating Ft. For those wanting a fully comprehensive explanation of Ft, an excellent article is: https://www.nxp.com/docs/en/application-note/AN139A.pdf which will give you the full unexpurgated story from a manufacturer's point of view.

As amateurs, we only need to know a few basic features of a transistor. Typically, you'd need the maximum collector current, collector - emitter voltage, device dissipation, the gain at the frequency of operation you want and the input / output capacitance. This will get us most of the way, and is fine because we don't work to timescales, budgets or manic sales departments.

If you measure the voltage gain of a common emitter amplifier stage at various frequencies you'll see (if the drive waveform is a clean sine wave) the gain rolls off with frequency in a linear manner; this is the Collector - Base capacitance and Miller effect in play, and it's these that sets the frequency where the device has unity gain. Circuit designers use a simple rule of thumb for a first approximation when designing an amplifying stage: Ft should be > 10 times the operating frequency. For example, if you want a transistor to run at 21MHz, choose a device that has an Ft of 210MHz or more: the gain at 21 MHz will be near enough 10.

An easy way to estimate Ft is to build an L/C oscillator, with plug in inductors, to cover expected frequencies up to about 800MHz. This is the realm of free-running UHF oscillators, and they are very strange beasts compared to their HF brethren! A superb example - and useful too in this context - is to be found at: https://www.instructables.com/id/UHF-oscillator/ and this article includes a pick up coil to measure the oscillation. The article shows how different loops for the inductor can be used, and a Lecher line to find the frequency:
https://www.instructables.com/id/Frequency-measurement-by-Lecher-Line/

So the answer for easy amateur Ft measurement is to hand: it's a simple oscillator. You'll note the oscillator is running in *common base* mode: you'll get higher frequencies out of transistors running common base than you will in common emitter (common base exhibits far less Miller effect). It will give you a fair guide for common emitter Ft if you reduce the common base maximum frequency of oscillation by 25% or so; this figure is a reasonable "guesstimation". For example: a transistor to run at 21MHz, I'd be looking for a transistor that could run 250 - 300MHz in the common base test circuit.

To meet the Nyquist criterion for oscillation, the gain must be above unity and the phase of the feedback must be somewhere around 180 electrical degrees (i.e. the -1 point on the horizontal axis
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of the Nyquist diagram) must fall inside the plot of gain vs. phase of the circuit. This means you'll only get oscillation when the gain is > -1, so making the oscillator inductor less and less until oscillation ceases gives you an indication of the frequency capability of a transistor in common base. A set of hairpin loops or a sliding shorting bar arrangement facilitates rapid "go / no go" testing of unknown transistors; if you're one of the blessed you could use a UHF frequency counter to measure the frequency where oscillation just stops - you've found the unity gain point and thus the Ft.

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Using fuses as both protection and current sensing

Any radio amateur who has memories of repairing TV sets that contained Cathode Ray Tubes, line output stages that generated 25kV or more at a hefty number of mA's will recall the subtle (and not-so-subtle) circuit tricks and techniques that wrung every last ounce of performance from the fewest components. The early solid state TV chassis were fine examples of the circuit designer's arts; to keep those pcb's running in such hostile conditions the design had to be minimal, robust, yet economic and business-like in manufacturing. Not easy bedfellows as many a "Muntzed" design proved.

