HOT IRON # 120

End May, 2023

Table of Contents

CQ-CQ-CQ....3
Thank you for all the good wishes!....3
'Blue Sky' Repairs....3
Receivers....5
Peter Parker's NO inductor receiver…....5
The VK3YE converter…....6
A.M. Broadcast interference filters....7
Stray Magnetic Fields....8
Transmitters....10
RMS power....10
Transmitter or Signal Generator?....10
Power Supplies....12
Reducing source impedance....12
Faulty loads... and solid state relays....12
Your DC PSU has no current limit?....13
Crowbars…....14
Components....14
Logic Diodes?....14
Logic controlled xtal oscillators…....15
Diodes in parallel = more amps?....16
Vaping gadgets....16
Goodbye, SA612…....16
LT5512 Internal block diagram....16
Negative resistance??....17
More on Manhattan construction…....17
Test Gear & Fault Finding....17
Watt-Meters....17
Fake N type connectors....18
Heathkit noise tester (2)....19
Components under test....20
Home made needle prods....20
Lead Free solder troubles....20
350 volts is nasty....21
Construction....21
Repairing diecast or plastic boxes, et al....21
"Copper to Copper"....21
Antennas....22
ATU polyvaricon Voltage ratings…....22
Co-Ax Feeders through walls…....22
An ancient 'Quad'…....23
Stop Press....24
AFDD's - another 'official' red herring?....24
It's Goodbye from me....26

CQ-CQ-CQ

Thank you for all the good wishes!

Once again, Hot Iron readers have stepped up to the plate, and helped me produce this edition. I couldn't write Hot Iron without the abundant input of ideas, articles, suggestions and circuits; your inputs to me show me the direction you want Hot Iron to go and it's my pleasure to share my experiences and learning from all my years in semiconductor manufacturing.

Every wafer fabrication plant has it's own equipment guiding rules, often using live data from their machines, output and ongoing costs - the Intranet within a facility allowing this very easily nowadays. Live data is collected every few seconds or a certain event happening: the start of deposition in epitaxy for instance. This data, logged, graphed and stored electronically can give a time frame scenario of the real operating parameters - any deviation from established patterns indicates a fault developing, from a slight rise in collector / emitter leakage, or the need for more drive to attain a known output for instance. The hardest part of this technique is to know what parameters to monitor - on reflection you could probably think of hundreds in a simple transceiver!

The Maintenance effort plays an active part in this; just as the user of a transceiver will note immediately any deviation from 'usual' running and take appropriate steps to rectify or alleviate the problem, this might indicate a shift in operating parameters and indicates repairs or re-alignment is required. Not that it might be a problem in the transceiver; maybe a shortcoming in the design, or an antenna issue or an external interference you can do nothing about, like mains AC power noise or voltage shifts.

'Blue Sky' Repairs...

It's often the case you have some elderly bit of gear to refurbish, repair, re-use, and have no access to any spares or replacement parts. What to do? This conundrum was a daily issue in production machinery maintenance in manufacturing semiconductors - some of the military devices (I'm thinking of microwave diodes here, that fit inside Wave Guide 16) were produced, tested and quality assured on instruments long since gone to the great Valhalla as far as spare parts were concerned; an ancient GenRad capacitance bridge, to be specific.

The MOD had specified this particular instrument - no substitutes allowed - and the Calibration Laboratory had passed it to us to repair: a calibration procedure had shown that the bridge could not be brought to balance on a low (0.2 to 2.0 pF) range.

An hour's stripping, cleaning and generally looking at the physical condition inside the double screened innards had shown nothing obvious; so it was 'Blue Sky' thinking time. In other words, anything and everything that could possibly be related to - however abstruse - was examined, and given a good dose of 'maintenance from first principles', meaning: 'take it to bits, clean it inside and out, check every joint / connection / plug and socket, ensure all insulation was in order, no bulging electrolytics, popped capacitors, burnt marks near resistors', that sort of thing.

A trip to the Calibration Lab to collect the test jigs and other ancillary equipment required for the calibration shed some light: a GenRad audio oscillator specifically for this bridge showed rough, noisy (supposedly regulated) supply rails; we didn't have any specifications, but the ripple and noise was definitely more than you'd expect in a precision bit of gear like this.

The discrete voltage stabiliser circuits yielded more: a transistor (an old germanium alloyed device) was definitely leaky, and had an Hfe of roughly - well - one or less. Now - how to replace this device? Not a chance of a spare, this was a custom piece, with GenRad specific markings and encapsulation. The circuit looked 'Wien Bridge-ish', so a quick look at the transistor amplifier showed a bias resistor potentiometer from negative rail (these were all germanium PNP devices) to base of one transistor with a pull down resistor to emitter. A quick tweak of the bias chain allowed a silicon PNP substitute; lo and behold! the supply rails now looked a lot cleaner. The frequency was spot on; so a quick test with a 2.2pF mica capacitor substitute for the microwave diode proved good, but the oscillator was definitely vibration sensitive.

This was narrowed down with the 'standard bump tests', to a slide switch that was part of the range setting function, so this - being part of the mechanical assembly of the job - was stripped, and given a thorough going over with switch cleaner (no, we don't use Tri-chloro-ethylene nowadays!) and that was that. It was an almost unwritten law that complicated slide and wafer switches were never to be dismantled; it entailed hours of struggle to get the damn things back together!

All returned to the Calibration Lab, who went through several days of checking every aspect of the gear to maintain the MOD standards, all provable back to National Physics Standards, and the test rig returned to Production.

They used an acid dip to etch the wave guide mesa diodes until the capacitance came into a set range; this could entail many diodes making bottom limit but not the top (or vice versa), all being discarded (but made for superb microwave mixer modules for my 10GHz experiments!).

This is an example of Blue Sky thinking; no matter how obscure or off the beaten track, sometimes you have to think way out of the box and try repairs with what you have available. Maybe it's no spares available; maybe it's an integrated circuit specifically manufactured for the original maker, now long gone; maybe it's a complete redesign of a section of the equipment. Keep an open mind, try, try, try, substitutes and 'jumpered in' IC's if you can't get the exact replacement. If it begins to work something like, you've nailed the fault; maybe not exactly to the original spec., but at least you've proved the point, found the fault and can work onwards and upwards from there.

If you want to see a modern example of the way I and my colleagues worked in maintaining kit, but in a modern context, see: https://www.youtube.com/resultssearch_query=mend+it+mark+youtube

...and note how he repairs all these bits of kit he works on. Mark has far better test gear than we had; but his approach to repairing gear is exactly as we used! The golden rules:

- ✔ Use ‘maintenance from first principles’ - pull it to bits, clean everything and try again;
- ✔ ALWAYS check power supplies from AC outlet to most remote bit of kit;
- ✔ Find out (if possible) EXACTLY what happened immediately before it faulted;
- ✔ Split complex gear into sections to isolate the faulty bit;
- ✔ Look for physical damage to casings, covers, hand controls, in fact anything a frustrated operator can hit, twist, rive beyond end stops - despite all claims of innocence;
- ✔ ALWAYS physically inspect in minute detail every component, pcb, cable, connector for signs of damage, heat, loose / slack connectors, split encapsulation; swollen or leaky electrolytics; bunged up fans, fried transformers, blackened relay covers, melted wire insulation, signs of mistreatment;
- ✔ Use sensible substitutes to replace ‘unobtanium’ or ‘museum’ spares - it’s not unknown to jumper in a CMOS IC plus buffer transistors on strip board to replace ancient logic chips;
- ✔ Use a DC supply to feed limited power into a dud circuit and use a finger tip to find ‘hot’ component(s)…. your own personal infra-red (‘OUCH!)’ sensor;
- ✔ Keep a few 1Meg-ohm resistors on croc clip leads and jumper EVERY high volts, high µF capacitor. Not all designers / manufacturers envisage open circuit loads that won’t drain away a Stored charge;
- ✔ Your MEGGER is your friend, use high volts to test insulation, wiring and connectors far better than multimeter ‘ohms’ can (after you’ve made all semiconductors safe!);
- ✔ Keep a dim lamp (series limiter) on your bench and use it on unknown progeny equipment;
- ✔ ‘If in doubt, whip it out’ (apply to ANY suspect component) put in a known good new part and test the circuit again, keeping in mind open circuits don’t drain charged capacitors (as Mark demonstrates with some ‘industrial strength’ language in one video…!)

