GATEWAY

The Official Magazine of the Gippsland Gate Radio & Electronics Club Inc A0016893M

September 2024

AntennaPalooza 2024.

Ancient Calculator Fun

Dodgy Wiring

And More

WIA Affiliated Club

Cover photo,. WICEN talk at the 16/08/2024 meeting.
(If you have any good photos, please send them in)

Contents.

Event Queue

September:

20th.	8:00	General Meeting

October:

4th	7:30	Prac night
5th.		Oceania DX Contest, Phone section (wia.org.au)
12th		Oceania DX Contest, CW section (wia.org.au)
18th.	8:00	General Meeting

Club run events are only possible with the involvement of ALL members.
Without volunteers to coordinate and participate in club events the club will fail to prosper

President's Report September 2024

Greetings All

So over the past month like with the previous month a lot has been happening. Some items, not so obvious to members.

As usual I would firstly like to welcome new members to GGREC. Our newest member, being Peter Collie (VK3HX). If you see him around the club please give him a warm welcome.

Back to business, let's start with the obvious first.

Wednesday 10am coffee mornings are still taking place and this has helped members who can't turn up to Prac or General Meetings due to various reasons, meet face to face with other club members.

Speaking of Meetings, at the September Prac meeting, Steven Schnitzler (VK3OZI), kindly gave a practical demonstration on how to load and get working (without the pain) the very popular HamClock 3 onto a Windows 10 laptop. Previous prac nights have covered HamClock 3 and all it has to offer but using the raspberry Pi.

At the last General meeting (GM) mark Hudson (VK3MDH) gave a talk on the valuable role the Wireless Institute Civil Emergency Network (WICEN) play if called upon, during natural disasters and community events such as car rallies etc. We thank Mark for giving up his valuable time to do this and for Bruce Williams (VK3BRW) for organising this.

Behind the scenes Ian (VK3BUF), Mark (VK3PKT) & I (VK3FWR) and others are still working on getting Echolink up and running, just waiting on the arrival of two new Xtals to arrive. We are also looking at repurposing some of our existing repeaters. For example swapping out the repeater equipment VK3RGW with the analogue set and setting a DMR Brandmeister repeater with the VK3RGW equipment.

We are always looking at ways of raising additional funds for the club. These currently include, but are not limited to Bunning's sausage sizzles, Hamfests, car boot sales, council grants and renting a table at other club hamfest's, to allow this club (and its members) to sell their excess equipment. This helps the club to purchase new equipment (E.G. New HF equipment, to be installed soon), carry out maintenance and to pay our never ending ongoing bills. Without having to increase our membership fees going into the future.

To finish up we need volunteers to do a shack cleanup on one of the upcoming Saturday's (to be announced). A BBQ will also take place on the same day to feed the masses .And a reminder that other volunteers are still needed for future sausage sizzles and Field Days. Let me know if you are interested in helping out at any of these events.

Fred VK3FWR

President GGREC

From The Editor

Antique Speakers

Many like collecting old valve radios; however that brings a problem, how to feed them. These days I find all but zero draw to the broadcast radio bands, I more liked the shortwave bands, however that is kind of hard in the QRM hell hole that is suburbia these days. Trying to pick up a signal without any local interference is a challenge to me. It used to be just fading and other stations encroaching on what you want to listen to.

To me the rot really set in with plasma TV's, how were these allowed to be produced with no intervention from the authorities? I have an old TRS-80 computer, in America these were fairly quickly identified as a big source of QRM and Tandy were told to fix it. Unfortunately the only real fix was to start from scratch, so they did, bringing out the model 3. They probably could have redone the model one's PCB, but that still left the interconnect between the main box and its expansion box, needed for floppy drives etc., just a great pile of QRM antenna's. So if this computer received the wrath of the authorities, how did all those plasma TV, and other (don't get me started on LED bulbs) horrors get past them? Was it more of what happened to the radio inspectors over here, where their numbers just dwindled to the point that keeping tabs on consumer gear was all but abandoned?

Once when working on that computer, I touched a multimeter probe onto one of the supply lines that went around the outer of the PCB and was shocked to see a reading on the meter as I had yet to probe anything with the meters other lead. I had a reading on an analogue meter from one wire! Needless to say, integrating my computer hobby with my radio hobby was a real challenge back then, as only the strongest stations survived.

So, getting back to that speaker, my 'antique' interests are more aimed at speakers these days, although a good clock will easily draw me away. Speakers are so much easier to feed with my audio selections than a radio, to get that yesteryear vive. I have an old Philips 'HiFi' speaker from the '60s, among others, (boy did they not seem to know what they were doing back then) however they don't have any nice woodwork etc., like the "Brunswick" speaker above. (Brunswick, that's just down the road…) Unfortunately this is an American job that I spotted in a YouTube antique radio collection deceased estate sale. I used Google image search to find out what it was. They do pop up on auction sites, sometimes for not that bad a price, until you add the Australia tax & shipping, then I tend to think, oh 'maybe another day.'

Later on I saw a very ornate speaker box, as in carved legs etc. etc. It appeared to have been kind of mass produced 'back then' for the burgeoning radio market, however this one was never used, never having a speaker (or a radio) installed… - darn old auction, long closed, and of course overseas again (America?)

Maybe I should join the HRSA https://hrsa.org.au/ or AVRS https://www.avrs.org.au/ they have auctions etc.

Paul VK3TGX

ANTENNAPALOOZA 2024

November 29 – December 1 in Drouin West

An update by Ian Jackson VK3BUF

At the next Antennapalooza in November, the theme will be Wire Antennas. This is an opportunity to do something interesting.

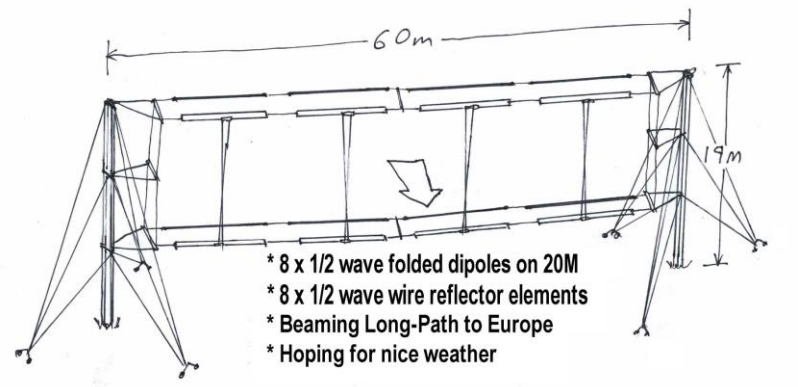
A few readers will remember the demonstration Rhombic antenna we put up in 2016. That was a bit of a monster, but a lot of fun. It was 71 metres wide, 135 metres long and sat on top of four 12 metre high guyed posts made from 90mm PVC tube.

It was thought to be pretty stable and would easily withstand 70 Kph winds. Unfortunately, two days before the event, a big storm with 80 kph winds came through and smashed all the posts. Undaunted, we made repairs and it all came together in time. Lessons were learned. Obviously it wasn't high enough.

The completed 12 metre high rhombic antenna on 40 metres. (wire radiator enhanced for clarity)

I have always been fascinated by some of the large broadcast antennas of yesteryear. These were the Sterba curtains and Bruce Array's with their 100 metre high poles. These are not suburban friendly Amateur antennas. This year, just to be different, we're going to put up a demonstration Curtain Array on the 20 Metre band. Some quick back-of-envelope maths reveals that the ideal model is really huge. So we are going to put up a baby Curtain Array as a temporary installation, just in time for Antennapalooza.