Below, for your delectation, is a circuit I spotted whilst carousing around looking for some fuse information (don't ask...). Having been (RF) educated in the days of using a wire-wound resistor on the anode cap as both damping resistor and an RF choke parasitic stopper, I like a component to deliver as many functions as possible yet live it's little life happily and contented knowing it's doing a good job comfortably within spec. When I saw the circuit below (from https://www.edn.com/pwm-circuit-uses-fuse-to-sense-current/) my heart gladdened: here is a designer squeezing more function from that most unlikely component, a fuse. Absolute elegance and function: what more could you ask?
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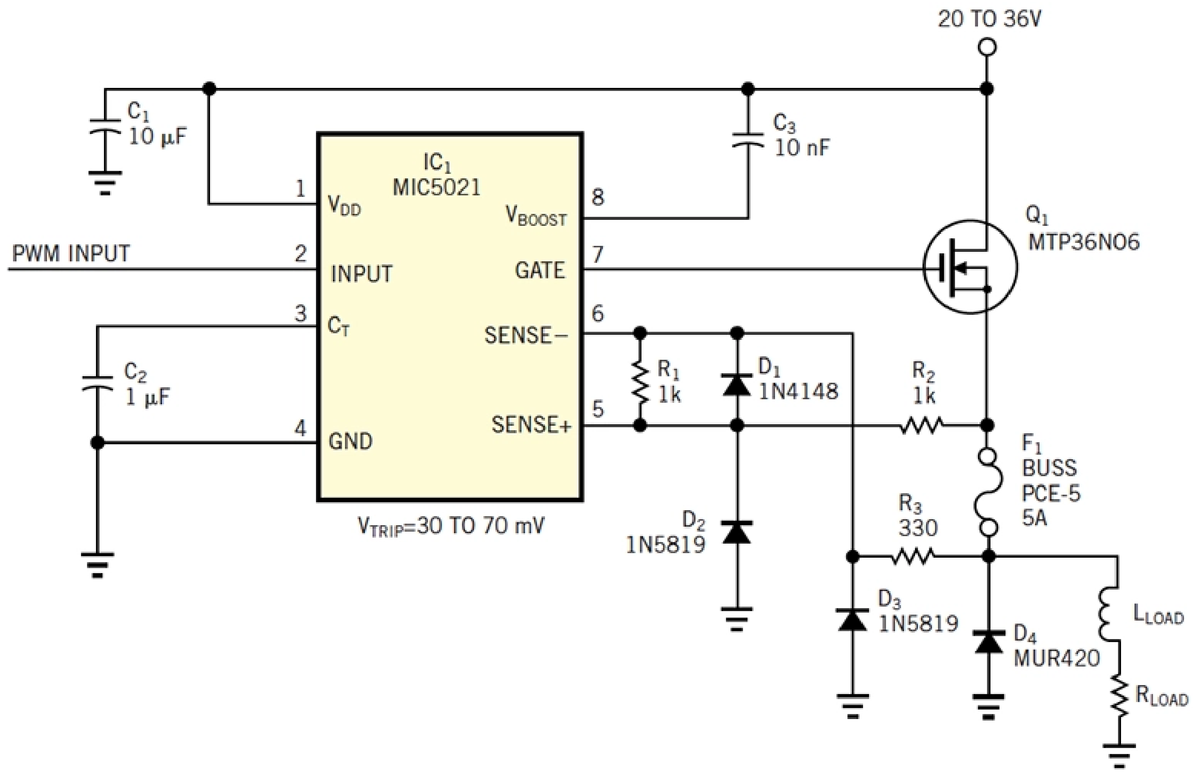

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Receivers

Synchronous Detection and freebies?

I have always found that coherent detection of A.M., though more complicated than the usual diode, pays significant dividends in higher S/N ratios, more robust capabilities in drifting and fading signals and audio quality. I came across several interesting designs which use the carrier to synchronise the local oscillator; by amplifying and clipping the A.M. signal, the carrier can be stripped out and applied to sync the local oscillator.

Alan Yates, VK2ZAY, uses a different approach - he uses a long tail pair oscillator with the constant current "tail" modulated by the incoming RF signal. Thus the incoming RF mixes with the local oscillator, and when the two are close in frequency (within the "capture range" as PLL designers call it) the local oscillator locks on - synchronises - to the incoming carrier. Alan uses this "lock" capability to strip out the precision carrier frequencies from WWV and broadcast signals - free-of-charge top notch frequency standards from a handful of components.

Alan calls up a CA3046 transistor array; if you could get your hands on some CA3086 transistor arrays, these would work just as well. Add a tuned RF amp, a decent quality audio pre-amp and power amp and you'd have a very potent receiver.

Alan comments on using his design for CW reception too; whilst I'm more interested in A.M., so if you want to follow up Alan's CW ideas, please let me know what success you have!
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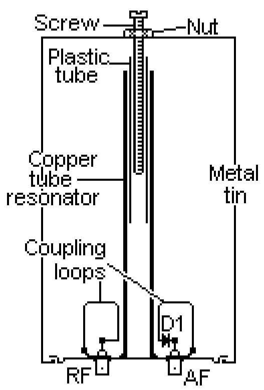
Alan Yates' 30m coherent autodyne receiver and his ancillary notes at:
http://www.vk2zay.net/article/154

That man of many and varied talents, Harry Lythall, SM0VPO, has some remarkably simple ideas and designs that really perform on his web pages. One which I've used very successfully is his VHF UHF resonator receiver, covering 6m to 23cms, which uses a copper pipe resonator as the selective tuned circuit. I've always hankered after using a BF199 transistor to apply some "regen" to this design; it should be reasonably easy to do (he sayeth, knowing that "in principle" is often very different than "in practice"!).