Receivers

Peter Parker’s NO inductor receiver…

Yes, our Antipodean pal Peter Parker, VK3YE has dug out an old reference and built an LF / MW receiver *with NO inductors*. An excerpt from his email to me is below:

“Hi Peter - my video demonstrating the receiver is here:-

https://www.youtube.com/watch?

I don't plan to do further work on it.”

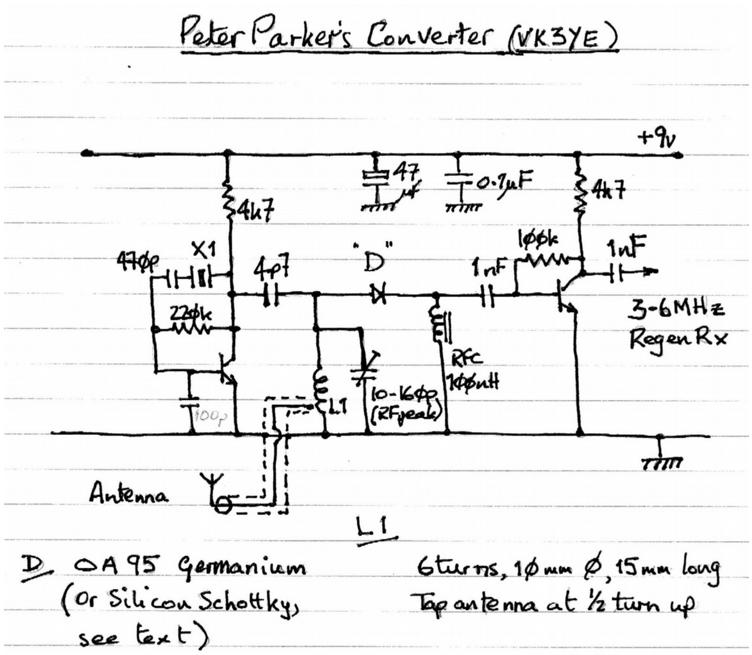
I can’t blame Peter for not spending too much time on this project; the whole issue is the matching of capacitors and the variable resistances for tuning a Twin TEE or Bridged TEE circuit. The capacitors need to be as near identical as you can get and the tuning pots need to be identical value, ganged, with linear tracks that are within a gnat’s whisker of running true right across their range.

These are not easy criteria to meet, and with any lack of tracking / linearity / matching, the Q disappears quicker than a cold beer on a hot day!

The VK3YE converter…

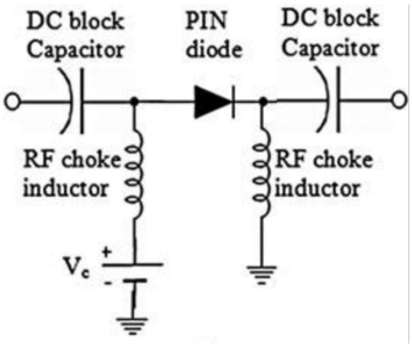
Peter has built an update on 1960’s technology that allows a 3 - 5MHz regenerative receiver to catch 11m ‘CB’ signals and the 10m band; or (by selecting appropriate crystals in his converter and ‘backwards’ tuning) many other bands of interest too. No, not that CB 11m band is of major interest to amateurs; but it is usually active with plenty of signals to help set up a receiver. See:

https://www.youtube.com/watch?v=Lb9XS06nTSU&ab_channel=AmateurRadioVK3YE



(Note: oscillator transistor base capacitor = 100pF)

Peter uses a single germanium diode as a mixer. He calls up an OA95, which might be a bit tricky to find nowadays. There are some significant differences in diode roles: if the diode is used as a detector, you need as low a forward drop as possible, as you’re dealing with µV. In a mixer, you have a local oscillator to drive the diode, so the demands aren’t so stringent - a Schottky will work as like as not. For µV detector service, bias a silicon junction (just) into conduction and AC couple the RF signal in and out. The PIN diode switch circuit (from which the detector diode biasing is an offshoot) replace the bias supply choke with 1 - 10 Meg-ohm resistor, and feed the local oscillator via the 4p7 into the anode of the diode. Thus the local oscillator switches the diode ‘off’, opposing the resistor bias on negative half cycles.



In Peter’s design, the diode is driven by the local oscillator via a 4p7 capacitor. On the positive half cycle the local oscillator biases the diode ‘on’. On the local oscillator negative half cycle the diode is biased ‘off’, mixing the input RF signal with the input. I have seen VHF single diode mixer designs where the capacitor driving the mixer diode was a small area of copper on a pcb beneath the diode, or even a short insulated wire alongside the diode body!

This is a real blast from the past, as Peter explained to me. It’s simple, practical and functional - you can’t expect World class nano-volt resolution from a handful of components, but… all mode capability, a simple regenerative receiver IF and an LM386 output stage, what more do you want? This scheme will easily adapt to VHF or LF too, giving an easy and practical way to build a functional and effective receiver. More at:

https://www.youtube.com/watch?v=CCreItQLzOA&ab_channel=AmateurRadioVK3YE

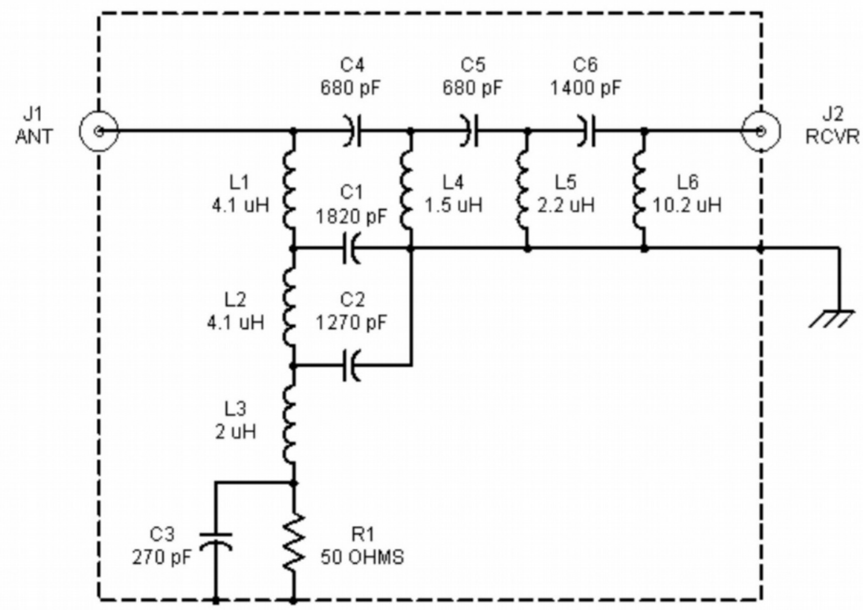
A.M. Broadcast interference filters...

For those who trawl around the lower HF bands, broadcast station interference - medium wave A.M., not much of a problem nowadays in the UK, but I maybe still applicable in the USA and Australia - it can be an issue. Not that the transmitted signals are riddled with harmonics, but after multiple reflections, added to corrosion in steel building structural joints and large steel fences / barriers can cause non-linear mixing products and other cross modulation which can give issues on the lower bands, especially Top Band and 80m. One ‘fix’ is a high pass filter to block Medium Wave (and lower frequency) signals, and below is a simple high pass filter from Dale Wentz, KB9JJA, at:

https://www.wentztech.com/radio/Projects/QRP_BCI_Filter/index.html

This effectively cuts off anything below ~2MHz, assuring no B/C MW - A.M. interference (or possibly more to the point) gross overloading if you’re downwind on one of these powerful monsters.

Below is a neat ‘band stop’ filter schematic, from Joe Carr, which has neat features:



Joe's design features a low pass filter and a high pass filter, which, coupled together, block a full band of frequencies, the A.M. broadcast band. This allows our LF / VLF brethren to operate seamlessly VLF→LF→HF without having to exchange filter modules, a great idea if you're into HF and LF operating all at once!