This compact Curtain Array will be sixty metres long stretched between two guyed posts, 18 metres high. Effectively it is eight half-wave folded dipoles on 20 metres with wire reflector elements.

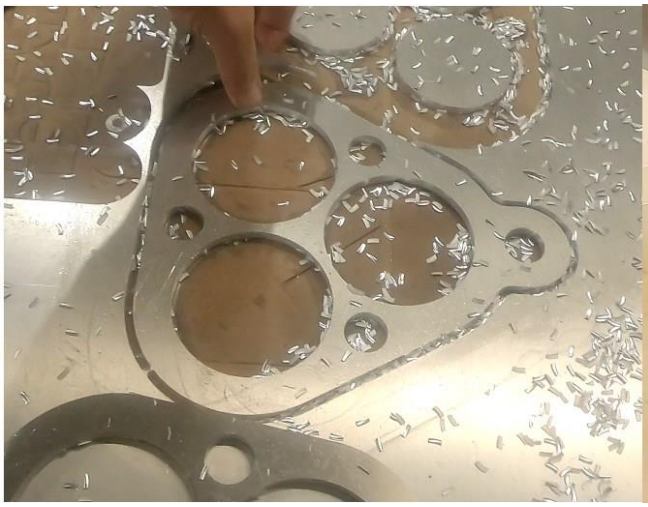


With luck, it will look like this adjacent sketch, only better. I don't have a rotating 3D CAD model to show, but I did find another old envelope and a pen.

'Where to point it' was the next question to resolve. In this instance we settled on Long-path to Europe. Hopefully someone will be home in Europe on that weekend.

Temporary 18 metre high poles were something of a design challenge. With the 2016 Rhombic antenna we totally learned our lesson from using stacked single lengths of plastic drain pipe. This year we will used *three* 6M lengths of 90mm plastic drain pipe, arranged in a triangle, stacked 3 high and guyed at three points with plastic rope. A total of 18 lengths of pipe. It will be an invincible combination.

The masts will need good guying points and an anchor point for the pulleys to hoist up the antenna like a sail on a tall ship. Six guy plates were designed for the 90mm pipe and have subsequently been cut out of 6mm alloy sheet. That process is complete and creates an ironclad impression that it will work ok.



The other end of the guy ropes will need something in the ground to tie to. On order are a set of Ground Grabba screws. Used in pairs, these screw into the sub-clay and definitely, probably, they should be fine.

This brings us to the guy ropes and curtain dipole support cords. The project is going to need a lot of rope. I have purchased about a kilometre of telecom rope from that well-known quality supplier, Ebay. The seller said that it ought be good for at least the average Category 4 cyclone.

The antenna itself is going to need a lot of spacers and termination points for the folded dipoles. For this task a bunch of circuit boards have been designed and ordered These will be machined out of 3mm fibreglass pcb material and are now on their way from a Chinese PCB company.

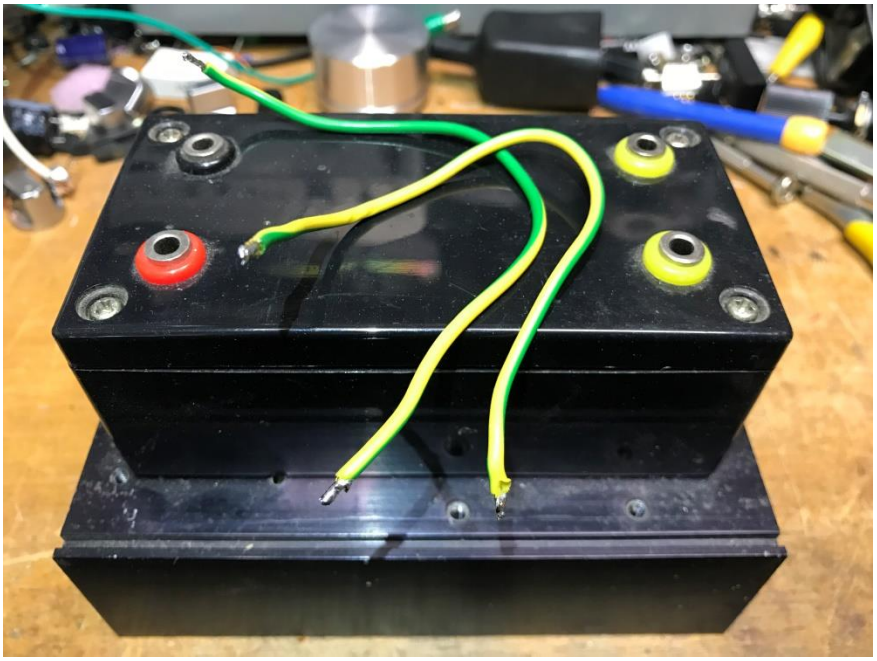
At some point this antenna has to connect to a radio. Broadcast stations use a lot of open feeder lines looking like giant guitar strings on sticks. That seemed like an awful lot of work to get right. For our antenna, I figure that each of the four dipole pairs can terminate in a toroidal balun that will bring the pairs back to 50 ohms unbalanced, then hook them all up with a manifold feed system of half-wavelengths of RG58. There is undeniably some real science in there somewhere.

The plan is to put this thing in the air mid-November, perhaps with the help of some stoic volunteers. As yet, the method of standing up the poles hasn't been finalised, but there is bound to be some alcohol assisted inspiration that will rise to the challenge at the appropriate moment.

Will it work? Definitely, absolutely there's a very good chance that it will. Come to Antennapalooza 2024 and we'll find out together. This year, the weather will be perfect *. Follow the Antennapalooza website for details. https://antennapalooza.net.au/

* maybe

Dodgy Wiring



Recently I thought of connecting a LED light to my garden lighting system, problem was the light needed 12V DC whereas the garden lighting system runs on AC. No problems a couple of diodes won't fix, however to be sure all will be happy I thought I'd jury-rig it first to be sure.

In my pile of castoffs I had this 'test' rectifier box, no idea who made it, or why, it was more of less on my 'to be stripped' pile, however it seemed kind of useful so has been spared for now.

All worked well, the light was happy with that very rippley 12V feed, however it left me wondering what was in that box, so curiosity getting the better of me, I had a look. The bridge rectifier inside was way smaller than I expected, probably a 10A job, (you'd think 50A given the size of the heatsink) however it was the wiring that really caught my attention, they had used yellow & green earth wire for the AC side of things.

To me this is a BIG NO NO, whilst this thing is incredibly simple and unlikely to spark any accidents, I have seen what can happen when you use wire intended for 240V mains on anything else. I promptly ripped it out and replaced it with some white 'lamp flex'

Many years ago I (Telstra/Telecom Australia) received these 'data/modem' boxes that were intended for telephone exchanges. Like anything made for that environment, it was designed to run off of 50V DC. Trouble was the manufacturer had cheapened out and supplied mains flex as the power lead for these. They had put Red and Blue heat shrink sleeving on the far end (Red and Blue being the standard Telstra colours for 50V DC power). Now I'm kind of guessing what happened next, someone installed the box into a rack at an exchange, then the power lead was trimmed to an appropriate length (losing the red & blue sleeving), then later on another tech came along, identified the grey cord with brown, blue and Yellow/green wire as 240V flex, fitted a 240V plug and plugged it in…. kapow, out with the 'magic smoke'. Having several people work on an installation is fairly common, it was probably installed as part of a much bigger works. Some stand up the racks, then other put the gear into the racks, then comes more to wire it all up, followed by systems testing and commissioning.

