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12

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Work, Part 2

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Triple Fan Controller
With Speaker Protector

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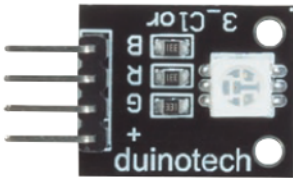
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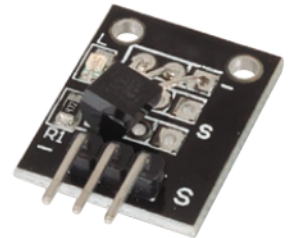
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The second article in our series on batteries covers upcoming technologies being researched, as well as detailing the 'tried and true' lead-acid battery and some other unusual battery types.

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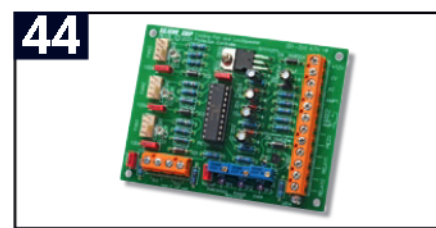
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If the controller for your sliding or swinging electric gate fails, replace it with this very reliable Gate Controller. It can be triggered remotely or via a local button, and it even stops the gate if it encounters an obstacle.

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Editorial Viewpoint



Be wary of devices that require apps to work

Devices controlled by mobile phone/tablet apps might seem convenient on initial inspection. But they can suffer from a range of problems that often make them inferior choices.

The first problem is that many of these apps are buggy (sometimes to the point of being useless) and can also have compatibility problems. It's incredible how apps from multi-billion-dollar companies can be so flaky. For example, many aircons now have apps to control them, and these can be very hit-and-miss in operation, even though the unit itself might cost thousands of dollars.

Then there are those compatibility problems that might mean that the operating system on your phone or tablet is too old or too new to work with the app. I've run into this on more than one occasion, being able to install and use the app on some devices but not others.

Worse, after a few years (possibly not even that long), the company will inevitably decide that they no longer want to update/support the app, so you will be unable to use it on the latest mobile operating systems. This leaves you with the unpalatable choice of either sticking with an older operating system version, resulting in a range of severe security problems, or upgrading and losing support for the app.

One member of our staff previously bought a Belkin remote-controlled power point controlled by an app on his iPhone. Belkin decided to stop updating the app, and now the device is a useless piece of eWaste. You might expect that from brands you haven't heard of, but I thought that Belkin was a more 'upmarket' brand.

This is a huge problem for iPhone users because the only way to install apps (unless "jailbroken") is via the App Store. So there's no way to get a suitable app on your phone once the manufacturer decides to drop support. With Android devices, you can install a .apk file if one is available – but the compatibility concerns still apply.

And now there is news that the company (MyGnar Inc.) behind the expensive product called the GNARBOX has gone bust. This is a device costing upwards of US\$500 that is used to back up photos and videos from your phone without you needing to carry around a computer.

Guess what? It works via an app, and now that the company has gone under, it has been pulled from the App Store. So even though you can still buy a GNARBOX, you can't use it if you have an iPhone or iPad!

Louis Rossmann* posted a video on this at <https://youtu.be/Elsbcyok6jA>

This puts retailers in a precarious position; presumably, they have already paid for their stock of GNARBOXes, but now they will be in legal trouble if they sell them because the marketing claims for that product are no longer valid. Similarly, many GNARBOX owners now effectively possess expensive bricks.

This will have to give anyone pause in future when they consider purchasing a device that can't be used without a specific app. All hardware devices should be able to be used in a 'standalone' mode, and I also think they should stick to using 'standard' access protocols such as HTTP over WiFi, avoiding the need for device-specific apps and all the problems described above.

* While his electronics knowledge seems a bit limited, Louis is very skilled at computer repair. His YouTube videos on Macbook repairs are often fascinating and entertaining. He also makes some excellent arguments in favour of the Right to Repair, a subject we reported on in detail in the June 2021 issue (siliconchip.com.au/Article/14881).

by Nicholas Vinen

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The PicoMite BASIC Interpreter; January 2022



Hummingbird Amp; December 2021



Raspberry Pi Pico; December 2021

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RADIO GIRL

BOOK REVIEW BY NICHOLAS VINEN

“THE STORY OF THE EXTRAORDINARY MRS MAC, PIONEERING ENGINEER AND WARTIME LEGEND” WRITTEN BY DAVID DUFTY.

In 2020, the now late Gary Johnston, owner of Jaycar Electronics, sent me this book along with a letter that reads, in part:

I really loved the book and read it in one sitting.

It really touches the history of hobby electronics and Amateur Radio in Australia. Mrs Mac as she was known was not only a technical person, she was an entrepreneur. She opened a hobby electronics shop and started Wireless Weekly – the precursor of “Radio & Hobbies” and [its later manifestations].

That’s a pretty resounding endorsement from Mr Johnston. His ex-Boss, Dick Smith, also clearly enjoyed it very much, based on his published comments. I regret not having time to read the book until recently.

It is essentially a biography of Violet McKenzie, née Wallace, pieced together from historical documentation and interviews with her friends. David Dufty has done a good job of that.

One aspect of this book that surprised me is that I thought it would concentrate more on the story surrounding how Violet became Australia’s first female engineer. I also wanted to read about how she started Wireless Weekly (along with three others), ran probably the first ‘hobbyist’ electronics store in Sydney and so on.

It does describe those events, but it concentrates more on her role in the formation of the WRENS, among the first women allowed to serve in Australia’s armed forces. That is certainly interesting in its own right. In retrospect, it makes sense that there would be far more information available on that aspect of her life than her earlier (and less ‘official’) activities.

Besides telling the story of this remarkable woman’s life, the book also contains lots of fascinating history. I was amazed by the contortions that went on in the first half of last century trying to justify why women should not be engineers, serve in the armed forces or (one gets the impression) even leave the kitchen.

That is all in the past now, especially given the drive to get more women to take up “STEM” subjects (science, technology, engineering & mathematics) – coincidentally, a movement that Gary Johnston was part of. In Australia, this can arguably all be traced back to Violet, and her fascination with radios and electricity in general.

I was a little disappointed to reach the end of the main part of the book after about 250 pages. Still, that’s understandable given that a limited amount of information is available, especially regarding the early years of Violet’s life, up to the 1930s.

Perhaps a technical person perusing some very early copies of Wireless Weekly could have dug up some technical facts that would have spiced up the book for the more switched-on (ahem) readers. But while that would be interesting to me, I suppose it might turn casual readers off.

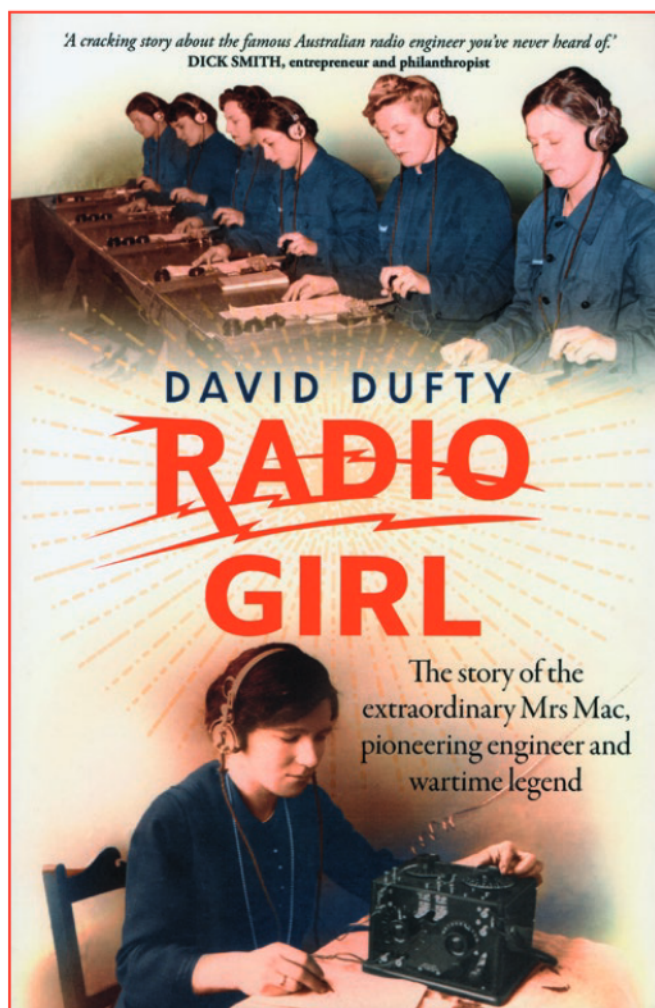
Of the 250 pages in the main part of the book, about 150 are dedicated to the wartime period of 1940-1945 or so. That isn’t surprising given the momentous events that occurred. Still, I wish enough information were available for Mr Dufty to have written a bit more about those fascinating early years.