Joe uses a very powerful trick; he adds a 50 ohm load (R1) termination to the low pass filter section (L1,2 and3). This absorbs the rejected energy, stopping it from possibly circulating in the filter circuit - but is far more complex than Dale's super simple design. As ever, 'you pays your money and takes your choice'!

Stray Magnetic Fields

Magnetic flux coupling from E-I lamination transformers can represent a big problem in a sensitive receiver power supply, it can cause all sorts of wild goose chases trying to get rid of hum and related problems though the dreaded Direct Conversion receiver "hum" can be from a very different source, but at least you can eliminate the transformer in your power supply if you're aware of the issue.

Suppose you have a bargain transformer from an unknown background or original purpose: it has all the right attributes like primary and secondary voltages, VA rating and physical size, but after designing and building your project, you find it's a "hummer" and no amount of decoupling, isolation or other known means can stop the damned "hum".

I'd suggest you try this simple experiment and see if it can find a cure for your problems. Wind a loose 12 turn coil of insulated hook-up wire over your fingers, in a roughly circular form about a ½ inch / 12mm diameter, the turns taped up for some rigidity, and connect your 'scope (or sensitive multimeter set on AC mV) to the coil ends, then move the 'search coil' in close proximity to your transformer, all around it, whilst it's powered up and driving the load. You'll find some positions where plenty of induced mV's appear in the coil - this is the leakage flux from the transformer core linking into your search coil. You might find some positions are almost free from stray flux; others you'll find plenty.

The question is though how to stop this stray flux inducing hum in your circuitry. Well, simple solutions can help: try some pieces of a steel can, cut to screen the transformer; the steel, being far more magnetic than copper or air will shunt away the magnetic flux. In fact any bits of sheet steel will suffice, and earthed to will give both magnetic and electric field shielding - two for the price of one! This isn't always easy or practicable though; you might not have room to do this - so heed the advice Stan M. gave me when I was tasked with building a reverse leakage measurement rig for Gallium Arsenide LED's. These involved current measurements of fractions of nano-amps; Keighley electrometer to the rescue, but I couldn't stop the mains power supplies from causing rectified hum issues (proved by using battery power!).

Stan brought me back to practical reality; he dug out from the "Black Hole" (otherwise known as Test Gear Stores…) an ancient power supply chassis once used for a valve (807's, actually) test rig, which sat on the floor beneath the operator's bench. This separated the power transformers from the bench top side; the underside of which Stan M. had lined with a steel sheet, earthed to the test rig common star earth bolt.

Problem solved: I stripped out the old electronics (carefully preserving the valuable filament and HT transformers…) and rebuilt the power supply module to the required specification, fitted the power supply transformer, rectifier bridges, smoothing capacitors and control relays. This fed the bench top electronics via a hole in the (bench underside) steel sheet. The 'umbilical' feeding the power up to the bench top test rig was fitted with Jones multi pole connectors (the ones with the big flat blades at various angles for polarisation) either end and the job was a success.

Stan M. had a few comments, which interested me. "The girls who did the testing loved this job; the old power supply sat on the floor under the bench made a dandy foot stool, and the warmth from the transformers was always appreciated" quoth Stan. "But keep in mind the idea of physical separation and magnetic screening. We're very lucky as we now have a Transformer Department who can knock up toroid transformers for us, but you might need to use an E-I cored transformer one day if you're stuck. Make up a leakage flux sensing coil… (as above) and check things out. Modular units are always a *GOOD IDEA* (Stan's emphasis…) as you can substitute a known good module and get the job up and running very quickly; and repair the faulty module back in the workshop, rather than struggling with it *in-situ*. You automatically get better screening, isolation and happy operators".

I’d agree every time with modular philosophy. Make your radio gear as modular as practicable, it will help you immensely in improving and / or fault finding. Keep to the motto of ‘adopt, adapt and improve’ as you’ve only the faulty module to work on and you can easily go back to your last (known good) circuit if you only alter one thing at a time, then test thoroughly.

The moral of this tale:

- use a modular approach;
- use magnetic and electric field screening;
- fit transformer power supplies in steel boxes for both E and H field screening: steel conduit boxes are cheap and have plenty of knock-outs;
- keep the design of a PC “ATX” power supply to mind, note how the SMPS noise generators inside said beasts are screened with magnetic material - in fact, use scrap ATX power supply boxes, they are often available for free from dud ATX PSU’s.

Transmitters

RMS power

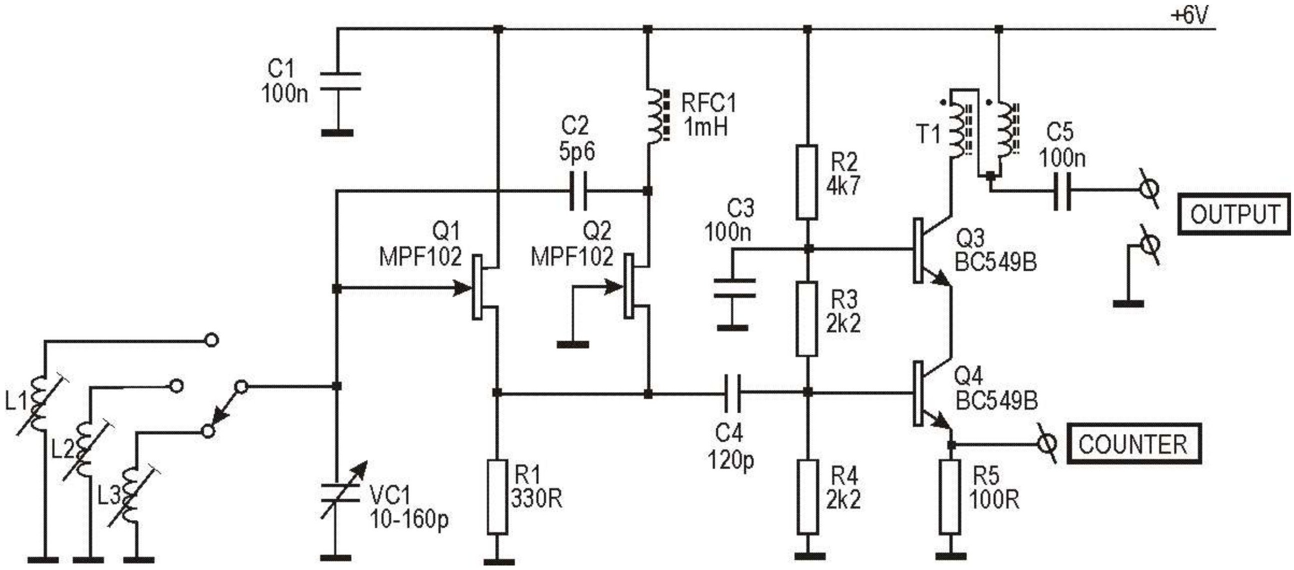
RMS is defined as the heating power of a waveform; it is the DC equivalent. Thus, if you want to check your transmitter output, connect a (non-inductive) 50Ω or 75Ω resistor and measure the temperature rise after some minutes of ‘CW’ key down. A well shielded and insulated infra-red temperature sensor will give a reliable reading of the temperature rise in the resistor - note it down, and replace the transmitter with your bench DC power supply.

Adjust your bench DC power supply to give the same temperature as noted above; multiply the volts by amps from the power supply and there you have true power indication - job done! For an SSB / AM transmitter, you’ll need an audio generator to keep the transmitter well modulated.

This technique will work on any power, it just needs time, care and thermal insulation. This is the core concept of the thermocouple RF ammeter, you can adapt the scheme to suit whatever you have available. You can use a thermistor, a thermocouple, a temperature indicating strip, what-have-you to indicate identical RF and DC temperatures - the absolute value is irrelevant.

Transmitter or Signal Generator?

From Andrew Woodfield, ZL2PD’s web page:- https://www.zl2pd.com/HFRFgen.html



Andrew describes this as a signal generator, but those familiar with low voltage power output stages will recognise transformer T1 as being capable of a good few hundred milliwatts, if not a watt or so, of output. The design is simple, but elegantly sophisticated: much like quality commercial or professional equipment.