In another story (probably more at home for members) a hobby fisherman liked taking a ghetto blaster out in his boat; this radio ran on either 240V, or batteries. He noted that it used 12V worth of batteries, so he connected a cord to the battery terminals so he could run it from the boats 12V system. Of course, like many back then, he used a regular mains plug for the DC feed (I've seen these used for connecting trailers to cars, and for phones before the post office used plugs).

Then one day after a fishing trip he dropped all his kit off on the kitchen bench, then his wife wandered by and though she'd like some radio music, so she picked up that lead and plugged it in……. another Kapow.

Back to the 'post office' bit, as a trainee at Telstra, in the training school we received a large box of old black Bakelite phones, one had a 240 volt mains plug attached – that's how home owners made the phones 'portable' back then, Anyway we were all daring each other to plug it into a mains socket – until someone opened it and realised it had already being done, oh well too late to that party – I'd hate to hear the 'line buzz' if I lifted that receiver…. smoookin

On a more naughty front when I was a little one, dad made me up a switchboard box, it contained a 12V Scalextric transformer, on the front were a few switches and a nice rheostat that I could use to cut the 12V down to what was needed by torch bulbs etc. Of course he used a 240V socket on the front panel for me to connect things too, back then electronics stores were a rare beast indeed, long before we had Tandy and Dick Smith, but quite a bit after the age where you had to build a radio if you wanted one, so just your local hardware shop, and the odd TV repair shop, of course none of these could supply anything useful for this switchboard.

We had a back yard shed (gazebo) where me and by brother Mark played around. I had my switchboard on one side, he had the other. Anyway he made up a 'light fixture' and fitted a torch bulb, he then connected it to a lead we had running from one side to the other and asked me to plug it into my box. Me being a bit mischievous shoved it straight into a 240V outlet. The bulb promptly exploded, but in a rather bizarre way, the glass envelope was blown free from the screw base, where it shot over my head and bounced off a wall, the glass envelope was intact along with the filament inside….. Mark was not impressed – I can't remember how he got back at me. Probably stuck his boot up my …… So definitely not the right connectors.

How many times have you made something and put it into storage, several years later, or maybe in someone else's hands, the fact that that socket, or lead is not intended for 240V has been all but forgotten, then comes the inevitable accident – what's that Queen song "Another one bites the dust"

However there is an extra twist here, none of the wiring etc. inside that box is probably rated for 240V, and most likely there is no isolation, no safety ground, double insulation etc. etc. either, so the chance that the case, or any metal surfaces on it can then become live is very high, so for safety's sake, just don't do it.

If it even remotely looks like it's intended for 240V, then don't use it for anything else.

Or if you really really have to (power cord test box etc.) then make sure it can safely take a 240V feed without doing anything stupid – like catching fire, or electrocuting someone.

Paul VK3TGX

Micro Controller History

Whilst you've probably seen the odd microcontroller, Arduino, Raspberry Pi, etc. have you ever wondered where this all came from?

Almost for the complete history of computers, they have been connected to sensors, probably the biggest and craziest cases was NASA and the Apollo moon landings. The launch tower and rockets were covered in sensors, these were all wired back to computers, with the results being displayed on the screens at the Houston control centre:-

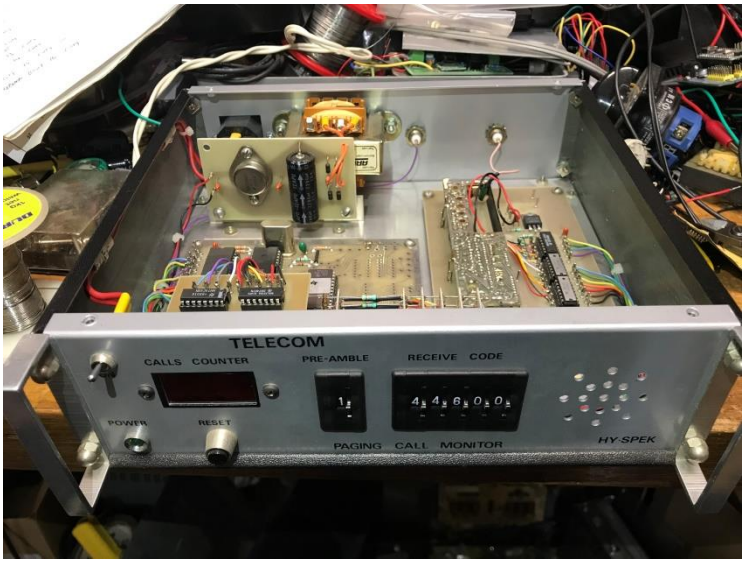
https://spacecenter.org/news-center/digital-assets/apollo-mission-control-center/

So what were they using for the 'Micro-controllers'? Well IBM mainframes none the less, there was not much else out there. Trouble was they were not exactly compute power houses, so they had heaps of them, all doing real time data collection, throwing the results onto dumb terminals, whose images were then relayed onto all the screens above. Actually basically every screen had a little 2 digit display to the top left of each, this was basically a channel number display, and you could change it to show whatever screen you needed.

I seem to remember being told the main controlling mainframe had something like 32K of memory, it was pretty much flat out running the whole show.

They actually did have smaller computers, for instance in the lunar lander or LEM, they almost came to grief at one stage as the poor processor was getting overwhelmed with data and kept throwing up error messages of such, just what they needed on final descent to the moon!

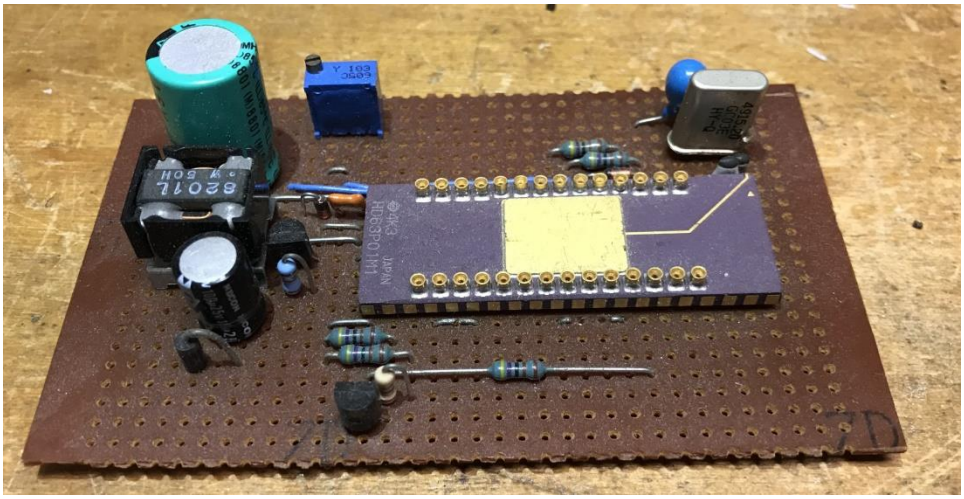
So what about the small boys, like you and me, well you basically had to build a more or less full blown computer, here is a board from a Telstra box, two 6820 I/O (input/output) chips giving you 32 I/0 lines, so not too shabby here, however that's all digital, the 6820 has no analogue abilities at all. Whilst this board has no serial port, one can be added by populating those empty IC positions with a 6850 ACIA (Asynchronous Comms Interface Adapter), more commonly known as a UART, along with 1488 & 1489 RS232 drivers and a good old 555, bottom left, for the serial clock source. Actually this is a later board, as it uses the 6802, a later derivative of the original 6800, the 6802 contains 32 bytes of internal RAM as well as all the clock generation logic, which would have added quite a few extra IC's to this board for a minimalist build – as in the minimum needed for a usable board.