Harry's design is ideal as a local station monitor. He uses a Germanium diode detector; in the past I've used an OA81 type glass diode, but... and it's a BIG "but"... I took very great care in soldering the Ge diode - tricks I learned during Klystron / Wave Guide 16 days: I chilled the diode in a freezer overnight, attached "fine wire" croc clips to the 2mm diode leads, and a 200 Watt temperature controlled soldering iron completed the soldering as fast as humanly possible.

Another solution, which avoids soldering to the diode at all, was culled from Wave Guide 16 days, by using the brass innards of choc-bloc connectors (alluded to earlier in this edition of Hot Iron) to mechanically mount the diode *without* soldering the leads of the oh-so-delicate Ge diode. I'm sure the more adept among you will come up with some simple mechanical means to mount the diode and it's short leads far better than my meagre attempts!

You'll find this article in the "Projects" section of http://sm0vpo.altervista.org/ ; in the "Receivers" tab look for "Cavity Rx" in the left hand side list. Below is a diagram from Harry's web page showing the general assembly.



Power Supplies

The "Silent" Power Supply

When measuring very sensitive parameters of silicon devices, be they transistors, diode reverse leakage, mosfets, what-have-you, then noise picked up from nearby electricity distribution cables, atmospherics, signal generators, chattering thermostats, ADSL routers and the like can cause havoc - just listen to any frequency below 14 MHz and you'll see what electrical interference really is.

Noise signals are induced in ANY conductor - if it carries electricity, it will act as an antenna, that's simple physics truth. Problem is, silicon , being such a good material for building semiconductors with, when being leakage tested, you're looking at giga-ohms equivalent resistance in reverse diode junctions, gate isolation oxide insulation layers, and similar constructions. The merest sniff of induced noise RF in a device leads obliterates the tiny currents you're trying to measure!

This is solved in production environments by building seriously hefty Faraday cages: screened rooms, with very carefully designed lighting and ventilation inside which produce zero emitted noise. In my day these were powered by banks of NiFe cells, creating only pure noiseless DC; indeed, when trying lead acid truck and bus batteries for "clean" DC power you could detect tiny bubbles of hydrogen being forming on the plates with the electrometer instruments we used!

Zero noise means no relays, contacts or mechanical switches; every wire, cable, conductor must be screened - multiple layers of 100% cover screening, too - so some of the more critical test jigs were machined from solid copper blocks and plates, bolted to solid copper bench tops to ensure absolute grounding to the inner earth system inside the screened room.

But... the problem remains of how to get the devices (and operators!) in and out of the screened room, or, in the case of automated test equipment, how to design test equipment that creates zero electrical interference. Not easy when you're trying to test several million devices every week - which means auto loading and unloading into categorised bins, with minimal human intervention. The human body is a 220pF capacitor as far as static electricity is concerned, and a hefty 10kV (or more) discharge built up by friction causes very fast edges and consequent RF inside the screened room when spark discharged. If the operators wore conductive shoes, the discharge currents generated by overalls, lab coats and the like, moving about within the screened room, caused currents to be induced just where you don't want them. The control systems that ran the test equipment and external signalling to and from the outside of the screened room was done by air signals, the control pipes being copper alloy (car brake pipes) fed through via brass clamp gland fittings to air logic modules (yes, some industrial "digital" systems use air operated logic gates and flip flops!) so the integrity of the Faraday cage was not breached.

This meant the electrical supplies for the test gear and the test signals themselves had to be absolutely clean DC - large NiFe cells (700mm long, 450mm wide and 500mm deep) did the job nicely - we had spare NiFe cells charging outside the screened room, to be exchanged at shift change-over.

Which brings me to the whole point of this diatribe: the need for a "silent" DC power supply for your amateur radio experiments. Any of those who have built a "direct conversion" receiver will know exactly what I'm talking about, it's the dreaded "DC receiver HUM" oft quoted as being caused by local oscillator leakage getting into mains power supply rectifiers, but it can also be from a myriad of other places: earthing, earth loops, mains wiring pick up, and more other reasons than you can shake a stick at.