Note, for instance, the oscillator section. This is a source coupled Franklyn; the use of two active devices gives vastly better performance than the common single active element designs - and allows Andrew to cover ~ 400kHz to 60MHz with just 3 coils. A crystal can be substituted at Q1 gate, though the small (3pF?) capacitance presented by Q1's gate being back biased might mean the crystal runs off the marked frequency as the loading capacitance won't be present (make VC1 a 2 - 20pF trimmer?). The Franklyn is good for waveform quality; the devices being J-FETs they auto bias to linear(ish) operating and the output from R1 (330Ω, the source common resistor) is 'clean' , almost harmonic free.

The Cascode output is a typical industrial technique: not only do you get substantial (and almost unconditionally stable) amplification, you get a low level output of the lower emitter for a counter to connect well matched to low impedance drive - with a significant power output, and load isolation from the Cascode connection. No matter what load is attached, the oscillator section will 'see' an almost constant impedance at Q4's base, a significant advantage over a single active element gain stage.

Andrew's design would make the ideal local oscillator module for my preferred modular approach to amateur radio: you get not only a piece of Test Gear, but a core component in a transmitter and a wide band local oscillator for a (VK3YE?) converter. The Cascode stage could be keyed; but you'll almost certainly get better results keying (or modulating) the later power amplifier stages, not the oscillator!

Power Supplies

Reducing source impedance

Many amateurs think that wiring and components in a power supply don't need to be too big; after all, electronics in this 'surface mount' age are tiny, yes? Wrong!! In a power supply (and all associated power wiring), use the heaviest gauge wire you have, big bus bars, over -rate the diodes, transformers and electrolytics as best you can. Make it big and chunky for sure performance!

Why? Because you are reducing the source impedance with every move to 'chunkier' construction: this inevitably improves regulation and helps stabilise the output - giving your regulator circuitry a fighting chance to cope with any load you might attach. And don't forget fuses; these little blighters can add a fair few ohms, if you don't believe me, test a few (especially those under a couple of amps) with your multimeter!

It's not unknown for pcb tracks to be 'beefed up' with lengths of tinned copper wire being soldered along the track length to reduce volt drop. PCB designers, in the 'surface mount' age, think copper tracks can also be diminished to near zero and still carry amps. 'It ain't necessarily so' as the old song has it: $R = \rho L/A$ (resistance = resistivity multiplied by length of track all divided by the track's cross sectional area), and that's physics that won't miniaturise!

Faulty loads... and solid state relays

….can accidentally stuff AC power back into control electronics - which 'don't like it up 'em', to quote Corporal Jones. The problems thus created aren't limited to just one IC or section of a circuit, however.

Most IC's have 'clamp' diodes on inputs, these are to catch excessive volts and dump them into power rails to be safely absorbed. Now imagine some hefty cycles of AC power finding it's way onto an IC's input (maybe an internal fault, or a back feed from a power mosfet gate, SCR gate, etc.): those half cycles dumped onto the supply rails go EVERYWHERE on the circuit board that the supply rail(s) run to. Nothing escapes the wrath of a misguided AC half cycle, it will severely damage anything it can. You might not see trouble immediately but rest assured, those errant half cycles of AC power have damaged junctions, blown holes in gate oxide layers, done a real nasty inside electrolytics.

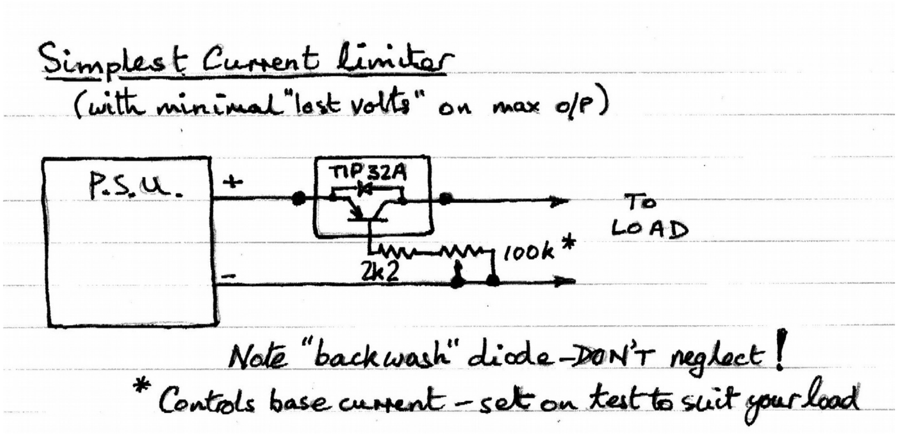
Your first instinct, on discovering an AC fault like this, will be to try to power up the circuit "to see if it still works", which is the kiss of death to the job. You're far better using your multimeter on ohms to test, test, test everywhere on that circuit board (before powering up) for shorts to rail or ground for leaky electrolytics, gate - source - drain shorts, blown diodes, in fact, test everything on ohms carefully.

Of course, the cognoscenti amongst us will have avoided most of this trouble by keeping AC power on the right side of devices that offer real input to output isolation: mechanical relays. Yes, yes, I know a solid state relay says it can withstand so many kV's… I recall Tony H's face when he first saw the destruction 230v AC power had wrought in his Test rig, in which he used solid state relays. What he hadn't taken into account were the transients present on the mains in that part of the factory - where the Royal Navy radar magnetrons (10MW pulse jobs, a yard high) were tested.

A few kV down the AC lines in very brief spikes had done the dirty on Tony's solid state relays and shoved some nasties back into his logic IC's, all of which had gone AWOL right across the pcb, courtesy input clamp diodes steering energetic pulses onto the positive rail.

Your DC PSU has no current limit?

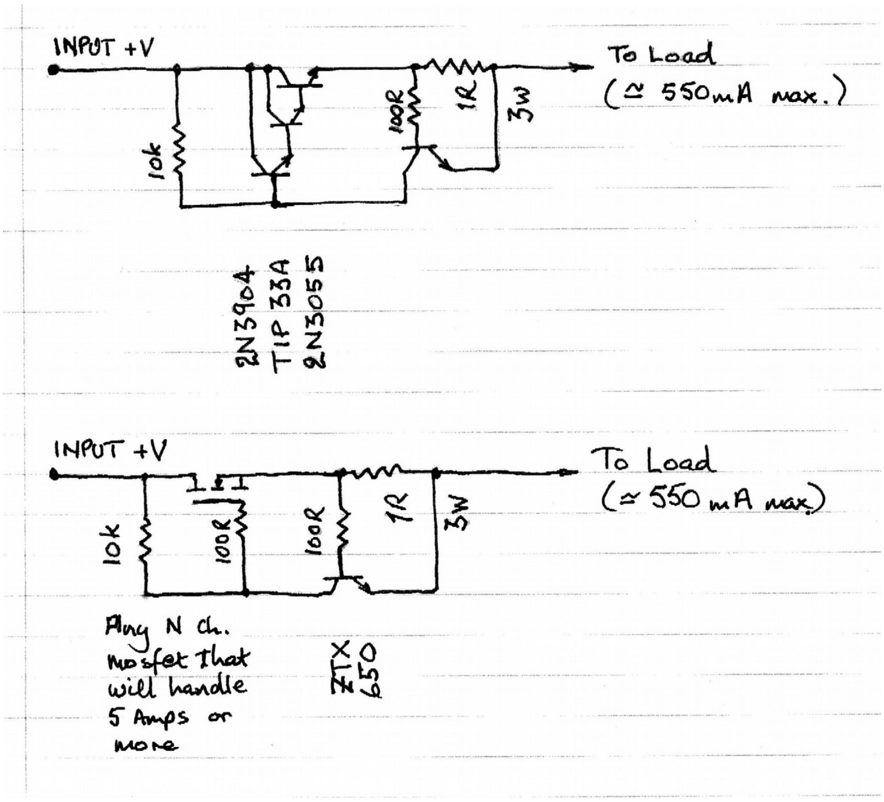
Try an external PNP transistor with emitter connected to +ve output of the PSU, the base biased by a variable resistor (as a rheostat) to -ve and load output connected to the collector, the base rheostat adjusted to give just sufficient current to your load. Simple and easy, this will eliminate most if not all of the 'bangers' you might suffer. If the load demand rises beyond the collector current you've set up with the base bias rheostat, the output voltage just sags.