This is what that board is in, a Telecom pager call counter.

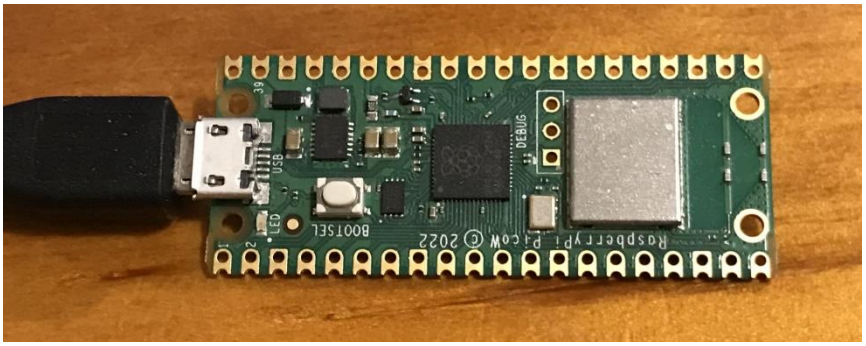
All but useless these days, however it's really well built, so a shame to just chuck, so I'd like to convert it into something usable to me, if just a novelty box that sits over in the corner going 'ping' every so often, to steal a line from 'Monty Python'

This was all in the era of the 8 bit processor, before that we had four bit chips, with the first chip processor being the Intel 4004, which was originally designed for a calculator. The actual company building the calculator did not ask for a processor driven design, however the Intel engineers came to the conclusion that this was the best way forward. It would be an interesting chip to play with, however they are exceedingly rare – who keeps old calculators?

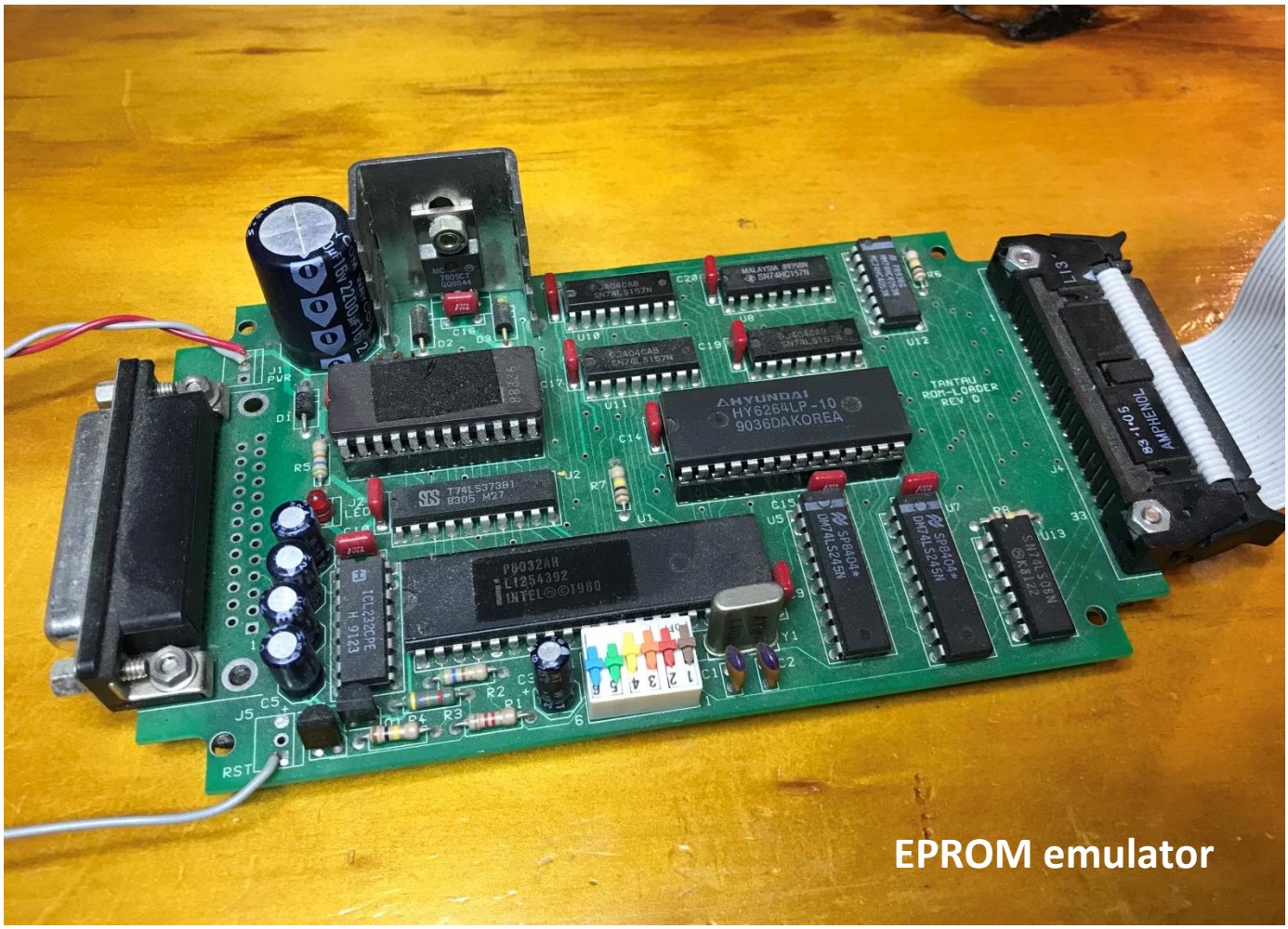


Somewhat later on Hitachi produced the 6301, this family had all you'd need on chip, all you needed to add was a crystal, 5V, and a simple reset circuit, the chip shown here the HD63P01M1 was more intended for prototypes, the main ones had onboard factory programmed ROM, with this one you add your own EPROM, meaning most of the legs are I/O ports, however they can be started in several modes, so even if you score one of these with some useless to you hard coded ROM contents, you can start it up in another mode and the internal ROM will be ignored. If only other more modern factory programmed chips could do this, as once they are programmed in the factory, that's it – unlike modern chips that can be re-flashed, these cannot. Another twist was chips that had regular EPROM type storage; however they have no window to allow for UV erasure, making them one time programmable – all to save the last cents used for the window.

Here is a 6303 board courtesy of Ian VK3BUF, I can pop in the 6301 from above and it will run as if all that EPROM stuff didn't exist, with a full external data & address buss. Whereas the top one has nothing external, making for a more compact device.



So this is where we kind of are now, this is actually a completed project, it receives time from the internet, then feeds it out the USB port as if it were a GPS time receiver, handy when you have no clear sky access for a real GPS.



So how does one program these, (older systems) they are usually older than USB, so no just plugging it into a PC and playing with flash memory.

Whilst larger network etc. boxes often booted from floppy disks and often just contained a regular computer board – smaller devices, of the type I'm more talking of here usually store their code in EPROMs, Erasable Programmable Read Only Memory. You pop a blank chip into a programmer then load you code into it, then you plug that EPROM into your target system and hope it works. Of course when your designing something, that is highly unlikely. So you better have a good stock of EPROMs and a UV eraser handy, as you can easily go through a dozen chips in no time flat.

That's where this board here comes into play, it's an EPROM emulator, it plugs into your board in place of the EPROM, and has a serial port allowing you to quickly change the code without burning any EPROMs.