I also note that the book doesn’t really contain any criticisms of Mrs McKenzie. I suppose you would not expect to hear many negatives in interviewing her friends and family, and perhaps there was very little about her not to like. But it does seem a little one-sided as surely, nobody is perfect. Having said that, I don’t want to cast any aspersions on anyone as I prefer to look at things on the bright side myself.

The book has extensive information regarding the sources used to piece Mrs Mac’s life story together. That undoubtedly makes it an excellent resource for anyone who wants to investigate further.

So the bottom line is: should you read this book? It is well-written and well-researched. If you are into Amateur Radio, Vintage Radio or are interested in the history of electronics, I would say yes. Or perhaps you want to read a story about how one very clever woman overcame much resistance to live a life that we would take for granted these days. In that case, you would also enjoy it.

In fact, if all you are looking for is an interesting but true story about a unique individual who became a pioneer, you could do far worse than to read this book. Most readers, young and old, would get something out of it.



Radio Girl is published by Allen & Unwin with an RRP of \$29.99 (softcover/paperback). It is sold by most book retailers, in-store and online, and is also available as an eBook.

SC

ALL ABOUT BATTERIES

PART 2:
BY DR DAVID MADDISON

Battery technology is being actively researched worldwide in an attempt to find a better way to store energy from solar panels and wind generators and for powering the latest generation of technology. This article will look at some of that upcoming tech, and will also describe the 'tried and true' lead-acid battery in more detail.

In the first article in this series, we gave the history of cell and battery technology, listed some common battery types and explained some of the theory behind them. This article will describe lead-acid batteries in more detail (as they are still in widespread use) and discuss some of the more obscure battery types.

A third and final part, to be published next month, will cover electric vehicle batteries, how to characterise batteries and take certain measurements. It will conclude with some miscellaneous battery facts.

More about lead-acid batteries

Lead-acid batteries might seem 'primitive', but they are still very useful. A major reason for this is that they are inexpensive compared to their capabilities, especially capacity and current delivery. Many decades of research has led to them being almost perfected, and many different sub-types are available to suit various applications.

Lead-acid car batteries, in particular, are subject to many myths because they need to be replaced regularly (sometimes at a relatively high cost), and when they fail, it is usually at the most inconvenient time.

How a lead-acid battery works

Let's start by considering just one cell of a standard 'flooded' lead-acid battery. A typical "12V" battery has six cells in series, each developing about 2V.

The essential components of such a battery are (see Figs.31-33):

- A spongy, porous lead plate anode that provides a large surface area to assist in the dissolution of the lead (negative)
- A lead dioxide plate for the cathode (positive)
- Sulfuric acid electrolyte

The lead plate is usually alloyed with antimony or calcium for strength. The two plates are kept apart with a

porous non-conductive membrane such as fibreglass.

In a fully charged state, a lead-acid battery has one lead plate, one lead dioxide plate and a high concentration of aqueous sulfuric acid. Both plates develop a lead sulfate (PbSO_4) layer as the battery discharges, and the aqueous sulfuric acid becomes very weak, almost like water.

It is essential to realise that, unlike most metal oxides, lead dioxide is electrically conductive. However, lead sulfate is a poor conductor and that is why a discharged lead-acid battery has a higher internal resistance than a fully charged one.

During discharge, the following

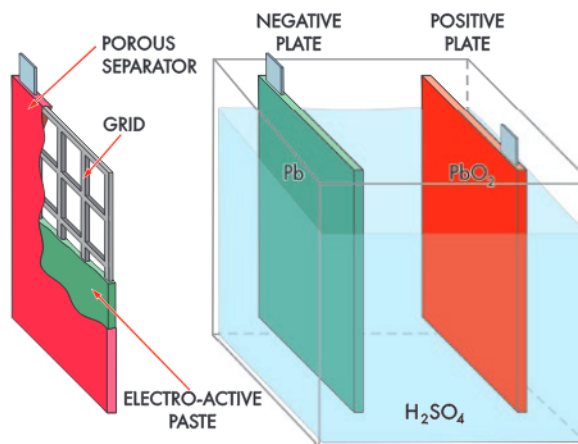


Fig.31: the basic layout of a lead-acid battery. The positive and negative plates are supported by grids made of lead alloyed with calcium or antimony for strength. The active material that fills the grid of a charged positive plate is red-brown lead dioxide, while on a charged negative plate, the grid is filled with sponge lead. Original source: Jorge Omar Gil Posada, CC BY 4.0

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INTELLIGENT DUAL HYBRID POWER SUPPLY

PART 1: BY PHIL PROSSER

This power supply has two separate outputs, each capable of delivering up to 25V DC at 5A. They can be connected in series and ganged up to form a dual tracking supply, and both outputs are controlled and monitored using a graphical LCD screen, two rotary encoder knobs and two pushbuttons.

Both outputs are powered by a single transformer, and they can be used independently or ganged up to form a dual-tracking (positive and negative) or higher current single-ended supply.

This design uses a hybrid switch-mode/linear approach for decent efficiency and low output ripple and noise. Due to its high efficiency, it doesn't need fans, so there is no fan noise or associated dust buildup.

Much audio and analog work demands a bench power supply with decent voltage and current capability, plus dual tracking outputs, so this supply fits the bill.

We received some questions on the practicality of building a pair of our 45V, 8A linear supplies (October & November 2019; siliconchip.com.au/Series/339) and hooking them together.

You certainly could do that, but this supply is a much more compact and lower cost solution. It adds valuable

features like monitoring the voltages and currents on one screen, and switching off or reducing the voltage of both outputs if either current limit is exceeded.

The slightly lower voltage and current capabilities (25V instead of 45V and 5A instead of 8A) will still suit most applications. For example, while this supply won't allow you to test a 100W power amplifier module at full power, it would be good enough to test it at lower power levels, to verify that it works before hooking up its normal power supply.

And when you aren't using it as a tracking supply, you can make the two outputs completely independent and control them separately.

Another advantage of the digital controls is that the internal wiring for this supply is quite straightforward and neat, consisting mainly of some ribbon cables that carry control

signals, plus a handful of wires that carry DC power.

Using a microcontroller to control the power supply and drive the user interface allows us to be smart in how we control the limits. It can work out voltage and current limits based on the transformer's VA rating and secondary voltage. This allows a wide variety of transformers to be used. Dig through your parts bin and recycle!

The supply uses two alike regulator boards for dual rails. It can be built with a single board if you only need one rail – the user interface can handle single-/dual-rail implementations.

If you're dead set against using a microcontroller, the regulator board has been designed so that it can operate with just two pots. You would need to organise your own voltage and current monitoring, but you can build it that way, and leave out quite a few of the more expensive parts, like the

analog/digital conversion chips, isolators, CPU and display.

The microcontroller interface is simple to use, though. There are just two controls you will use day-to-day: the output voltage and current limit. If you need it, there is more detail accessible in setup menus, including calibration and configuration screens.

The interface is controlled using two rotary encoders with integrated push-buttons, plus two extra pushbuttons. The encoders adjust the voltage and current limits, while pressing either swaps between controlling the two outputs.

One of the extra switches lets you go into setup mode, while the second button is an 'emergency stop' button that shuts down the power supply output immediately. This is useful if the magic smoke starts leaking from something! Pressing it again restores the output.

Performance

When measured using an oscilloscope, mains-related hum and buzz is not detectable (see Fig.1), nor is switchmode noise. Output noise is typically less than 20mV peak-to-peak, and less than 5mV RMS. This is pretty much constant across the full range of load variations.

The response of the power supply to load change is good. Figs.2 & 3 show that the output voltage recovers within 100µs with a 5A load step, with a maximum offset of just 200mV over 40µs.