Below the current limit set by the base current (collector current = Hfe x base current), the transistor feeds the circuit as a saturated switch, with only Vce-sat, (0.2v or less) drop.

Keep in mind this is a very simple arrangement, relying on the Hfe of the PNP being the current limiting setting so you'll need to cut and try the base bias rheostat to get satisfactory limiting - but it might just save that lovely little circuit you've just built from releasing all its magic smoke.

This circuit needs THREE connections; sometimes you just need to break into the positive feed line to do the job (remote supplies, etc.) Here are a couple of simple circuits to feed limited power into a darkroom where I'd built some cathodoluminescence gear: basically a 90kV electron gun and scan coils swept a beam of electrons across a Gallium Phosphide wafer and the light was collected and measured with an integrating sphere - all in a high vacuum chamber running at 10^{-7} Torr. The gear produced abundant X-Rays when running, so the control gear had to be external. To avoid a major re-design and consequent inspection by the relevant 'Elf-N-Safety' authorities, I came up with these circuits. The MOSFET version is a modern take on the original Darlington scheme, you might find trouble with stability unless the MOSFET has a gate damping resistor and negative feedback (gate to drain) capacitance fitted. The Darlington version showed none of this bad behaviour!



Note: you might need a ‘backwash’ diode on the Darlington circuit. You can set the maximum current with the 1R sense resistor: R=V/I, and V= Vbe of the sense transistor (ZTX650). A sense resistor of 0.47Ω will give 0.55v/0.47Ω, = 1.17 Amps, for instance.

Crowbars…

Use for ‘rest assured’ protection on power supply outputs, ALWAYS downstream from a fuse! A simple SCR plus zener diode and resistor to gate will work just fine, protecting your precious circuits from a wayward pass transistor (or worse) in your power supply. And… on the feed-in point on your precious gear, fit a reverse biased diode & fuse (a-la the Rockmite modified by Forrest Cook, at http://solorb.com/elect/hamcirc/rockmite20/index.html. Of course, you could make up a stand alone module to fit onto your power supply output sockets / terminals, or keep a free-standing module for testing any ‘sensitive’ or especially ‘valuable’ gear.

Note that the fuse can be a filament lamp, following the ‘dull lamp’ principle, to avoid replacing the fuse after every (inevitable..?) misadventure; if you try a circuit breaker, make sure it’s a fast one and can open quickly enough on 12 volt supplies. AC Mains circuit breakers won’t, that’s a dead cert!!

Components

Logic Diodes?

In amateur radio you often come across various ‘sequential’ switching situations - like changing over a single antenna from receiving duty to transmitting, then shutting down the power amplifier once the transmitting role is done. The problem comes from the hidden sources, like decoupling capacitors discharging, and the drive signal generated bias shutting off allowing high currents to flow in the finals.

This is a common problem in designing logic circuits - yes, they are still required in some situations where the development of code, proof testing (you DO prove your software under every possible situation, don't you?) doesn't justify going the micro route, in my honest opinion, it's realistic in about 50% of cases to use a handful of logic gates to do the job. Mind you, for those little jobs, simple diode logic is probably more than adequate, and you've probably used diode logic before, many times, but never recognised it.

Take for instance the use of diodes in 'Net', 'Operate' and 'Receive' functions. Yes, these odd diodes scattered about are actually diode OR gates. Selecting one function doesn't activate any of the others, the diodes are reverse biased and block the command from reaching other inputs.

A single +12 volt railed CMOS quad two input NOR gate (plus emitter follower buffer if more current than a CMOS gate can source / sink is required) can do these jobs too: if you only need two of the gates for the logic switching job, leaving you two NOR gates to make crystal oscillators, or other jobs - and don't forget, by fitting a resistor from output to (strapped) inputs, you've a simple op-amp for that bit of audio processing.

One problem often encountered are the delays required in switching from transmit to receive. You have to keep the antenna load connected *after* switching 'off' the transmitter, to avoid the decoupling capacitors dumping their charge into the PA device when no load is connected. Result: blown (or considerably foreshortened) active life for the PA device. On the switching from receive to transmit, you probably don't need a delay; so a simple RC delay that times on both edges (transmitter off and on) isn't satisfactory - it leads to unwanted delays before the transmitter fires up. Some designs eliminate receiver overload issues whilst the transmitter fires up by having a shunt to ground transistor / mosfet that protects the receiver input. Providing this is up to the job (considering a receiver input is connected to an antenna, which can pick up many kV's of lightning impulses and / or static charge destroying dinky MOSFET devices in the wink of an eye) then a shunt can really help.

Logic controlled xtal oscillators…

Talking of logic, I noticed on a Diodes Inc. data sheet a logic controlled precision oscillator with very low noise and jitter. See:

https://www.diodes.com/products/connectivity-and-timing/crystal-and-crystal-oscillator/crystal-oscillator-cxo/programmable-crystal-oscillator-xo/#tab-finder

If I'm reading this data sheet right, ("and that's not always guaranteed with you, is it Peter..." sayeth Stan in the background) then these little beasties output a frequency that's controlled by logic inputs, as the data sheet says, "the programmable oscillator IC contains a very low jitter PLL and can therefore generate any frequency based on your needs."

This chip might well provide the means to make very simple and accurate local oscillators, using for instance thumb wheel switches to create the digital control word, much simpler and cheaper than mucking about with software, and eliminating yet another digital noise generator in your radio environment. I haven't tried one of these on the bench; would a reader like to take up the job?

Diodes in parallel = more amps?

NO! You can’t parallel silicon diodes to get more amps from a rectifier set, as the slope resistance and forward volt drop must exactly match in each diode - and in this Universe, that ain’t necessarily so! So, how to shunt up extra diodes? Easy. Add some *ballast resistance*, ideally nichrome wire (pinched from salvaged firebars...). This has a positive temperature co-efficient; so the **more amps** through it, the **resistance rises**. Adding a fraction of an ohm of nichrome to each shunted diode will thus help equalise the current in the paralleled diodes. Should one diode hog the current (lower forward drop, lower slope resistance and Vbe falling by 2mV per °C as the amps heat the junction) the nichrome ballast resistance will heat up, the consequent rising resistance reduces the current, forcing amps through the other paralleled diodes.

This is exactly how power bipolar RF transistors - a collection of hundreds of low power devices in parallel built on one silicon die - spread the current across a whole array of transistors.

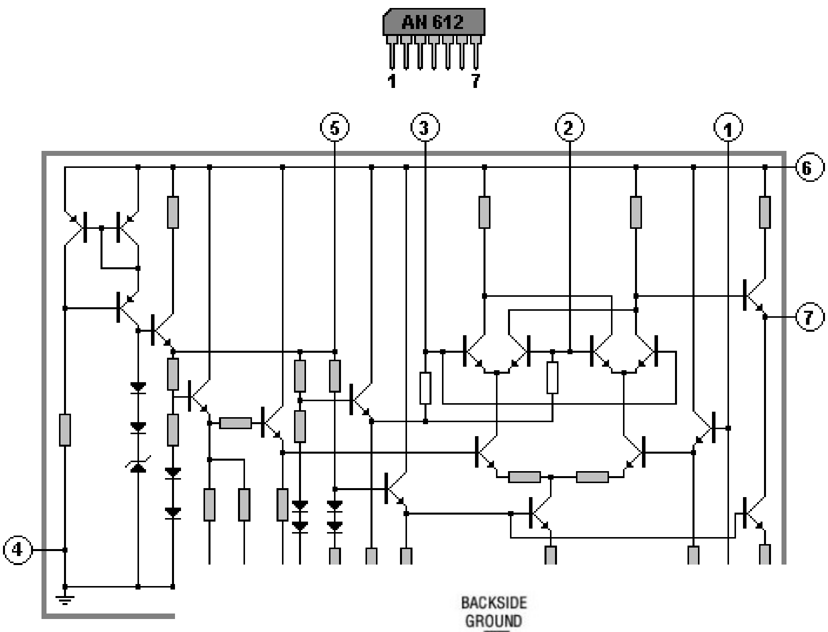
Note that you can’t solder nichrome wire, you have to use mechanical clamp connections (like choc bloc inners) to connect.