The other way was to make a development system, usually with a lot more RAM than would be needed in the final device, and also with a serial port. In this setup the EPROM is loaded with a 'monitor program' this allows you to talk to the system from a terminal, and to load code into that extended RAM, and then run it. Often the monitor program will allow you to single step a program, set break points and examine memory and processor register contents so you can see what's going on. In my 6301 board, you obviously cannot add RAM, however you could use Ian's 6303 board with 8K of RAM to get things running, before going back to the 6301 single chip.

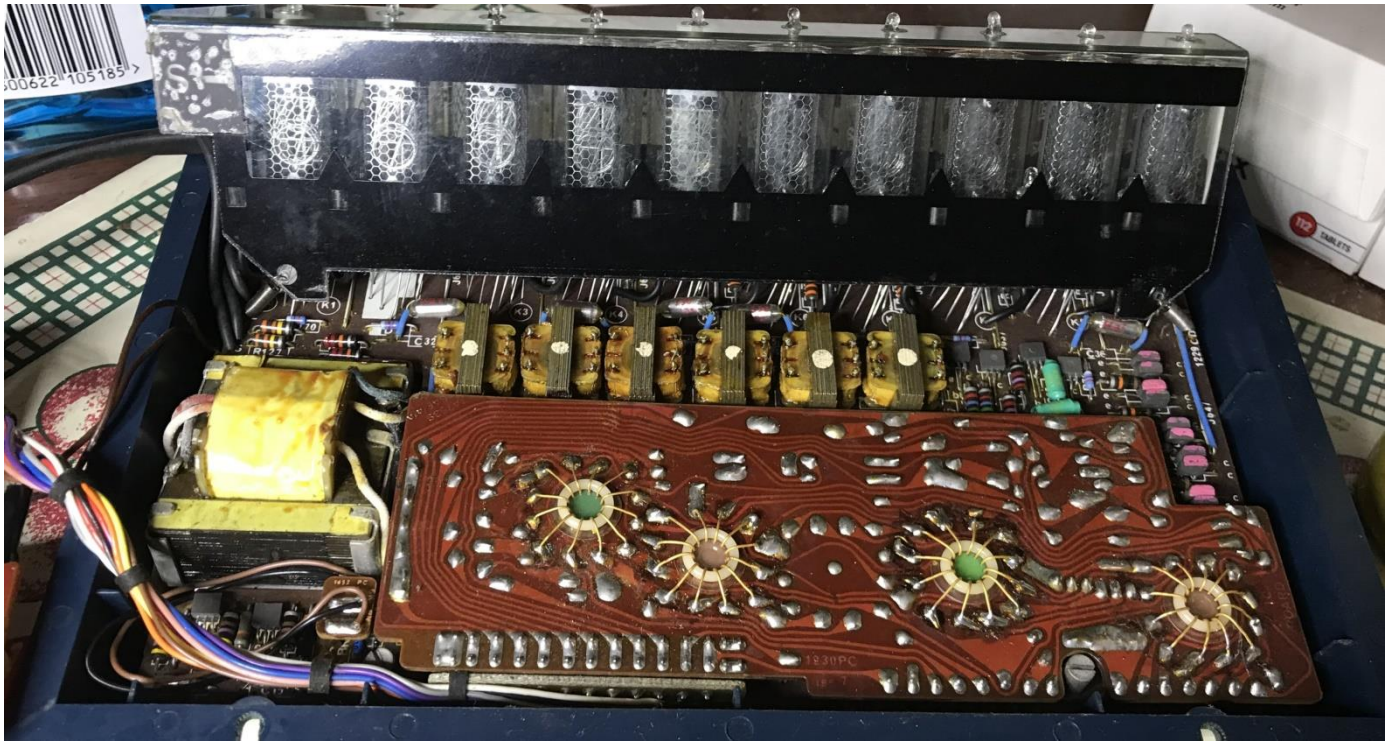
Paul VK3TGX

Ancient Calculator Fun

In writing my “Micro Controller History” bit, I mentioned early calculators, as in pre the processor, I was going to put in a picture of my old Anita calculator, unfortunately I could not get it to run, even after sorting out it’s frozen switches with a can of contact clean and lube.

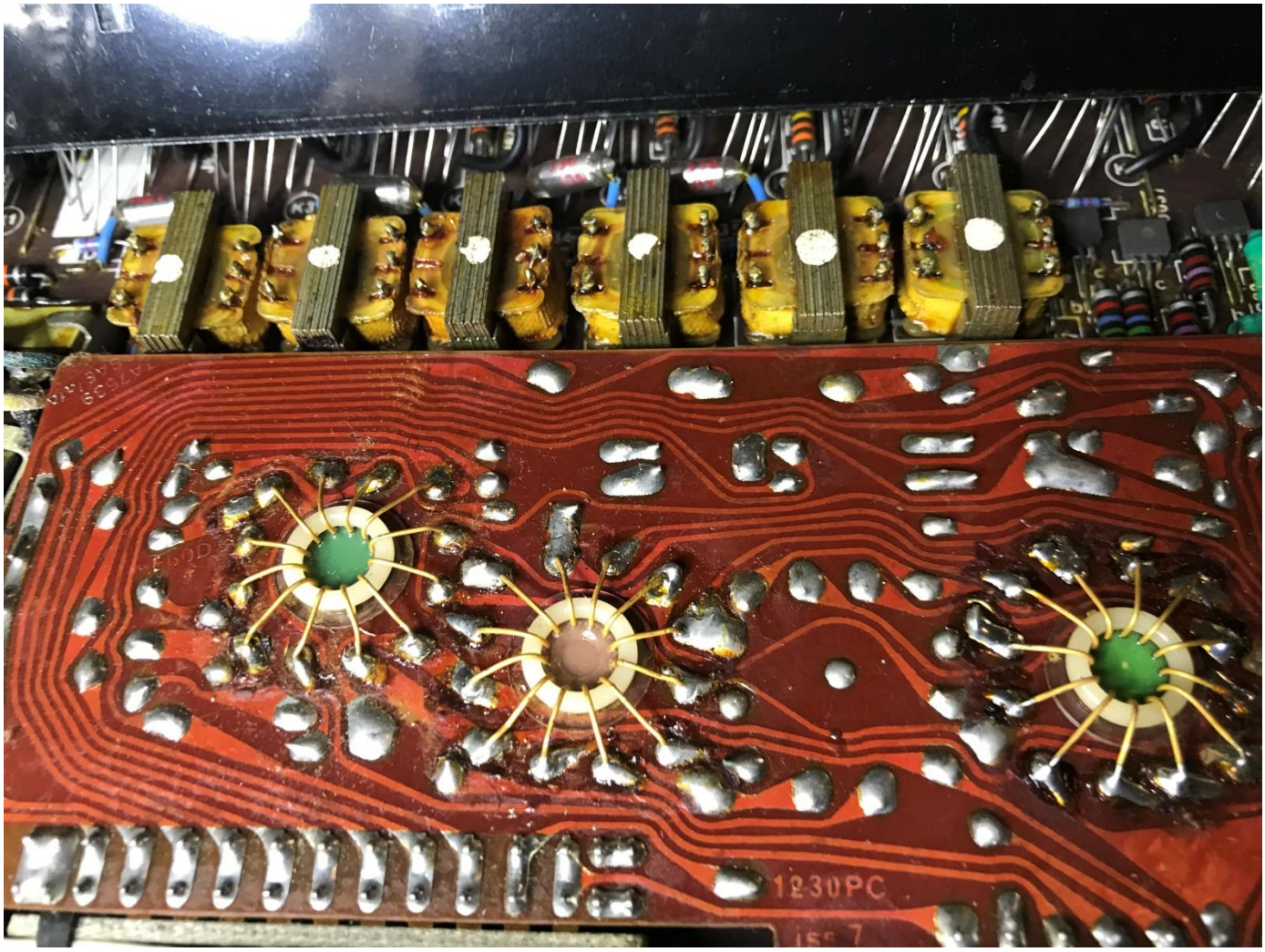
The switches (lower right) now are back to their former glory, however the screen remains blank, darn, so here, a few pictures of the insides of this beast, a Sumlock ANITA 1011 LSI calc.