When I first faced this problem, that of a high gain audio amplifier, Stan (my mentor), simply dragged out a 12v NiFe battery and bade me “try it on this!” And lo, once connected, quoth Stan “I bet the HUM has gone, yes?” and so it was: dispatched to a place of beautiful silence, just the faint hiss of the audio amplifier (I’d scrounged some lovely low noise prototype ZTX951 transistors from the Application Lab, very low Rbb values). And, what’s more, it proved that my star point earthing was good, too: no sign of instability even with the gain flat out.

You can make a “silent” power supply for very little money, using the very good value sealed lead acid batteries beloved of burglar alarm designers. They are small, cheap, and very effective, and long lived if you use a careful designed charging circuit to make sure they aren’t over-charged. The nominal 12 volt cell has a maximum charging voltage of around 14.2 volts, so a bit of juggling boosting a 7812 regulator - or if you’re very posh, an LM317 - will do the job with bells on, and can be found in just about every burglar alarm panel you care to mention. Then a current limit circuit would be required, whilst it’s not dangerous to charge sealed lead acid batteries with fairly hefty current (but ALWAYS check the manufacturer’s data sheet). Of course, here at G6NGR such casual (and costly!) frippery is taboo: how can it be done with what’s to hand, the simplest possible way?

Answer: a 15 volt DC / 300mA “wall wart” power supply, a couple of 1N4007 diodes and a 47 ohm 5 watt resistor, that’s how. First I measured the open circuit output volts of the wall wart: 15.2 volts DC. Thus I reckoned a pair of 1N4007 in series with the output, assuming a forward drop of ~0.5v to 0.6v per diode, would reduce the output to something like 14.0 volts. That will do nicely, thank you!

A 47 ohm resistor in series would limit the current if a dead flat cell was connected: you’ll never get less than 10.5 volts or so from a discharged (but still viable) sealed lead acid gel cell, so the current maximum would limited to approximately 3.5 volts across 47 ohms = 74mA. Again, that will do nicely. I intend to leave the silent supply charging whenever it’s not in use, so I measured the current at 70mA (dead flat) to 12mA (full charged). Easily within the cell’s ratings and data sheet figures.

As with all lead acid batteries I included a 2 amp fuse. Small these sealed lead acid cells might be, but a short circuit across one of these little blighters will run many tens of amps! ALWAYS include a fuse, as close to the “hot” terminal as you can: that way any shorts or chafed wires won’t do any destructive damage.

How does it perform? Superbly! It’s very portable, small, safe and can be used to verify wiring and design of a direct conversion receiver, or a general purpose “bench” power supply. Sure, a good quality 12v bench power supply would be better; but you seen the price of a quality, lab standard power supply recently? I case my rest, M’Lud!

The “Economy” Valve Power Supply

For our hot cathode brethren out there, the power supply is usually an expensive bit: that big lump of iron and copper that makes boat anchors boat anchors, is the problem, so any means of reducing this item in size, cost, bulk, weight, is to be appreciated.