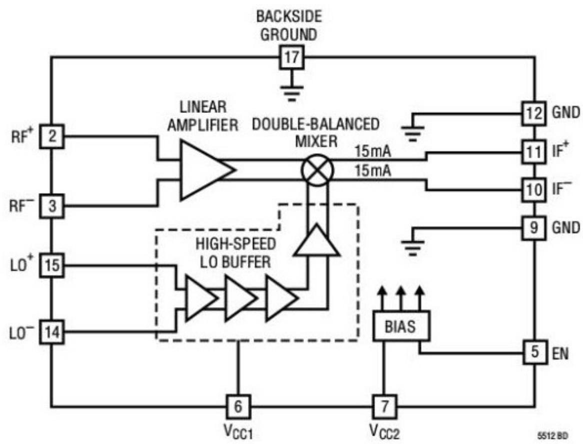
Vaping gadgets...

Commonly ‘discarded’ (i.e. chucked aside anywhere) once the cell is discharged often contain LiPo cells, 400-500mA/H. Careful dismantling and an intelligent charger will yield a useful collection for ‘ /P ’ operators, for FREE!

Goodbye, SA612…

The SIL alternative to the SA602 / 612 is the AN612 and LT5512. Internal circuit of the AN612is very similar to the SA612, and very often found in Citizen’s Band gear, and the like:





LT5512 Internal block diagram

The LT5512 is a similar beast; it has a very high spec. and is a very capable device (but not cheap). Note the enable pin (‘EN’). This allows the bias circuits to be switched off for muting and the like.

Negative resistance??

Tom McKee told me of his work and his web page(s) links, for which I am most grateful: negative resistance is a fascinating topic and well worth studying - shunt a negative resistance across an L/C circuit, or a quartz crystal, and you’ve an oscillator, for instance. Think of what circuits you could create with negative resistance - not just zero resistance losses, but GAIN!

Tom’s negative resistance pages:
http://www.radio.imradioha.org

Tom’s Index Pages (from which the above is from) are an amazing resource; go take a look!
http://www.radio.imradioha.org/index.html

More on Manhattan construction…

I am reminded that those who enjoy building with mini copper pads, super glued onto an earth plane - a superb way to build gear, right up to UHF - might want a more rounded approach, in that the pads are better circular to allow easier and shorter wiring for 15m and up. Be that as it may, here’s an idea by Keith D., and old pal of mine.

Keith notes: ‘remember the old REXEL office paper punches? The really robust iron handle jobs? These can punch easily through 0.5mm and 0.75mm copper clad pcb material, FR4, SRBP and the like - the little circular ‘waste’ bits make perfect solder pads, and the punch can make thousands at one session - plus they all get collected in the storage drawer gizmo underneath’.

Cheers Keith!

Test Gear & Fault Finding

Watt-Meters

Watt-meters* are available now that simply plug in a domestic outlet, with a ‘metered’ socket on the front, allowing you to see the immediate consumption of a load. This can give immediate indication of a problem, if (and this is the big ‘if’!) you’ve previously noted the draw under the various operating conditions, i.e. “x” watts on receive, “y” watts on transmit and so on.

Any deviation, more than the expected range seen previously, is a sure sign something's amiss. Don't just shrug ¯_(ツ)_/¯ …. check this change out, make sure you're not missing some unwanted shift in operating conditions.

In my previous life, in semiconductor wafer fabrication, machine operating parameters are routinely logged, either by a technician with meters, or (in later times) automatically logged by computer and the values stored, analysed and graphed to see trends, slow changes indicating wear, motor bearings, pumps degrading with time, etc. or sudden shifts in machine parameters, indicating something had broken, a casting had split, or a major change in operating parameters for a new 'recipe' had been called up. These trends or jumps flagged up the day's immediate jobs: data proved very useful in predicting breakdowns to the extent we could tell the Production wallahs that a machine would need routine maintenance in the next few days, or that a jump in a reading had caused a breakdown alert.

In an amateur scenario you might not need such depth of data analysis; or do you? With modern micro-controllers and instrumentation being so readily available, software from open sources (like 'GitHub', for instance) data logging / monitoring could be a very valuable tool. How long will it be before the latest Transceivers will include a data port with all the critical values inside that shiny black box being presented for customers to analyse? Are these parameters already available for the auto testing and alignment in the manufacturer's factory, or in the franchised repair shops?

*Note: for the impoverished amongst us, a moving iron AC ammeter can do a similar job, but let your imagination guide you - monitor heatsink temperature as an indicator of a power fault, etc.

Fake N type connectors...

Chasing that rogue lousy SWR on your latest VHF / UHF construction project? Noted the BNC antenna socket doesn't 'feel right' when engaging? You might be victim of fake components! You can bet odds on that as soon as a useful bit of kit comes on the market, some unmentionable will start making cheap copies of it, nowhere near the original quality or specification, and you've likely fallen victim to a copy.

Not only connectors get copied: fake IC's are rife. In the worst cases, the innards are nowhere near the original; another die completely. At best, they are probably reject dies, not up to full test. Transistors too suffer from this scam; especially the high priced end of the market. Cheaper transistors, in identical packages, are solvent cleaned or abraded to remove original type markings, then a new type number printed on. A simple multimeter check will show an apparent active device; but rest assured the fake won't carry the amps expected, withstand the rated voltage or have gain at the desired operating frequency - or even be the function you're wanting.

Look too for IC markings when buying ‘NOS’ parts from our favourite auction house. Real 1980’s IC’s were printed with ink identifications; more modern IC’s (i.e. the fakes) have laser ablated (burned in) marks - much smaller and finer sized.

This plague of fakes isn’t going to stop; even ‘reliable’ suppliers fall foul to these fakers, but at least they will happily exchange, as reputation is a very powerful marketing plus. If you’ve got fakes, get them back to your supplier. It’s the best thing you can do that will help get shut of the thieves.

Heathkit noise tester (2)

This very useful device (we’ve mentioned a’fore) applied ‘floating’ high volts (hi-Z for safety) adjustable bias to a pair of test probes, and then amplified any ‘noise’ from the device under test. Leaky capacitors make random noise and crackles; corona discharge makes an ethereal wavering hiss; leaky antenna insulators makes ‘hissy’ crackles just before breakdown.

You can make an instrument like this, it’s much more helpful than a meter or led indicator in finding leaky insulators, transformer insulation faults or dud capacitors - especially HV insulators at the RF resonances often found whilst tuning antennas. I’m reminded that safety these days is far more rigorous than years ago (thanks, Martin A.) and some basic operating procedures might be useful.

To make your own, you need a floating adjustable HV supply from a transformer and voltage multiplier circuit to generate the hi-Z, HV supply. The HV output is connected via a 10Megohm (or more) potentiometer, so the probe test voltage and available µA can be set to a suitable value (you wouldn’t want 450v DC applying to a 63 volt ceramic capacitor!). The HV positive output is connected to a simple audio amplifier via TWO 10kV (known good!) 1nF capacitors, so if one goes short, t’other will hold off the volts. The positive and negative outputs are connected to INSULATED crocodile clips for hands free (unlike the original Heathkit job!) operation.

To test a capacitor, ensure the output voltage is set to zero. Connect the capacitor on test to the output croc clips. Turn the audio amplifier gain up to maximum. Turn on the tester, and slowly increase the output voltage. Any breakdown in the capacitor on test will be heard distinctly as sharp crackles. To test antenna insulators in a dipole, test as capacitor above. For a long wire, or suspect feeder: clip the positive output to the ‘hot’ core of the feeder, and the negative to the antenna ground connection. You’ll hear all sorts of noises as the voltage builds up - damp leakage tends to ‘fizz’; bad insulators will crackle, corona discharge from sharp points (like stray strands of wire?) will make a wavering hiss as the breeze blows the wire.

You can ground the negative to an outdoor earth spike; then short the (disconnected) feeder core to screen, attach the positive output to the pair - this will test the antenna insulators and feeder outer plastic sheath to earth.

Your imagination using this tester is the only limit!

Components under test

For safety it's wise to keep both hands well away from test voltages, even using low volts in multi-meters, readings can be disrupted by finger contact.

The best way to hold components on test is to use a piece of 20mm thick of plywood, well varnished, and attach croc clips (with short screws) to hold items safely. You'll perhaps need a few at different spacings or one clip on a flying lead to accommodate larger components.