Underside of the keyboard, the power switch was frozen, with awfully thin wires for 240V. Four screws and the keyboard was free of the front cover, giving me a touch more access to the two switches. A squirt of clean & lube then leave it alone for a while did wonders for them.

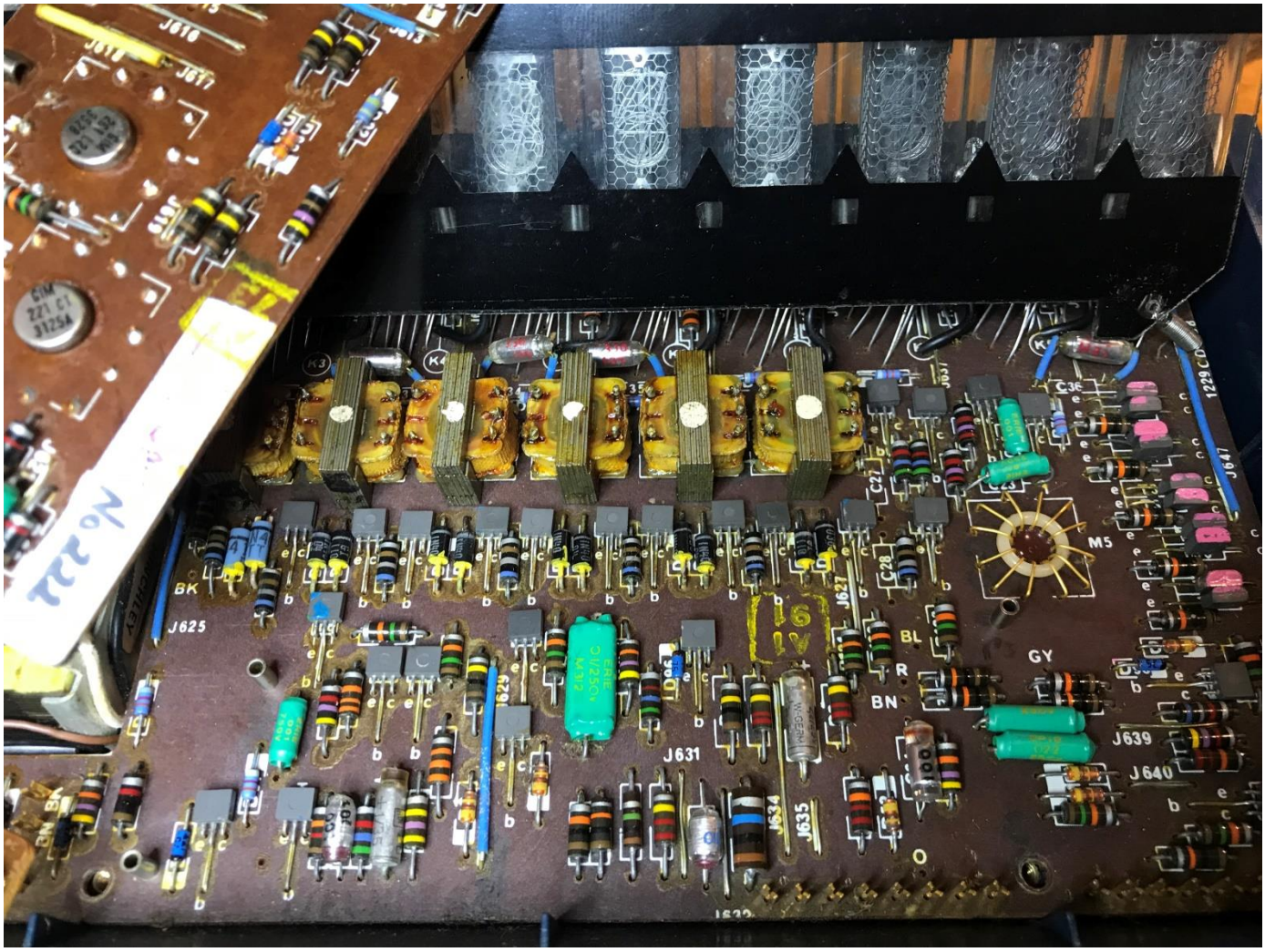


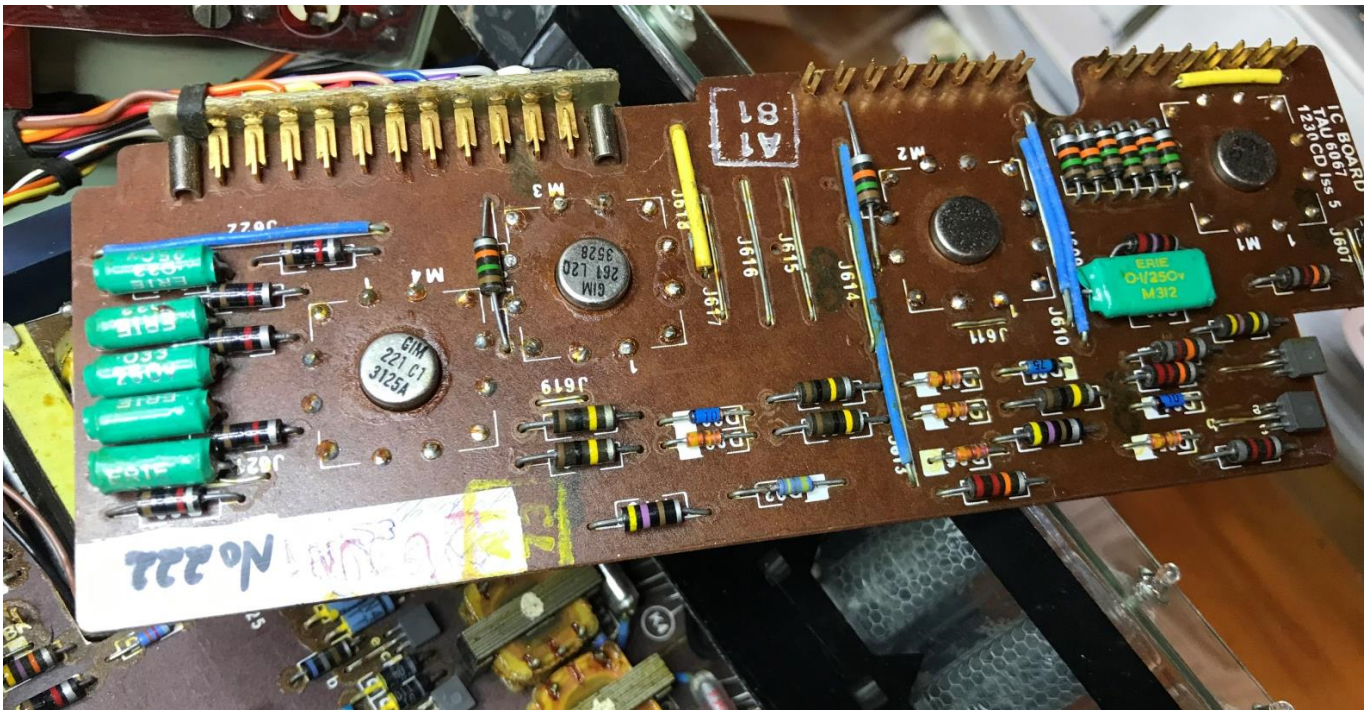
Bottom view, whats the go with those transformers? 6 for 10 Nixie tubes, the mystery deepens

On my dim bulb tester it makes a 15W lamp glow, so it is getting power, just not much.