Fig.4 shows how the unit behaves when it goes into and out of current limiting, with the current limit set to 5A. In response to a short circuit on the output, the voltage falls to achieve the programmed current limit almost immediately, and remains stable. Recovery takes around 5-10ms and has very little overshoot.

The supply has no thermal problems when short circuited. With both channels delivering 5A continuous into a short circuit, the heatsink will get quite hot to touch, but settles at about 60°C.

Hybrid design

This supply uses both switchmode and linear regulators, like our Switchmode/Linear Bench Power Supply (April-June 2014; siliconchip.com.au/Series/241) and the more recent Hybrid Lab Power Supply with WiFi (May & June 2021; siliconchip.com.au/Series/364).

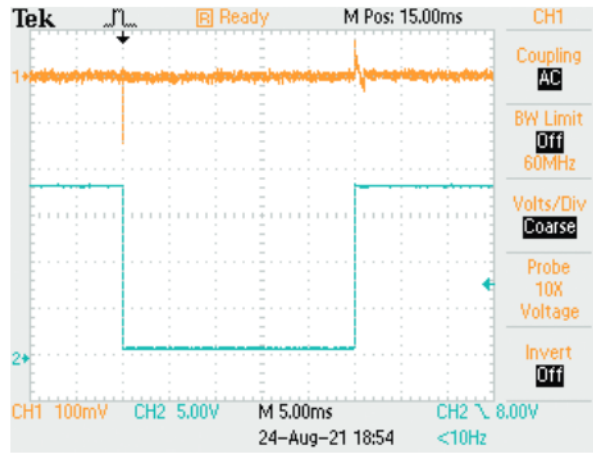


Fig.1: the blue trace shows a 2A load step with the supply set to deliver 15V. The yellow trace is a close-up of the output voltage, showing how it varies. The vertical scale is 50mV/div, and the output voltage only varies by a small amount when the load changes.

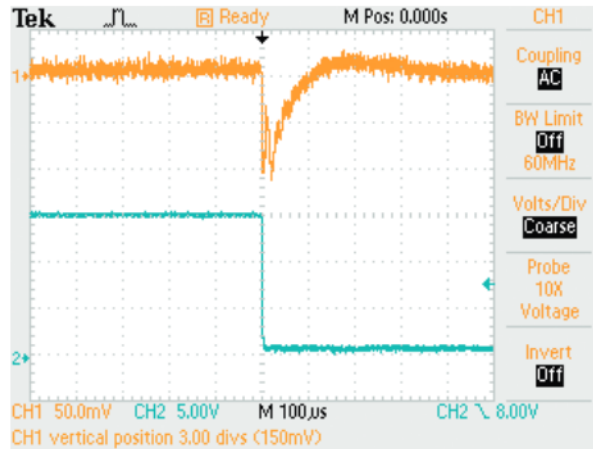


Fig.2: this is a similar view to Fig.1 but with a much faster timebase (100µs per division). The initial 100mV step is characteristic of the LM1084 and the overall loop feedback response brings the output back to 15V within 100µs.

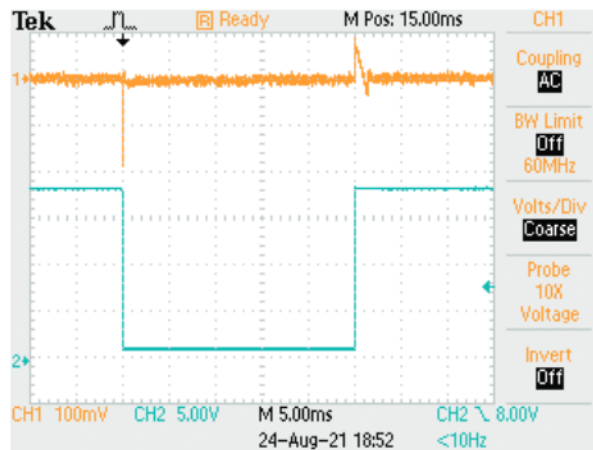


Fig.3: the same scenario as in Fig. 2 except this time, the output voltage has been set to 18V and the load step is 4A. The change in output voltage is slightly greater at 200mV peak drop, recovering within 100µs. On the trailing edge, the output changes by 75mV and it recovers within 2ms. This peak is small for such a large load step with minimal output capacitance.

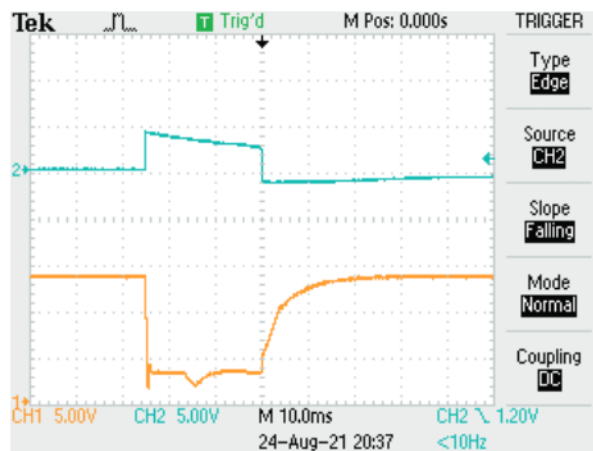


Fig.4: this shows how the unit behaves going into and out of current limiting. Ideally, its reaction should be swift and with little overshoot. In response to a short circuit, the output voltage is rapidly reduced. When the short is removed, the output voltage recovers in about 20ms, with no overshoot visible.

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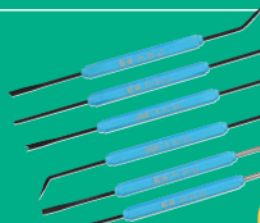
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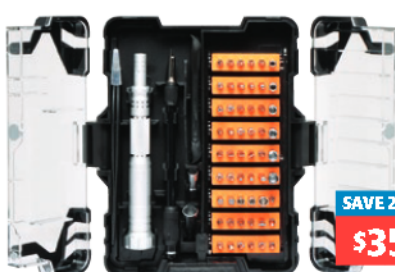
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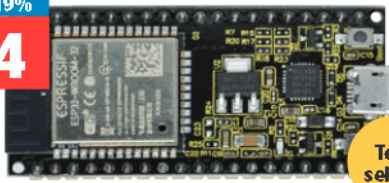
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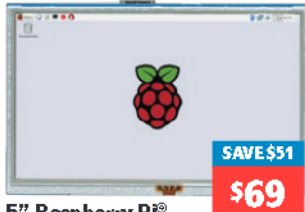


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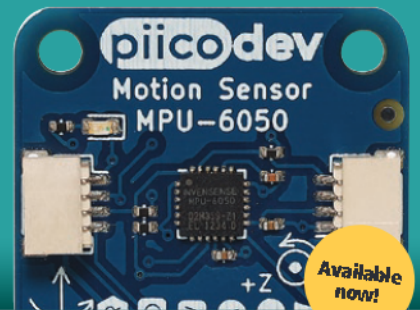


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Three low-noise HF-UHF Amplifiers



Left-to-right: module one (1MHz-3GHz), module two (5MHz-6GHz), module three (50MHz-4GHz)

All three of these low-cost wideband HF-UHF amplifier modules claim to provide 20dB of gain, over frequency ranges of 1MHz to 3GHz, 5MHz to 6GHz and 50MHz to 4GHz. They vary mainly in terms of size, shielding, supply voltage and price.

The 1MHz to 3GHz module is the largest, with a PCB measuring 50 x 50mm. It has SMA input and output connectors at each end and a mini 2-way terminal block for the power connections at the rear. The amplifier circuitry is inside a 32 x 30 x 6.5mm shielding box in the centre of the PCB, visible in the photos. There's also a small power indicator LED at upper right (D2).

This module is currently available online from Banggood (code 1238137; siliconchip.com.au/link/ab8q) for around \$15, plus \$7.50 for postage. That makes it the cheapest of the three modules we're describing.

It has been designed to run from a 12V DC supply, with a stated current drain of 75mA. It has a maximum input level of 0dBm, and the maximum output power is said to be +19.5dBm (approximately 100mW). While it's described on the PCB as a low-noise amplifier (LNA), no noise figure (NF) is given.