Testing mosfets: a very neat method is to use a multimeter on 'diode drop' test mode so the full battery voltage is available on the prods, to add / remove Gate - Source charge and check consequent Drain Source conduction. Assuming N Channel devices, connect the positive potential test probe to the Gate, and the negative probe to the Source which will charge the Gate capacitance - the MOSFET will be turned ON. Reversing the probes (or shorting the Source to Gate) will discharge the Gate capacitance, turning the mosfet OFF.

Bipolar transistors respond similarly, but you'll need a source of bias current to apply to the base. An old favourite was a PP3 battery, with wires soldered to the terminals plus a 10k resistor fitted in the positive lead, to 'mini' croc clips to connect positive to the base and negative to emitter leads. The transistor on test should be open circuit with no bias; almost dead short with bias applied. If no reading is obtained as expected, reverse the bias clip connections, it might be PNP!

Home made needle prods

Needle prods are a god-send on surface mount pcb's, but they are not cheap, and very easily damaged. Save time and money, make your own.

Strip out the inner brass connectors from a 1Amp choc-bloc, and clamp a needle in one end (remove the clamp screw from the other end) allowing the needles eye to come almost out the other end . You'll find multimeter probes will push into the (now screwless) open ends, the needle eye jamming the probe tightly in the 1 amp choc-bloc brass inner. You might need to try several different needle sizes to get a good fit on your meter prods.

Lead Free solder troubles...

At long last, lead free solder from the early days of 1980's and 90's is beginning to show it's true colours: dry joint failures in older gear are becoming a common failure point. Look for power supply and other 'hot' joints - i.e. on transistor legs, along 'single in line' amplifier IC's on heatsinks and the like for being open, high resistance or intermittent. Then it's out with the 63 / 37% tin / lead solder and reflow all those unreliable 'lead free' joints with some decent stuff.

Any solder joint that is dull, crystalline and not slightly concave has proved NOT RELIABLE in the long run. After you've reflowed all those dodgy joints (with quality tin/lead alloy), apply the standard 'Bump' test: your insulated screwdriver, held backwards by the blade, has the handle bumped somewhat vigorously all around the circuit board(s) you've suspected and reflowed, with power applied. Any crackles, clunks or other audible or noticeable effects at each bump indicates further - usually intermittent - faults awaiting your attention. Zero in on the culprits by progressively more gentle 'bumps' till you nail the little blighters!

350 volts is nasty...

...if you cop it across your chest! To Valve (or Tube) aficionados this is de-rigeur procedure; but to all you versed on 50 volts and under, avoid these heart- stopping moments by making up a 1Meg-ohm resistor with insulated croc clip leads. Clip this across the main reservoir capacitor in that switch mode power supply you're repairing to eliminate any nasty 350 volt DC shocks across your chest from those charged μF's - in fact, make a few of these Meg-ohm leads up and use them liberally on any valve B+ gear too. Might just save your life!

Construction

Soldering iron sponges after some use are a soggy, mucky mess. SAY 'NO' to such! Use a stainless steel pan scourer pad, in a small glass jar - the jars potted meat sandwich spread comes in are ideal. You can get a pack of 4 scourers in your local "Discount Shop" for pennies; they can be dosed with flux, of just used plain - they clean bits beautifully, don't damage the bit's iron plating and last for years.

Repairing diecast or plastic boxes, et al...

Mix fine powder (cigarette ash, talcum powder, etc.) & super glue for instant casting and repairs. This mixture sets like rock, but be quick! It goes hard in seconds. One very useful trick for repairing stripped threads is to insert a cotton bud in the stripped hole; drip in plenty of super glue to saturate the cotton wool and in seconds you've a rock solid filler with a pilot hole (the cotton bud hollow stalk) to help you re-tap the threads in the hole. Job done!

"Copper to Copper"

I had an email, which, to keep things short, asked about feeding multiple loads from a 'Choc-Bloc' screw connector strip. We've been in this district before! The Golden Rule is, if you want to steer lots of Amps around, any joints have to be "copper to copper".

Most users don't appreciate this when using choc-bloc connectors. Don't just bung your wires into the Choc-Bloc willy-nilly; If you've got several loads to connect, then select the heaviest load current wire, and put it into the same 'hole' as the feed wire: thus you've got copper to copper on the heavy draw connection. The lighter load(s) go into the other side of the brass insert, on top of the feed wire core which goes all the way through so these will be copper to copper too - and you've reduced the current flowing in the brass insert to it's least amount. Proper Job!

I've seen a fair few melted Choc-Blocs where 'temporary' fixes that ignored the "copper to copper" guide became 'permanent' and forgotten, only to fail later because the heavy currents weren't flowing "copper to copper".

You might get away with it for months, then quietly, without making a sound or giving any hint, a Choc-Bloc connection becomes a resistor. And just how do Choc-Blocs know the time? It was always on a night shift when these insidious little beggars decided to do the dirty and blow fuses!

Antennas

ATU polyvaricon Voltage ratings…

See https://www.datasheetarchive.com/pdf/download.php?id=0e3f84f91d06fd368e417b7df22b835fe48dda&type=P&term=Polyvaricon%2520toko

Which gives maximum rating of 100 volts; for a grossly mismatched or o/c load, even in QRP, can easily be more than 100 volts. The failure is likely to 'punch through' the insulating sheets; making a (now carbonised) hole from one plate to another. This will be benign until a voltage - far less than the rated 100 volts - is applied, when, in Royal Navy parlance, 'over she goes!'

To test a suspect Polyvaricon, dig out your Cockroft-Walton / Villard / Greinacher voltage multiplier (you DO have one to hand for high voltage testing, don't you?) and a 6.3v filament transformer to make high impedance high volts DC power supply, and use your fancy 10M-ohm digital voltmeter to measure break-over volts, and your 'noise' tester too. The very low current from a multi-stage multiplier won't carbonise the plastic insulation between the "plates" when it punches through (hopefully). See also previous notes on Heathkit "noise" testing!

Co-Ax Feeders through walls…

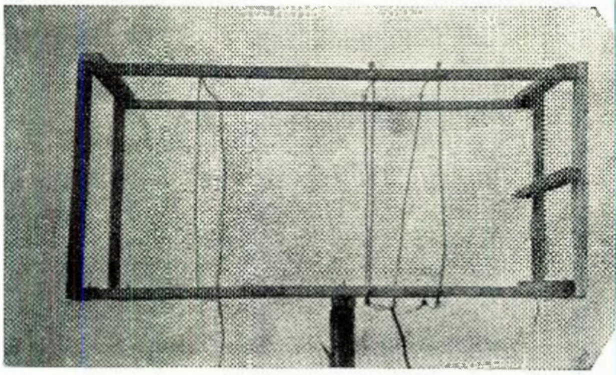
A sure fire solution is decent coax inside (bonded to coax braid) copper pipe, with appropriate connectors in an out (quality / Amphenol N type for instance), using copper end caps, drilled and / or machined to take the connectors. The copper pipe protects the coax, and, assembled in low humidity indoor environment, the plumbing fittings seal against further moisture ingress. Muggins here, in tender apprentice days, tried soldering the assembled copper end caps; Stan soon put me right by explaining that a smear of silver loaded epoxy resin would make a better job of it than the melted ruins I presented to him! The trick, of course, is to select the end caps to be a tight push fit, so pick-n-mix for a good fit. Ronnie B. had seen this sort of thing before when making vacuum feedthroughs; he advocated compression pipe fittings, but (he added) "they're big; use compression fittings only if you've a lot of room, and it's never as pretty as soldered caps - BUT - you can strip 'em out for repairs!".

You’ll soon realise that unless you can get telescopic pipe (rare; very rare), the coax needs to be a bit longer than the pipe it’s to fit in - this is of no matter, as the coax can scrunch up inside the protective outer pipe. The slight bends are of no consequence unless you’re pushing 10kW or more “down the hole”.

An ancient ‘Quad’…

Could be easily made with bamboo canes and cable ties, and easily scaled for other bands. What’s not to like?

Article follows on next page…. my thanks to the original authors. I have often found useful and easily constructed bits of kit in old magazine articles: always worth a good look through the old references.