Absolutely nothing like modern builds, I've never seen that chip package used for logic, just op-amps and matched transistor pairs, They must be doing some crazy multiplexing as 5 by 12 pins does not give you anywhere near enough I/O for 10 Nixie tubes and a keypad….





You wouldn't believe the bottom, covered in patent numbers, made in England, Serial number LM 110024. 24th off the line?, that's nuts.

So how did they do it? Sometimes it is interesting & educational to explore old circuitry to try and figure out how they did what they did. These days we are all very spoiled with modern tech like the lates Raspberry Pi pico2 shown in the 'YouTube' links last month, tasks like making a calculator seem so trivial, why would anyone bother. However as has been proven, there are calculators and there are calculators, and there is some rather simple tests you can run through one that more than likely bring it to it's knees and make you question why you ever trusted it.

In reading up on the Anita before publishing this I noted that one of the early pioneers made a point to highlight the fact that his calculators did everything in decimal numbers, not binary, without then having to convert it for users to read.

```
Buffer 14 Delay 0.161
Buffer 6 Delay 0.16
Buffer 12 Delay 0.168
Buffer 4 Delay 0.17200000000000001
Buffer 10 Delay 0.165
Buffer 2 Delay 0.161
Buffer 8 Delay 0.162
Buffer 0 Delay 0.169
Buffer 6 Delay 0.17200000000000001
Buffer 12 Delay 0.165
```

Here is some very simple python code output, with its crazy glitches.

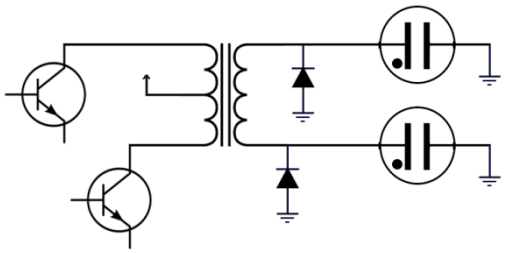
The code is basically a software PLL trying to generate a steady data stream, rather than a bursty one, emulating 50bd RTTY.

My interest was more on how they were driving the Nixie tubes, many say you cannot multiplex them, however it looks like they did it in this case.

Many moons ago I made an experimental Nixie counter, I had made a simple one transistor oscillator based around a small audio coupling/output transformer, it was producing some nice high voltages that easily lit a neon bulb (later I was throwing 7CM speaks from 2 9V batteries!) so could this drive a Nixie tube? The answer was yes, the whole thing runs on 5V courtesy of a 7805, so USB powered Nixie, no probs. As a side benefit I can easily handle that board whilst running and receive no nasty/lethal shocks that you get from a traditional 190V DC design.

Now if that inverter was driven from a micro, then I could easily blank the tube, something not possible with a traditional 7441 build as it cannot withstand 190 odd volts, so they made sure the tube was always lit (by having no blanking function), meaning the IC only saw about 70V.

Now if I take that transformer, with its centre tapped primary, make the centre tap common then pulse either side I can have a controlled alternative pulse high voltage generator, and with a pair of diodes steer that into two Nixie tubes, as per this simplified diagram here.

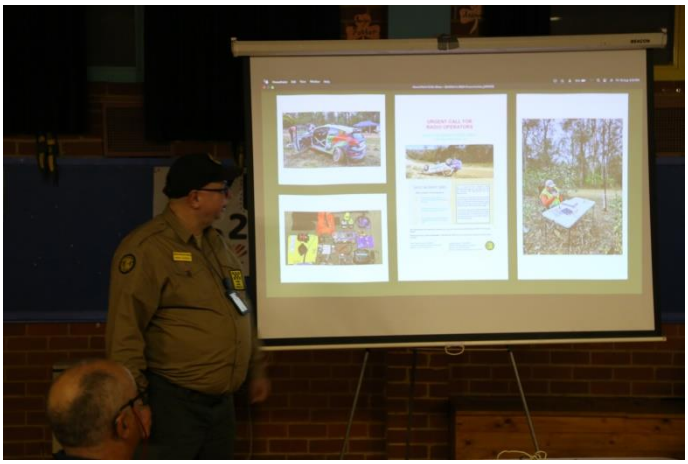


I can choose which lights, so replicate this 5 times and I have a 10 digit multiplexed display which looks like what they did.

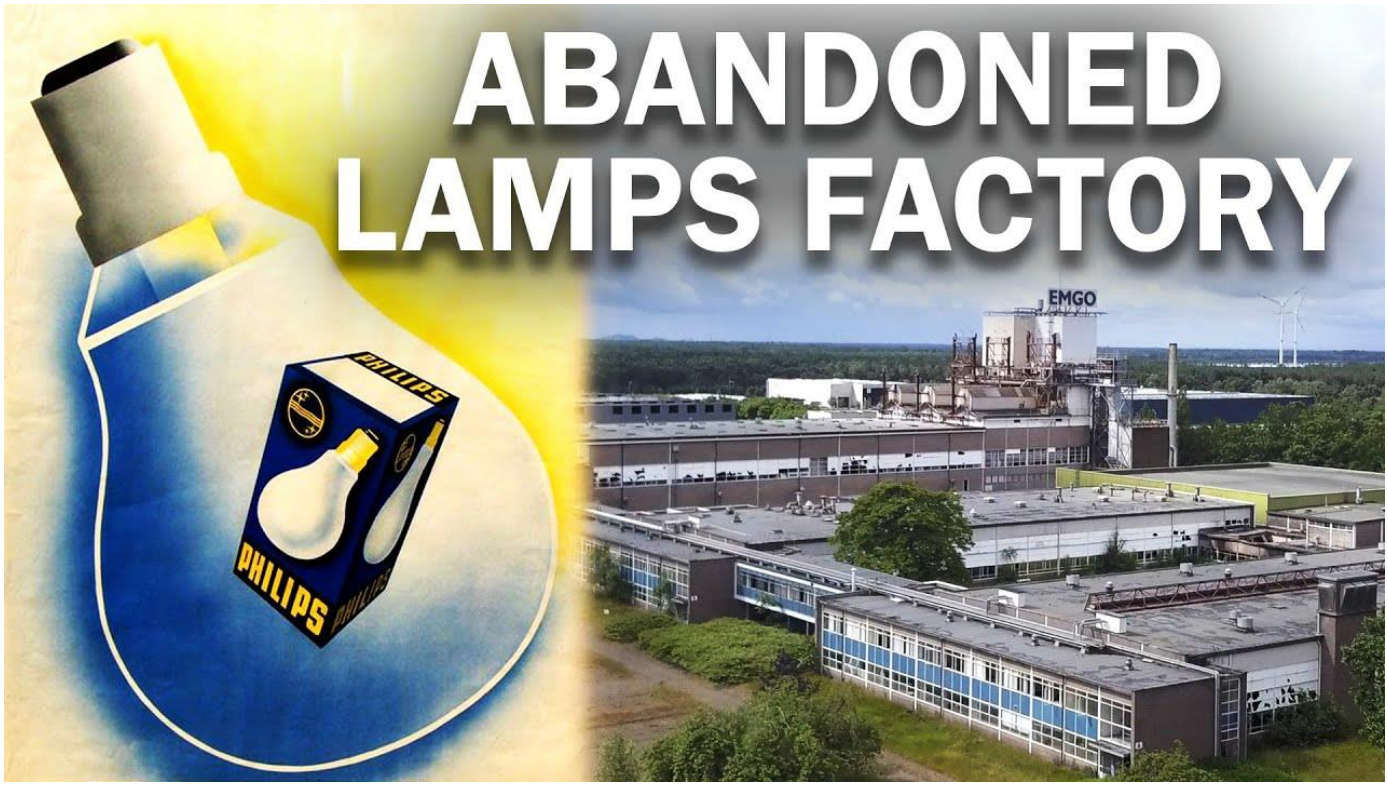
I have a nice row of Nixie's out of an old bit of test gear, driving them now looks a whole lot easier, and safer…