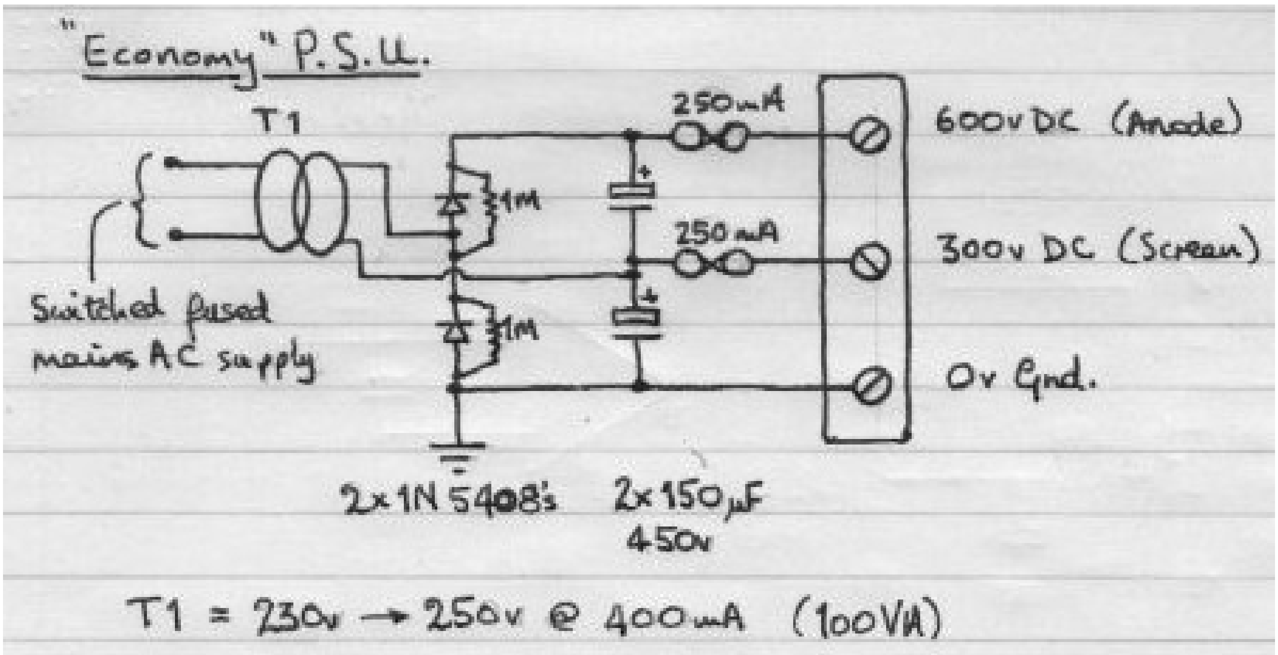
The simplest - and kindest to the transformer - is a full wave voltage doubler circuit; but because that features a single high voltage output, and you need a screen grid supply of roughly half the B+ positive rail. It's tantamount to a criminal offence nowadays to use whopping screen "dropper" resistors to chuck away those unwanted watts (even though they kept your tin mug of tea hot on top of the PSU).

Some simple circuitry comes to the rescue: a power supply that delivers both the screen and anode supplies from one transformer, runs on both half cycles so no DC currents in your transformer, and is cheap, simple and easy. I included 230v AC neon indicators on primary and secondary for safety, and I prefer LED indicators on the (separate) transmitter so I know immediately the PSU and the link cable are in good order.

I prefer 1N5408 1kV P.I.V. diodes rather than the ubiquitous 1N4007's because the much higher surge current capability of the 3 amp 1N5408's is valuable in capacitor input smoothing circuits like this. The 1 Meg-ohm diode balancing resistors also act as bleed resistors for the smoothing capacitors, via the transformer secondary.

I know it's a "golden oldie" standard circuit, but in these silicon daze (yes, "daze") of wonder microcontrollers and the like, these simple techniques are sometimes lost - especially for those who think 24v DC is "high voltage"!

Below is the schematic of the HV DC section; the filaments are fed from a separate 6.3v AC, 8 amp transformer powered from the primary side of T1, the HV transformer.



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Antenna Topics

In Hot Iron 108 I mentioned Peter Parker's, VK3YE, experiments with active antennas of the "E Field" probe type, and how he found that with the probe very close to the dround he found much better reception S/N. This prompted me to do some in-depth research on this - and related - topics; and lo! Antenna "gold" was discovered.

At: http://www.kk5jy.net/LoG/?fbclid=IwAR0dDk21M6XqZg7IwQ5NE7ggmS5Ux6Ivc_-_gtSZpE9Qbeu4EB9h5T4NGyU I found, that on the low bands, this "ground effect" as illustrated by Peter Parker, VK3YE, is real: a lossy Rx antenna can improve signal to noise! I'll not go into too much detail here, best to see the web pages at KK5JY; but this again reflects the practical findings our erstwhile radio operators 100 years ago took great advantage of - that lower frequencies do, by diffraction, follow the curvature of the earth and will be found close to the surface of the globe at great distances. That is why wavelengths shorter than 200 metres *in toto* were given to amateurs: they were considered useless for any long distance communication as the ionosphere was unknown to those early pioneers.

The gist of all this I suppose is that experiments that are, in "theory", pointless, aren't always necessarily so: in true amateur terms, "give 'er a bash and see what happens".

OK, so it didn't work out that time; but keep the "suck it and see" mindset and keep trying. There is more often than not "gold" at the end of the experimenter's "rainbow"; the hard bit is finding the exact "end" and sometimes the search for the rainbow's end in our offbeat experiments will lead to a very different (and remarkable) results than you expected!