The antenna is built on a simple wooden frame. A pipe mast is used for support and permits rotation.

A Two-Meter QUAD

By G. P. OBERTO

A three-element, high-frequency version of the quad antenna, giving a unidirectional pattern.

MANY hams and experimenters have been searching for an antenna that will give outstanding results on two meters and still fit into the family budget.

The type of quad to be described has a lower angle of radiation than that of the original cubical quad, because it is mounted horizontally instead of in accordance with the diamond mounting system used with the original quad. Height is not too important in using this type of antenna. Getting the array above trees and surrounding objects is all that is necessary for DX work on two meters.

Front-to-back ratio is very good. With a field-strength meter you will obtain readings only within 30°, standing 50 feet away from the front of the quad. Impedance is approximately 150 ohms, with one director loop and one reflector. The results obtained with this quad seem better on horizontal polarization than on vertical polarization.

Making a frame, 18 by 36 inches in size, is the first step, using 1" by 1" wooden strips. Take care to make this as light as possible, yet sturdy enough to withstand bad weather. For good, secure construction, slot the ends of each strip and use small bolts.

The radiator is made by winding two turns of No. 12 wire around the center of the frame with one-inch standoffs at each corner to give the wire a 19-inch length for each side. Space the turns five inches apart; no matching stub is required at this point. The 150 ohm feedline is connected to the ends of the loop.

Construct the director by making one turn of No. 12 wire, spaced 15 inches from the center of the two-turn loop, wound on the inside of the frame with insulators mounted one inch above each corner, leaving a 17-inch length of wire for each side. A 9- to 10-inch matching stub is fastened to the end of the one-turn loop. Proper matching can be determined by varying the length of the stub. A shorting bar will save a lot of time. However, a piece of 150 ohm twin-lead can be used by experimenting with different lengths.

The reflector is formed from two sections of No. 12 wire, 10¼ inches long for each section, mounted on a 22-inch board; the first two insulators are mounted one inch apart from the center of the board, and the last two are mounted 10¼ inches apart from the inside insulators. The board is fastened on the inside, 10 inches from the center of the two-turn loop. A 9- to 10-inch matching stub is also required at this point.

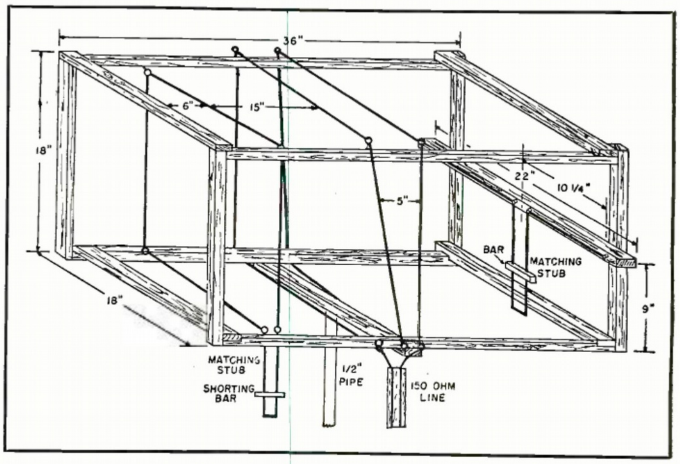
Although it was not tried, it is probable that the reflector could be a duplicate of the director if the reflector were wound on the outside of the framework to give the necessary added length.

The radiation pattern of an antenna of this type is horizontal, and parallel to the long dimension. The maximum radiation is off the director end.

Judging from experiments made with this antenna, it should perform as well or better than two five-element beams stacked.

—30—

Construction details and dimensions for the antenna. Rigid construction is necessary.



Stop Press

AFDD's - another 'official' red herring?

https://www.cibsejournal.com/technical/arc-detection-devices-fault-finding-mission/

Those ‘scope Waveforms look just like my ‘finger test’ touching a scope probe tip; the difference between an arc-n-spark (arcs = amps; sparks = kV’s); Paschen’s Law and 30kV per inch at normal atmospheric pressures (barometer so low it’d have to do 100 full turns downwards); why, and how, in real practical day-2-day scenarios, will a series or parallel arc be created?; Why won’t existing RCBO’s trip? The HF detecting trip - the ‘shoulders’ are indicative of HF oscillations in wiring L and C. https://www.fxsolver.com/browse/formulas/Paschen%27s+Law

Note (1) -

Here’s a quote (below) I found on t’internet (https://physics.stackexchange.com/questions/595577/what-is-the-difference-between-electric-spark-and-electric-arc) whilst exploring the difference between an arc and a spark - they are indeed very different beasties and should be noted:

“According to Wikipedia …. an arc is maintained by "thermionic emission of electrons from the electrodes", that is, in practice it relies on (‘thermal’ Ed.) *energy already being dissipated from the current to heat the electrodes.*

A spark can occur immediately when breakdown voltage for the [‘insulating medium’ Ed.) *air gap is exceeded and the gas is ionized enough to become relatively conductive; depending on the source parameters and overall geometry, the spark can then become an arc (the conductivity rising even more) or extinguish within milliseconds.*

Once both electrodes are hot enough, they present a constant supply of charge carriers (ions and electrons) into surrounding air. Unlike the spark, the ionized conductive channel in the arc can then survive even short drops in power input, like those occurring each 10 ms in AC network or transformer welding. It can also maintain its conductive properties even when extended to several centimetres or even metres - this no more depends on voltage, but rather on the availability of current to keep electrodes and arc's plasma hot.

Typically, an arc is extinguished similar to a flame, either by blow of fresh air, or by its own updraft that stretches it too long to keep hot enough. Both mechanisms are employed in HV power lines, where arcing is a major danger and must be prevented.”

Note (2) - the geometry of the electrodes involved has a massiove influence on the chances of a spark happening:

“While exploring different electrode types, it was noted that where the breakdown voltage was significantly reduced by using carbon rods, the AFDD’s detection of arc faults became unreliable.” NO!! Breakdown voltage is NOT a function of gap material - so long as it’s conductive it’s the geometry of the gap electrodes that affects breakdown volts. He mean “arc voltage”, NOT breakdown voltages!

One simple rule, hammered into every high vacuum engineer, is the simple fact that at atmospheric pressure in clean dry air, you need **30kV per inch** of air gap for a spark to occur; and before the spark jumps, you'll get corona discharge manifesting itself, showing as a leakage current across the gap. The inclusion of PVC (or other insulating medium) in the gap significantly increases the volts required to break down that gap; once the spark has punched through the insulating medium it leaves a trail of ionised particles which can then carry sufficinet current to create thermionic emission of electrons, thus creating a sustained arc, signified by a very low volt drop across the gap (50 - 500 volts or so, depending on the geometry and materials). That's how TIG / MIG welder arc triggers work, they usually use Tesla coil generated High voltage HF to initiate a spark, then an arc can form and sustain itself.

Does this mean arc welders on the same feeder phase nearby will falsely trip downstream AFDD's? Or how about LF / HF induced in house wiring from your transmitter?

Whilst I'm all for fire prevention - and the original IEE wiring Regulations were specifically aimed at preventing fires, using appropriately rated fuses - aren't modern MCB's and the like up to this job? The amps from a true arc being so high the MCB protective elements will open the circuit safely and self-extinguishing PVC insulation complete the job?

Costs quoted by a local electrician to me came to considerably more than £1000 for a simple 'consumer unit' change with AFDD / MCB / RCBO protection. I don't think this reasonable or required; do you?

It's Goodbye from me...

I have written and compiled Hot Iron now for 5 years; I'm most honoured to have been asked to do so by Tim Walford, the originator of Hot Iron. I'd like to thank all the contributors (and that includes all those web pages and references I've found so useful).

My health is not what it used to be, COPD - probably not helped by all the rosin flux fumes I've inhaled over the years - is becoming a big issue in my life and I have to spend more time out: it takes a lot of hours to put together an edition of Hot Iron, edit it, correct all the dud links, wrong references, checking attributes and the like.

Thank you for allowing me to drop into your (amateur radio) lives every quarter, I hope I've brought something useful to your enjoyment of this fascinating pastime. It is with regret that this is the last Hot Iron I will be editing and compiling; if another writer wants to take up the reins please contact me (equieng@gmail.com).