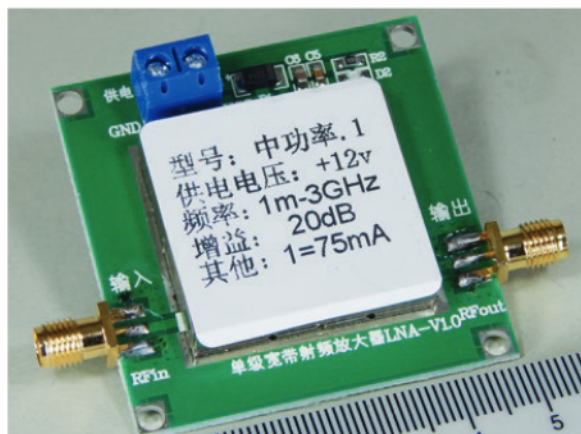
I could find no information regarding its internal circuit, or the active devices inside. But when I powered it up and checked its gain with my Signal Hound SA44B spectrum analyser and TG44A tracking generator (controlled using their Spike software), the results were quite impressive, as you can see from the red trace in Fig.1.

The gain measured about 21dB at the low end, drooping fairly smoothly

to 13.5dB at 3GHz, and then wobbling up and down a bit before falling to 3dB at about 4GHz. That's not bad for a low-cost module with a rated frequency range of 1MHz to 3GHz.

I don't have the equipment to measure the NF, but I was able to use the SA44B with Spike to measure the module's DANL (distortion & noise level) at 1GHz and 3GHz with a 50Ω input termination. I then compared these measurements with the DANL of the SA44B alone (50Ω input termination) at the same frequencies.

The results showed a rise in the DANL from -153dBm to -138dBm at 1GHz (+15dB), and a rise in DANL from -149dBm to -139dBm at 3GHz (+10dB). This is perhaps not good enough to qualify the module as an LNA, but quite acceptable for many applications.



I also checked the module's current drain from the 12V supply, and it measured precisely 75mA.

So overall, this module is a good choice if you only need to amplify signals at frequencies up to about 3GHz, and would be happy with the gain curve shown in red in Fig.1, the maximum output of 100mW and the modest noise performance. It would likely provide a good way to boost the output from a drone control transmitter, for example.

The second module

The next amplifier module is physically smaller, with a PCB measuring 33 x 24.5mm and again with SMA input and output connectors at each end. This module doesn't come with a mini two-way terminal block fitted to the PCB for power, but there are two

Module one is the largest of the three measuring 50 x 50mm, it uses a two-way screw terminal block for the power connection.

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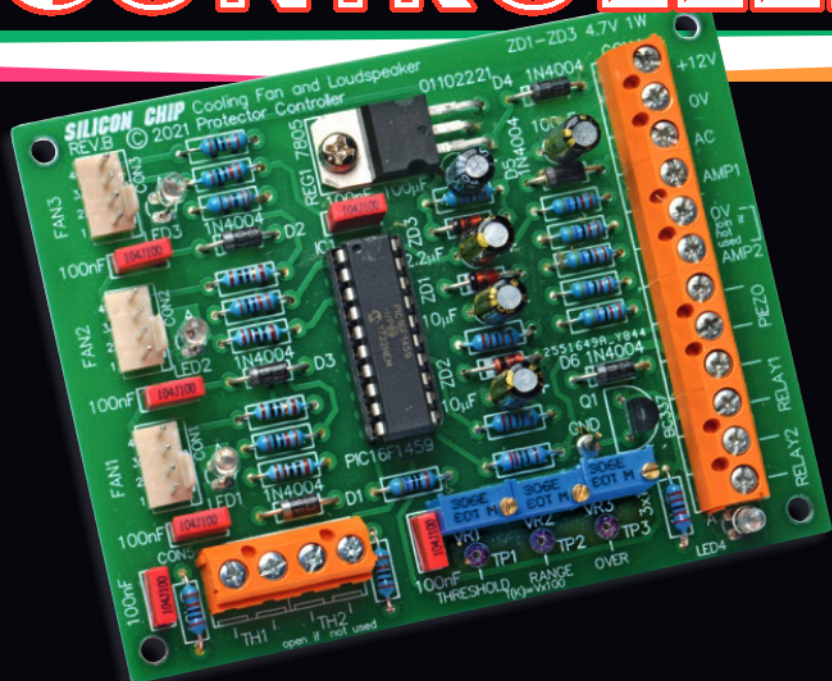
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COOLING FAN & CONTROLLER



This board controls up to three cooling fans, switching them on at a preset temperature and ramping their speed up as it increases, preventing overheating while minimising noise. It can also protect loudspeakers from damage while also preventing power switch-on and switch-off thumps. It isn't just useful for amplifiers; this board is ideal for any device that needs cooling fans.

Many devices need forced-air cooling when working hard but do not need fans to be running (or perhaps only running slowly) when they are idle or under light load conditions. This includes large power supplies, audio amplifiers, motor speed controllers – just about anything that gets hot under load.

Even devices for which passive convection cooling is adequate can have their lifespans extended if they are fitted with fans that switch on once things start heating up. Those fans might only need to run during summer, when ambient temperatures are high. Ideally, the fans stop or spin slowly when only a bit of cooling is required, to prevent the annoyance of constant fan noise (and dust collection).

One simple method to provide cooling fans is to have a thermostat connected to the heatsink that switches on the fan(s) whenever the temperature exceeds a certain threshold. But, when switched on, the fan(s) run at full speed and make considerable noise. That is especially bad for an audio amplifier as it can ruin the listening experience.

A less obtrusive method is to adjust the speed of the fan(s) so that there is a gradual rise in speed as temperature rises. Once the heatsink passes a certain temperature, the fan(s) run slowly to start with; this usually provides

SPECIFICATIONS

DC offset reaction time: 75ms

Temperature setting range: 0-100°C (273-373K)

Fan PWM control frequency: 25kHz

Over-temperature hysteresis: 4°C (4K)

Amplifier DC offset detection: < -2V or > +2V

AC loss detection threshold: 9V AC

Relay power-up delay: typically 6s after fans are detected

Fan disconnect/failure audible alarm: 264ms burst of 3.875kHz at 1Hz

Trimpot voltage/temperature conversion: 10mV/K (2.73V = 273K = 0°C)

Over-temperature or DC fault audible alarm: 264ms burst of 3.875kHz at 0.5Hz

NTC thermistor range: 0-100°C (responds to highest temperature when two are used)

Trimpot adjustments: three – fan switch-on threshold, fan speed range & over-temperature alarm

LOUDSPEAKER PROTECTOR

BY JOHN CLARKE

sufficient air movement to bring the amplifier back to a lower temperature. If the temperature continues to rise, the fan will run at a progressively faster rate, up to full speed.

By choosing the right fans, they will be extremely quiet at slow speeds, and the temperature can usually be controlled without making noise. Here, we're using PWM-controlled computer fans with brushless motors. They are readily available at a range of prices, start at just a few dollars each, and generally are silent at low speeds. Some can still move a lot of air at full speed, though.

As this board is especially suitable for power amplifiers, we've added several extra features to it. Power amplifiers should include loudspeaker protection to disconnect the speakers if the amplifier fails. Power amplifier failures can destroy the speakers and even start a fire, especially if it's a high-power amplifier.

That's because one common failure mode involves one or more of the output transistors failing short-circuit, possibly resulting in the entire supply rail DC voltage (up to perhaps 80V) being applied to the speaker. Given their low DC resistance, any loudspeaker connected will be quickly destroyed by this.

At best, the loudspeaker coil will burn out without any further damage. But a worse scenario is that the speaker cone could catch fire, burning the speaker box and anything else that's in the vicinity.

The built-in Loudspeaker Protector Controller averts speaker damage by disconnecting the loudspeaker from the amplifier should the amplifier exhibit this type of fault.

Since there is the ability to disconnect the loudspeaker from the amplifier, we can provide de-thumping features. At power-up, an amplifier can generate a brief, uncontrolled voltage excursion until its power supply stabilises. This will produce a thump sound from the loudspeaker(s). We eliminated it by adding a delay from power-up before connecting the loudspeaker.

A similar thump can occur at switch-off. Therefore, we disconnect the loudspeaker as soon as the AC supply is lost, before any voltage excursions from the amplifier can cause a thump sound.