And don't throw away the notes you made (you *do* make notes, don't you....?) on the way. Odds on next week / month / year you'll run into something that is distinctly similar and wish you'd kept better records!

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Active Rx antenna

Chas. Wenzel's active Rx antenna is similar in principle to PA0RDT's design, the "Mini Whip". I don't know which came first: Chas.' design or PA0RDT's? I liked Chas. Wenzel's design as I had the components to hand, and it suited my purposes - I wanted to extend or retract a telescopic antenna as an active RF gain control and besides, I had a neat and very robust 1.2m long telescopic antenna I could use. The Mini Whip uses a tiny square of pcb material as the E-Field probe; I wanted a bit more control of the size of the "probe" to control the signal induced at the input to the jfet impedance transforming stage.

I used a coil from a 6v relay of about 120R for the power supply feed choke, some commonly available ("Bartol" in the UK) plastic pipe fittings, and TV co-ax downlead. Perfect! You can see Chas. Wenzel's antenna designs - and they are a veritable treasure trove - at:

http://www.techlib.com/electronics/antennas.html

The active Rx antenna I built is below:
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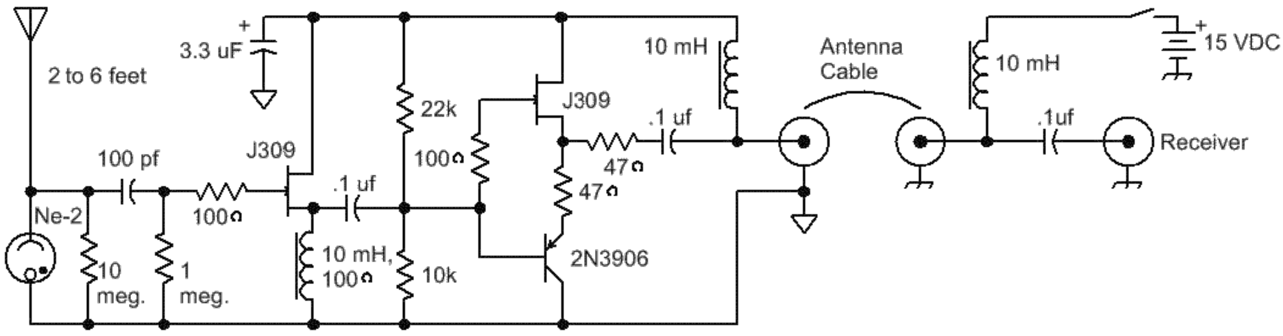

Figure 8: Improved Antenna Buffer.

Note the use of a neon for voltage clamping and a 10 Meg static bleed, and the jfet / PNP emitter follower "totem pole" buffer. Build it tight over a ground plane for operation above 100MHz; I had some 2N4957's (Ft = 1600MHz) which I used instead of the 2N3906 as I want marine VHF channels received, and I increased the supply voltage to 24 volts. The 10mH choke in the J309 source **must** have DC resistance 100 ohms or more to limit the J309's current safely. Add resistors in series to increase if required.

For the LF and MW / Top Band enthusiasts, Chas. also describes a tapped Rx antenna loading coil: a very good idea from a hundred or more years ago, and a proven improvement for Rx antennas on longer wavelengths, where you've no space for a decent length of wire. He shows a simple rotary switch inductor which can be a real space saver; two of these in series with 10 off 220µH chokes on one and 10 off 470µH on the other will cover down to 100kHz with reasonable antennas.

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Stripline SWR thoughts...

You may have come across the "stripline" SWR measuring method, which can be implemented very easily using a scrap of FR4 double sided pcb material, or a short(ish) length of "low loss" air-spaced TV downlead - you can push lengths of fine wire through the "air holes" in the dielectric to create the "forward" reflected lines, and avoid disturbing the braid covering. This reminded me of another very simple method of making "stripline" SWR meters: perforated copper strip prototyping board (Veroboard, other makers are available). Fine for HF and low VHF, and if some plain copper wire salvaged from mains "T&E" cable earth conductors is straightened by gently stretching it, one end held in a vice, the other gripped with pliers, is cut carefully so as to sit on top of the copper tracks and solder (sparingly!) run into the joint to secure the copper wire to the track, significant power can be successfully passed through the construction. You'll need some "slug and snail repellent" self adhesive copper tape from your local garden centre to make the underside earth plane, and a couple of coax line connectors of your choice to finish the job off.