Paul VK3TGX

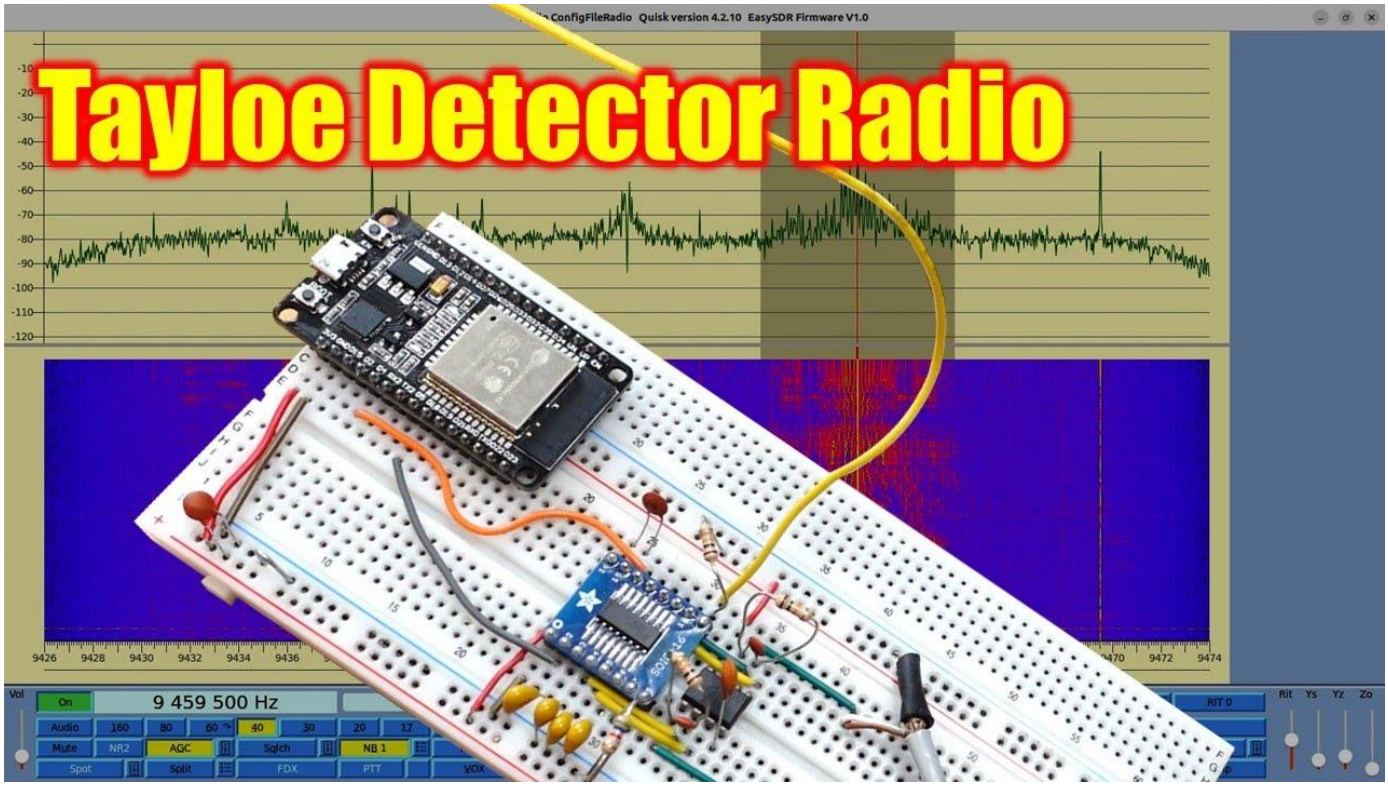
Meeting 16/08/2024



Interesting YouTube Videos



The Downfall of Philips - Exploring an Abandoned Lightbulb Factory
https://youtu.be/PW07pky-_sQ



Super Simple Breadboard-SDR Receiver from 50 kHz to 30 MHz
https://youtu.be/HCDi5qV1cmU

WIA Affiliated Club

The GGREC is an affiliated club of the WIA
https://www.wia.org.au/

We also give Thanks to

Jaycar Electronics

https://www.jaycar.com.au/

ALTRONICS
Build It Yourself Electronics Centre®

https://www.altronics.com.au/

For their generous support over the years

Club Information

Meetings 20:00hrs on third Friday of the month at the
Cranbourne Guide hall, Grant Street Cranbourne
Prac/Natter nights first Friday in the Peter Pavey Clubrooms Cranbourne 19:30hrs
Visitors are always welcome.

Office bearers

President	Fred Reid	VK3FWR	General 3		
Admin Sec	Klaus Illhardt	VK3IU	Web Master	Mark Clohesy	VK3PKT
Treasurer	Bruce Williams	VK3BRW	Magazine Editor	Paul Stubbs	VK3TGX
General 1	Leigh	VK3FACB	Property Officer	'committee'	
General 2	Ian Jackson	VK3BUF	Assoc. Secretary	Bruno Tonizzo	VK3BFT

Call in Frequencies, Beacons and Repeaters

The Club Station VK3BJA operates from the Cranbourne Clubrooms.
6m Repeater Cranbourne VK3RDD, In 52.575 Out 53.575 CTCSS none
70cm Repeater Cranbourne VK3RGW, In 431.425MHz Out 438.425MHz CTCSS 91.5Hz
VK3RGW Repeater supports Remote Internet access (IRLP), Node 6794 **offline**.
70cm Repeater Seaview VK3RWD, In 431.575MHz Out 438.575MHz CTCSS 91.5Hz
Simplex VHF - 145.450MHz FM, Simplex UHF - **TBA**
VK3RLP Beacons 1296.532MHz & 2403.532MHz **(currently offline)**

Membership Fee Schedule

Pensioner member rate $40.00, Extra family member $20.00
Standard member rate $50.00, Junior member rate $25.00
Fees can be paid by EFT to BSB 633000 - Account 146016746
• Always identify your EFT payments
• Membership fees are due by each April Annual General Meeting (AGM)

Magazine Articles to editor@ggrec.org.au Cut off, 10th of the month
All other Club correspondence to: secretary@ggrec.org.au
or via post : GGREC, 408 Old Sale Rd, Drouin West 3818
GGREC Web Site & Archive may be viewed at: www.ggrec.org.au
Website errors, contact web master: webmaster@ggrec.org.au
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