PWM fan control

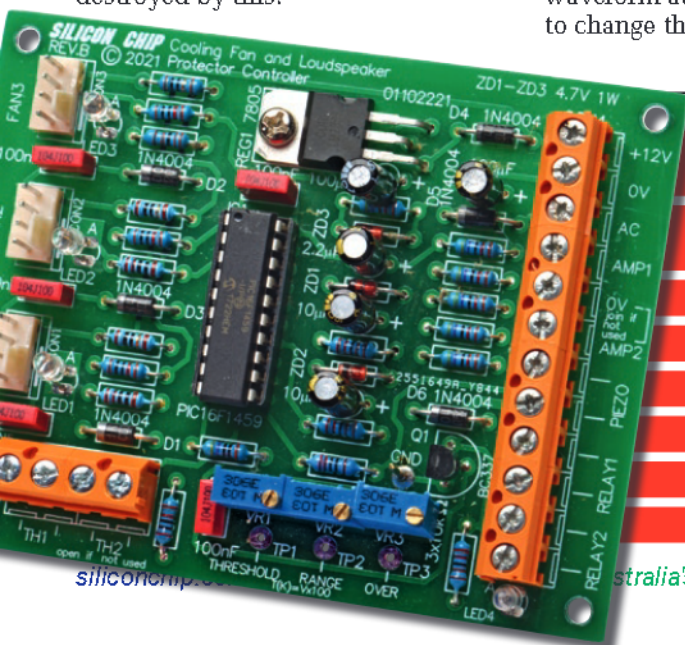
Our Controller works with 4-pin PWM fans. These fans have internal pulse-width modulation (PWM) speed control, where the duty cycle of the waveform at a control pin is adjusted to change the fan speed.

At low duty cycles, the fan runs slowly and increases in speed as the duty is increased. Our Controller can drive up to three fans. PWM fans have four connections: two for power (+12V and 0V), one for speed adjustment and one for speed feedback (RPM sensing). These are labelled as the Control and Sense terminals.

The sense terminal produces two pulses per fan revolution when the terminal has a pull-up resistor connected to a 5V supply. These pulses provide information about the speed of the fan, and in particular, whether the fan is running. If the pull-up resistor is not included, the fan will always run at full speed when power is applied.

The fourth pin is the Control terminal and is for the PWM signal to set the fan speed. The applied PWM signal only needs to supply a small amount of current as it does not directly drive the fan motor. Internally, each fan includes a motor driver circuit that operates based on the PWM signal applied.

Scope 1 shows the 25kHz PWM signal that is applied to the fan. The top yellow trace is a low duty cycle (16.7%) waveform, and when this is applied, the fan runs slowly. The lower white trace shows the PWM waveform when the duty cycle is increased to around 70%. With this higher duty



FEATURES

Suits mono & stereo audio amplifiers, or any other device which needs thermal fan control

Onboard loudspeaker protector controller with de-thumping at switch on & off

Loudspeakers are disconnected with over-temperature fault

One or two thermistors for temperature sensing

PWM control for one to three cooling fans

Over-temperature and fan failure alarms

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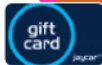
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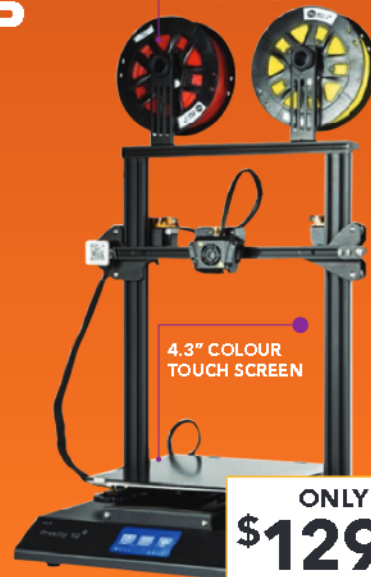
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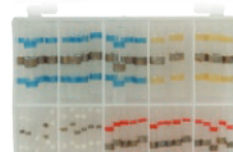
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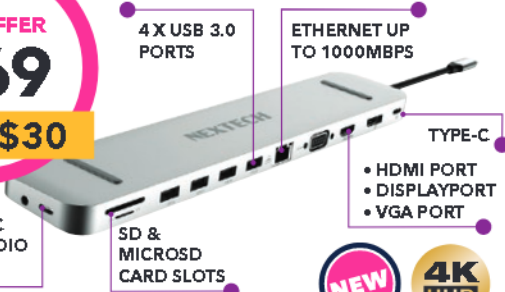
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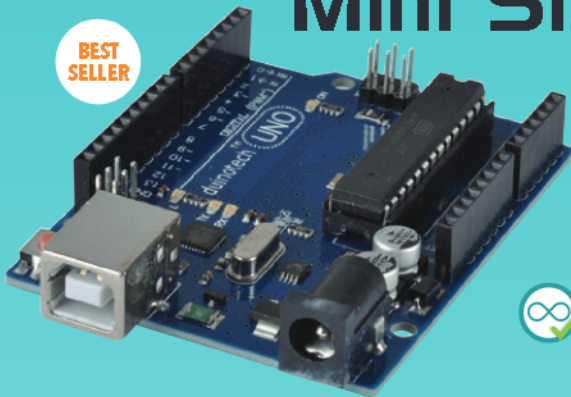
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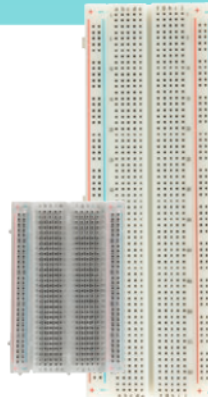
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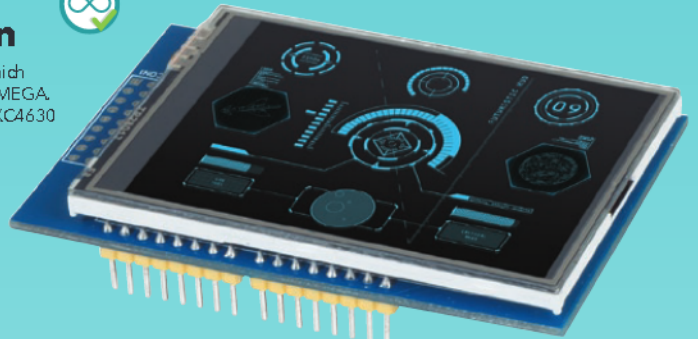


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PRODUCT SHOWCASE

KCS sells 500,000 TraceME LoRa units

KCS BV is proud to announce that a new milestone was reached in Q3 2021 – over 500,000 ‘TraceME’ LoRa and other tracking units have been sold.

Since KCS have integrated new LPWAN (Low-Power Wide Area Network) technologies, new use cases and massive IoT deployments became possible.

Switching from traditional GPS/

GPRS systems to LPWAN based systems resulted in reduced costs and increased battery lifespans to more than 10 years in some cases.

It has now become feasible for countless industries and businesses to implement IoT. Some examples of how to use it include smart waste management, temperature-controlled transport, smart road signs and large-scale

asset tracking such as E-bikes.

In 2022 and beyond, KCS will continue to build on its existing TraceME products to enable new use cases and provide further enhancements. KCS remains dedicated to showing why it is a safe choice for any large-scale IoT deployment.

Please visit www.trace.me for more information.



KCS TraceME

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New automotive boost controller from Analog Devices

Analog Devices (Maxim) have introduced a highly efficient multi-phase synchronous boost controller that regulates high-power Class-D amplifiers in automotive infotainment systems.

The MAX25203 features both programmable gate drive voltage and current limit blanking time, as well as accurate current balancing, and operates at a high switching frequency, all while shrinking PCB space by 36%.

The MAX25203 joins ADI's family of automotive boost controllers that include the MAX25201 and MAX25202 single/dual boost controllers, both designed for lower power applications.

You can buy evaluation boards, view the data sheet and order samples from Maxim's website at: <https://bit.ly/MAX25203Product>

The MAX25203 controller starts with a battery input voltage from 4.5-42V, and operates down to 1.8V after start-up. It sustains an absolute maximum output voltage of up to 70V and features a low shutdown supply current of 5µA.

The Max25203 is useful to generate backlight and Class-D audio amplifier voltages and also offers I²C bus diagnostics including die temperature, phase current monitoring and optional true shutdown to improve system reliability.

Output voltage is scalable via the PWM input or I²C interface and a sync-out feature supports additional phases for higher power systems.

The MAX25203 synchronous boost controller features:

- Factory programmable gate drive

voltage from 5.5-10V increases power density by reducing MOSFET R_{ds(on)} loss for higher efficiency and lower cost.