A full reference to the stripline swr system can be found in an excellent article by John Langsford, VK5AJL at http://vk5ajl.com/projects/swrmeter.php where you'll find all the information you need and a very good (simple!) explanation of what swr really means.

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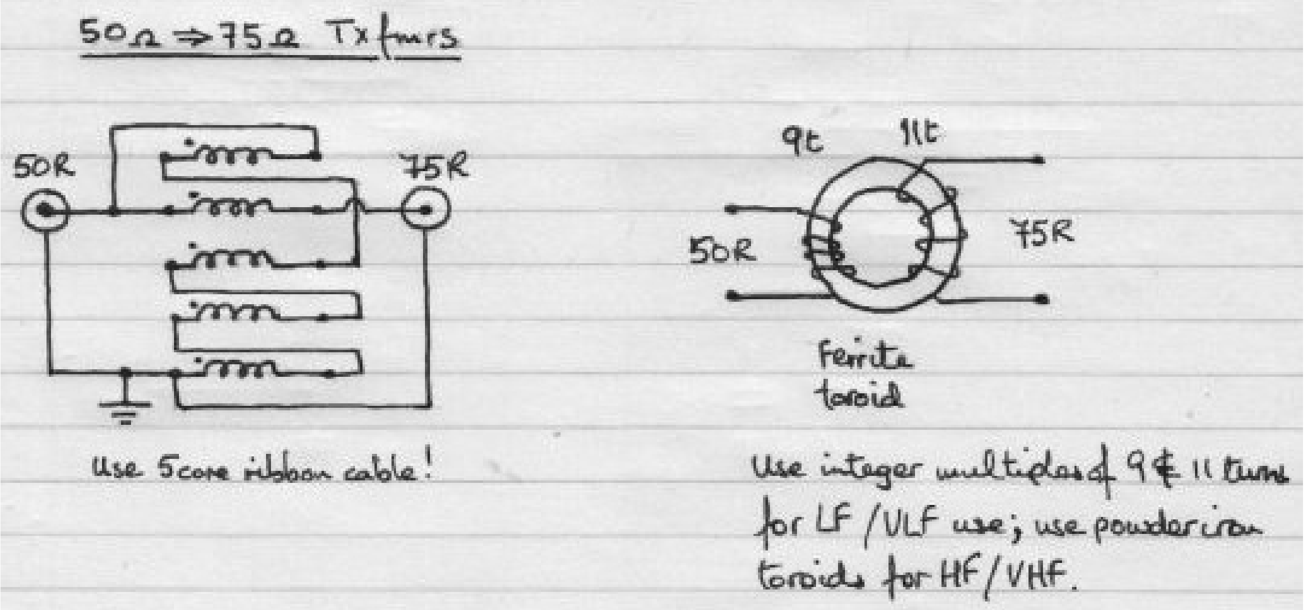
TV aerial downlead co-ax - it's cheap and effective!
But.. "it's 75 ohm isn't it?" Yes it is; and for those constructors amongst us who can add or remove a turn or two from the P.A. output link coil (or what-have-you) it's wonderful stuff. For those of you afflicted with the strictures of 50 ohm, "like it or lump it" equipment, then likely you'd find the diagrams below useful; they're low loss if built carefully, bi-directional (i.e. 50 to 75 ohm one road, 75 - 50 ohm, t'other road round) and can handle all the power you'll ever need as an amateur if you use a big enough core.

For the "balun" approach, 5 way mini-ribbon cable can be used, and it's good for HF / VHF without fuss with a few turns through a suitable toroid core; for the "isolating" transformer use integer multiples of 9 and 11 windings for low HF / MW / LF / VLF, and use a powder iron core for high HF / low VHF. The ratio of 9 to 11 gives impedances of 50 to 74.42 ohms one way round, or the other way round, 75 ohms to 51.7 ohms. Near enough in practice, and very easy to construct.

I use salvaged ferrite toroids from PC power supplies for isolated type transformers on 80m, 60m and 40m; if it proves a bit lossy I grab another off the pile and try that.


50Ω ⇒ 75Ω Txfmrs
50R
75R
Use 5core ribbon cable!
9t
11t
50R
75R
Ferrite
toroid
Use integer multiples of 9 & 11 turns
for LF / VLF use; use powder iron
toroids for HF / VHF.