- Programmable current limit blanking time supports short peak current events without power supply overdesign for lower solution cost.

- ±5% current share accuracy from phase-to-phase reduces inductor size.

- Resistor programmable switching frequency up to 2.1MHz improves EMI and reduces external components' size and number.

Maxim Integrated

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www.maximintegrated.com

Microchip further expands Gallium Nitride (GaN) RF Power portfolio

Microchip has announced a significant expansion of its GaN RF power device portfolio with new MMICs and discrete transistors that cover frequencies up to 20GHz.

The devices combine high power-added efficiency (PAE) and high linearity to deliver new levels of performance in applications ranging from 5G to electronic warfare, satellite communications, commercial & defense radar systems, and test equipment.

Microchip's portfolio of RF semiconductors in addition to GaN devices

ranges from gallium arsenide (GaAs) RF amplifiers and modules, to low-noise amplifiers, front-end modules, varactor, schottky & PIN diodes, RF switches and voltage variable attenuators.

In addition, the company provides high-performance surface acoustic wave (SAW) sensors and microelectromechanical systems (MEMS) oscillators and highly integrated modules that combine microcos with RF transceivers that support major short-range wireless communications protocols

from Bluetooth, Wi-Fi & LoRa.

The power devices announced include the ICP0349PP7-1-300I and ICP1543-1-110I, as well as other Microchip RF products, which are available in volume production. For more information, visit siliconchip.com.au/link/abcd

Microchip Technology

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This relatively small and simple device generates extremely high voltages, enough to form a 'flame discharge' resembling a candle flame. It can also demonstrate wireless power transmission by lighting up neon globes and fluorescent lamps at some distance.

The inspiration for this project came from a YouTube video by Jay Bowles of Plasma Channel in January 2021 of a Plasma Flame Generator. I loved the simplicity of the circuit (tuning and operation is a challenge, though), its unique output, and the fact that the resulting device is relatively small.

In this design, a solid-state oscillator drives a primary coil which excites the resonator (secondary) coil, producing a high-frequency, continuous-wave output. The discharge produced by the Coil is a very interesting "flame discharge" resembling a candle flame.

The Coil can be used to demonstrate wireless power transmission by lighting up neon globes and fluorescent lamps.

In the lead photo, you can see a matrix I made using 100 neon lamps, sections of which light up when placed

in proximity to a strong electromagnetic (EM) field (such as generated by this Tesla coil). Depending on the panel's orientation, it can display the amplitude of the EM field or the relative shape. I think this is a really interesting way to observe such fields.

The first thing you might think of looking at photos of this device is: "is it safe?" Yes, and no. It generates about 150kV, and given its operating frequency of around 10MHz, it can cause RF burns.

Clearly, you need to be meticulous in building, testing and operating such a device. But we won't tell you "don't try this at home". Still, we don't recommend that beginners assemble such a device.

It is more suitable for someone who, for example, has built several mains-powered devices and is used to the safety precautions involved

in working with 230V AC. That's because such people normally have the required mindset of 'hands off when power is applied', double-checking everything before switching power on and thoroughly insulating all high-voltage conductors.

So without further ado, let's get into it.

Tesla Coils

This Tesla Coil is based on a Class-E RF power amplifier that's tuned to oscillate at around 10MHz. It drives a tap on an auto-transformer; the transformer's secondary is excited by the oscillator to produce a high-frequency, continuous-wave output.

You might be used to seeing Tesla Coils with a doughnut-like metal toroid on top, from which the discharge emanates. This one is simpler, with a dome instead, but it's still a

This device generates hazardous voltages!

Although the unit operates from a low-voltage DC supply, its high-voltage output will cause RF burns if you come close to or contact the discharge terminal, even when no discharge is apparent. The flame produced is a plasma, which is extremely hot and capable of melting copper wire (not to mention flesh!). Without the brass/stainless steel breakout point, it can begin to melt the wire at the discharge point.

Always ensure that you are nowhere near the breakout point when powering the unit up. Keep all parts of your body (or anyone else's) clear of it until power has been switched off and the discharge stops. And remember that a high voltage can still be present even when no discharge is visible. The potentiometer specified has a plastic shaft; use caution if substituting a pot with a metal shaft. At a minimum, you would need to use a plastic knob and ensure that the knob fully covers the shaft.

For added safety, the coils (L2 & L3) and the breakout point can be encased in a 150mm diameter transparent plastic film or Perspex surround, with an open top 50mm higher than the breakout point.

Electromagnetic interference warning

This Tesla Coil is an RF generator. The input power can be up to 240W (48V @ 5A) and the Class-E amplifier is very efficient, converting a considerable amount of input power to RF energy. That said, when breakout is occurring, most of that energy is converted into light and heat.

Be aware that it can cause RF interference when operating, mainly in the HF (3-30MHz) band. That includes shortwave radio, multiple amateur radio bands, aviation and maritime communications and CB radio. The operating frequency of this unit is very close to the amateur 40m band, so be careful, or you might make some radio hams very unhappy!



Tesla Coil (we'll describe a larger and somewhat more complicated Tesla Coil with a toroid in a later article).

The Tesla Coil is a loosely coupled resonant transformer invented by Nikola Tesla in 1899. It is capable of producing high-voltage, low-current, high-frequency alternating current.

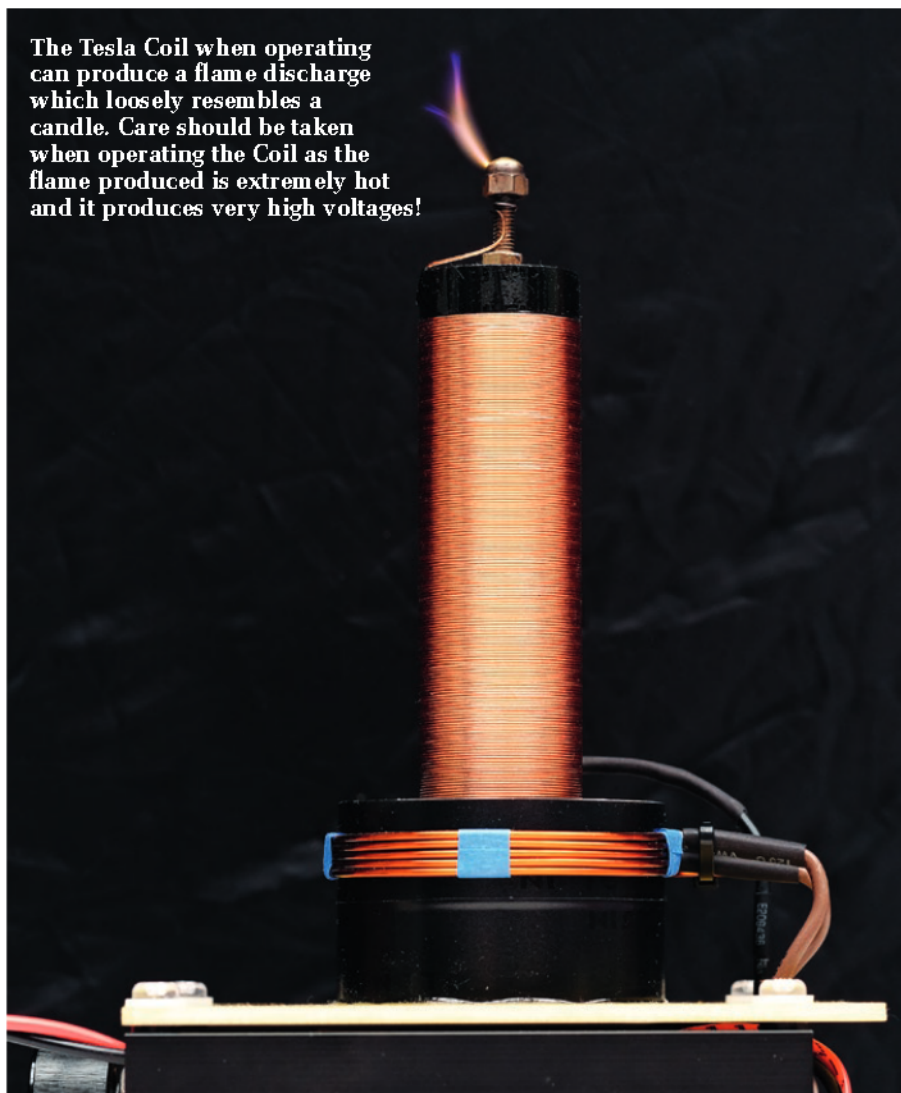
The voltages produced by Tesla Coils result from resonant voltage rise in the secondary and are not proportional to the turns ratio between primary and secondary windings as with traditional, tightly-coupled transformers. That allows exceptionally high voltages to be produced with a practical circuit; in some cases, over 1MV!

The Tesla Coil comprises two L-C resonant tuned circuits. The primary tank circuit consists of the primary capacitor and a coil. The secondary coil (and often, high-voltage toroid) and the surrounding air form the secondary L-C circuit. The two circuits are connected in series and tuned to resonate at the same frequency for efficient energy transfer.

The classical Tesla coil uses a spark gap arrangement to switch the energy stored in the primary capacitor into the primary coil.

The energy in the primary circuit, moving back and forth between the capacitor and primary coil, transfers (couples) some of the energy to the secondary circuit. The voltage in the

The Tesla Coil when operating can produce a flame discharge which loosely resembles a candle. Care should be taken when operating the Coil as the flame produced is extremely hot and it produces very high voltages!



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XGECU TL866II Universal Programmer



We like the Microchip PICkit 4 for programming PICs and many Atmel parts (eg, AVRs). But there are times when you might need to program something else, and you don't want to end up having to buy a different programmer for every type of chip you might come across. A low-cost universal programmer like the TL866 is the answer.

The PICkit range of programmers is indispensable when working with Microchip (and now Atmel) parts. The PICkit 4 is fast and versatile, while the Snap programmer is inexpensive and can program many chips that don't need a high programming voltage.

But if your interests span a broader range of chips, including EEPROMs as well as micros, there is an alternative. It is an excellent choice if you want to tinker with older components.

You might have heard of the so-called "MiniPro" programmers; this is a common nickname for a range of programmers produced by a Chinese company called XGecu. We sourced our unit from what appears to be the official eBay XGecu store (user xgecupro; www.ebay.com.au/usr/xgecupro).

The unit we are reviewing is the TL866II model. There are also the older TL866A and TL866CS models, plus the higher-performance T56 model. The one we ordered cost around \$75 and took about three weeks to arrive.

At the time of writing, the T56 costs around \$220, while the TL866A and TL866CS are no longer available from XGecu. Other companies have cloned these older models, so any that are available are likely clones. Since the clones depend on XGecu's control program (XGPro) to operate, XGecu's fix appears simply to be ending support for these older programmers.

Indeed, the control program can apparently detect and disable some of these clones. Thus, we can't recommend the TL866A or TL866CS.

The TL866II

The TL866II consists of a grey box around 10cm long with a 40-pin ZIF (zero insertion force) socket at the top. Two LEDs indicate power (POW, red) and operation (RUN, yellow). The top of the case is notched for the ZIF socket handle, and a USB socket is opposite.

A six-way header is available on one edge. This is for attaching an ICSP (in-circuit serial programming) header lead, to connect to a matching header on a PCB. Thus, the TL866II can be used to program DIP chips out-of-circuit, or just about any chip in-circuit, as long as an appropriate onboard header is present.

The case is also marked with a notched IC outline to show the orientation of parts going into the ZIF socket.

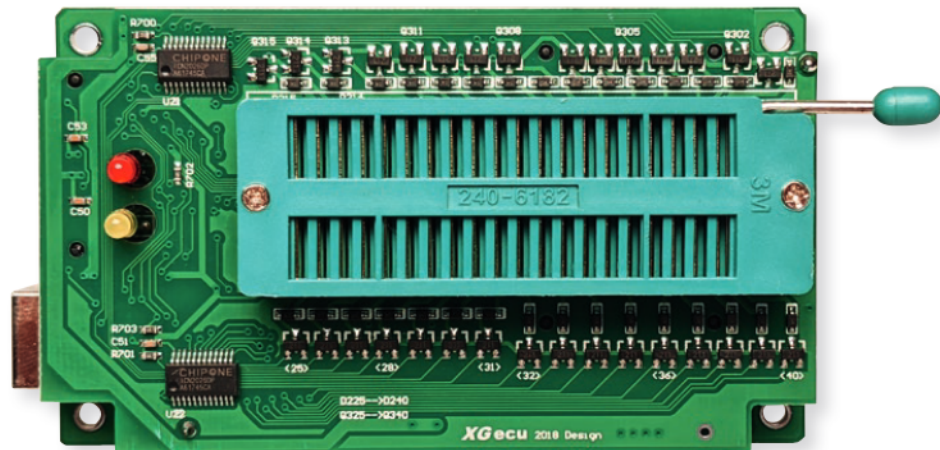
The unit feels weighty, and you can

see two stacked PCBs through the hole for the header. All in all, it appears to be a well-made and compact piece of equipment, no larger than it needs to be.

Just four screws hold the case together, so we whipped them off to take a peek inside.

The two boards are sparsely but neatly laid out with surface-mounted components. Each pin on the ZIF socket is accompanied by a diode and transistor. This is necessary to cater for the variety of pin layouts that can be accepted. Different logic voltage settings are available, so presumably, these parts also handle level conversion.

The two PCBs are joined by several socketed pin headers, and secured together by two soldered wire pins.



The ZIF socket's ability to work with such various chips with different pinouts depends on being able to drive any pin with the correct signal. This array of diodes and transistors help to do that.

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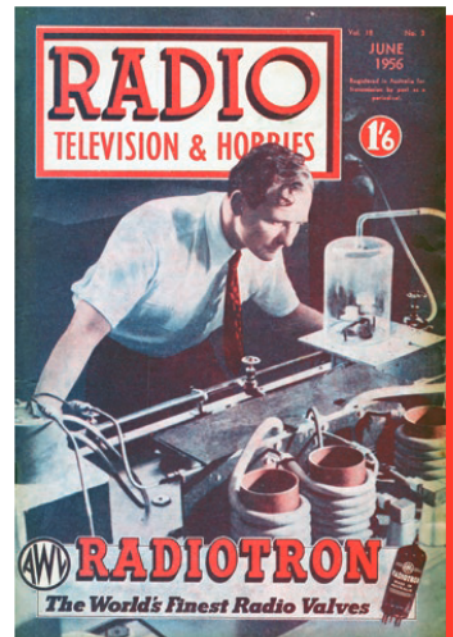
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DRIVEWAY GATE REMOTE CONTROL FOR SLIDING AND SWINGING ELECTRIC GATES



Sliding/swinging gate controllers inevitably fail after some years of service. The more poorly made models will die after just a few years, so you will end up repairing or replacing them frequently. The solution is to replace the controller with this much more robust design, and as you build it yourself, it's easy to fix if it does go wrong.

BY DR HUGO HOLDEN

When I moved into my current home some 20 years ago, I enjoyed the fact that the front fence had a sliding electric driveway gate. However, after about a year, the gate started to malfunction, initially with intermittent behaviour and then total failure.

I inspected the gate control module, which was based around a controller CPU. The motor switching relays looked somewhat small for the task, and I could see significant contact burning through their transparent covers.

I called the manufacturers for a schematic, but they did not want to provide any assistance. Instead, they directed me to their local repair agents. A fellow at the company seemed quite sympathetic, but it was apparent he 'wasn't allowed' to help a customer to effect their own repairs.

As is often the case, the repair agents were unable to make PCB-level repairs and could only replace the whole

control board for hundreds of dollars. Initially, I accepted this.

It failed again a year later, and again, I had to buy a new PCB. Further failures appeared after lightning storms on two occasions.

After repeated episodes of the system failing, I was getting fed up. I took one of the original boards and replaced the relays, to good effect. I also replaced some aged electrolytic capacitors, but the writing was on the wall.

Fortunately, the radio receiver board (a generic third-party product) had always been very reliable, so I kept that and decided to design a new controller board to connect to it.

My solution

I decided to throw the original controller PCB in the bin and design my own from scratch. Looking around at the parts in my workshop, I had a good supply of 74-series vintage TTL logic ICs (some of which were used

in a Pong system; see the June 2021 issue). These are rugged and reliable, also highly resistant to damage from electrostatic discharge (ESD).

The task of an electric driveway gate appears simple on its face. But like many automation systems, the devil is in the detail.

My sliding gate is powered by a 24V DC bidirectional brush motor. It has two standard micro-switches as motion limit switches. These are mounted close together in the motor drive unit and are mechanically activated at each end of the gate travel, via a spring arm, when the gate is fully closed or fully open.

A swinging gate is likely to have a similar arrangement, so my controller could be suitable for that type of gate. However, I have not tested it as such. You would have to check how your gate system works before deciding to use my controller.

The controller logic needs to take account of the states of these limit

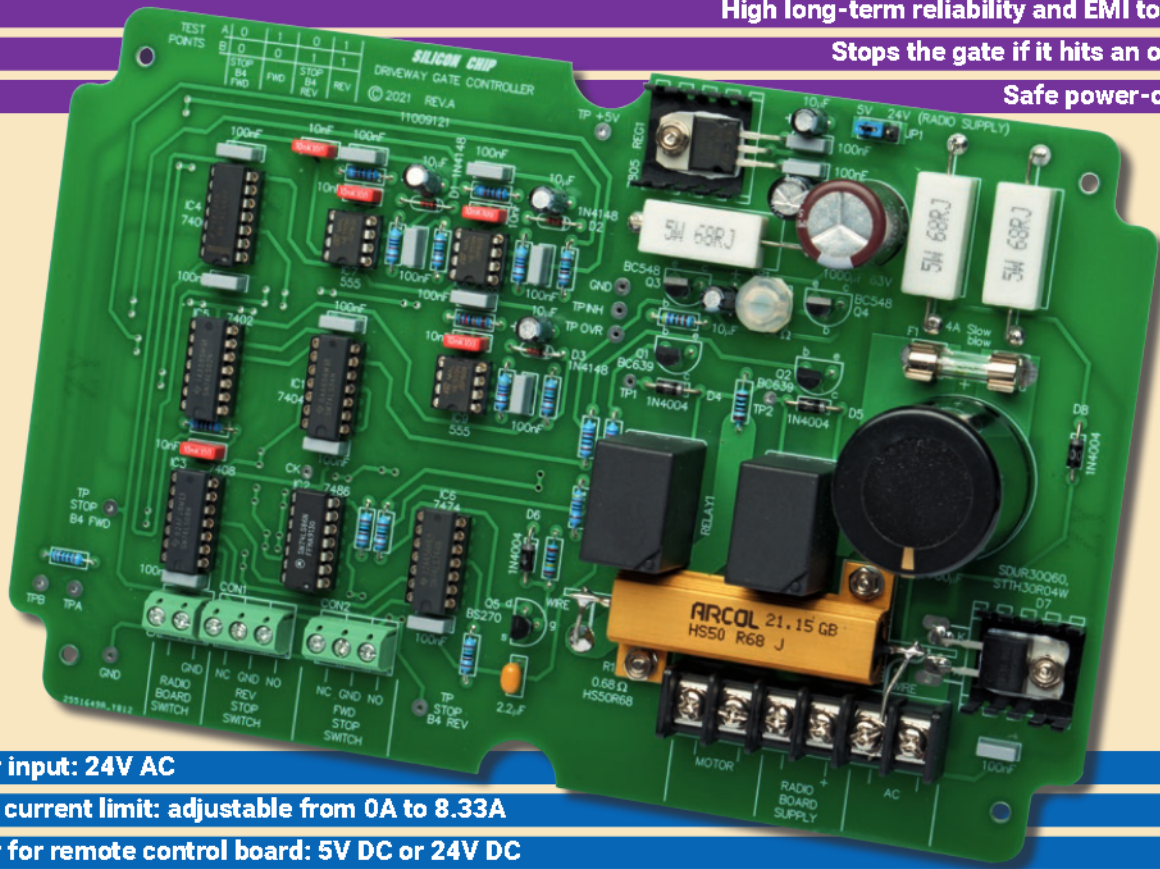
Easy to service; no software and all through-hole parts

Triggered by a single remote or local button (or both)

High long-term reliability and EMI tolerance

Stops the gate if it hits an obstacle

Safe power-on reset



Power input: 24V AC

Motor current limit: adjustable from 0A to 8.33A

Power for remote control board: 5V DC or 24V DC

Motor drive: 24V DC or rectified AC at up to 8.33A (200W)

switches during the use of the gate. It must then control the motor direction appropriately when the gate starts from a fully closed or fully open, or perhaps intermediate position.

It also needs to detect the motor current in case the gate strikes an obstacle, to stop the gate motor.

The gate is controlled by a handheld remote via a radio receiver board, its output being a momentary closed contact from a small relay on the radio receiver board. But it could also be controlled by a manual pushbutton.

Finally, the control logic requires a very effective reset function to ensure that the gate remains in its stopped position with any kind of rapid, slow, or variable mains power cycling. Otherwise, a brownout, blackout or other event could trigger the gate's motion and maybe open up the gate when you are not home.

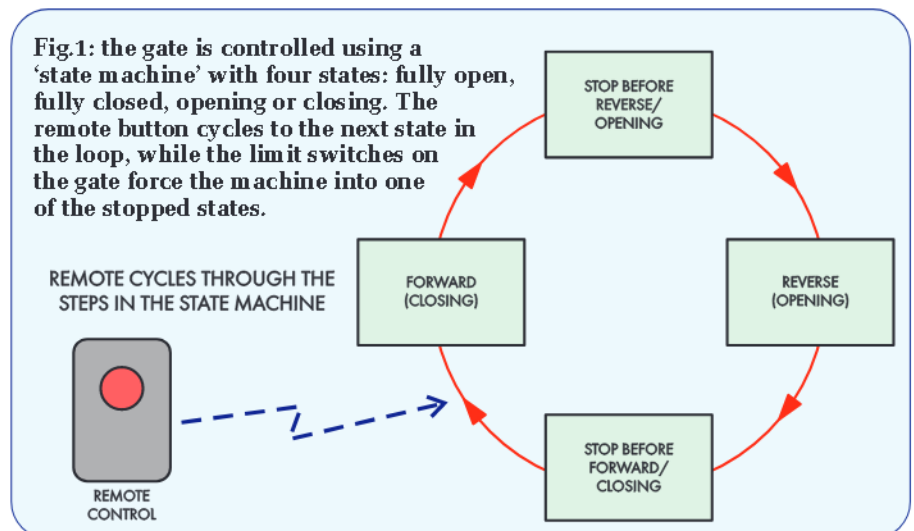
The state machine

Considering these requirements,

there are four fundamental modes of operation, cycled through by a button press.

Initially ignoring the two limit switches, the remote control needs to cycle the gate through four operational states, shown in Fig.1.

Therefore, a two-bit counter is needed, giving four logic states. I achieved that using a 7474 dual D-type flip-flop IC. These flip flops can be preset or cleared, which is required to take account of the gate limit switch conditions.



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Dave Thompson

The accordion job

An unusual job turned up at the workshop the other day. Well, it didn't just walk in; the owner brought it in after discovering it at an estate sale. The inheritors were going to throw it away, but my client saved it. It was a piano accordion, probably at least 50 years old, and this guy couldn't bear to see it chucked into the bin.

This client had played the instrument in various bands over the years and was always looking for a decent model to replace his existing ones because they eventually wear out with all that squeezing.

Back in the '90s, when I was playing in a folk-rock band, the accordion player was always on the lookout for good working models, perusing second-hand shops in towns we played because it was increasingly difficult to find a good working instrument. Life on the road is very hard on them.

When we did find one, it was pressed into use, and as soon as the bellows blew out or the reeds went west, it would go in the skip because repairing or restoring them was just an exercise in frustration. There were no spare parts to be found, so it was just easier to get another one and put it into service.

Now I know what you're thinking: "did he fire six shots or only five?" Oops, sorry, wrong script. I meant to say: there's nothing very electronic about a piano accordion. And usually you'd be correct, but this one had a unique feature.

At some stage, someone had mounted a couple of microphones on the outside near the grille (where the treble sound comes out). These feed via some not-so-neat cables into a small Jiffy box, which I assume housed a preamp of some description, making it ready to be plugged in and amplified.

Back when I played in the band, I was forever struggling to mic up the accordion properly. For one, the guy

who played it liked to move around a bit, and two, the microphones we were using (Shure SM57s) were very awkward to mount onto the instrument itself, so we inevitably ended up just gaffer-taping the mic in place.

Not very elegant, but it worked reasonably well for what we liked to call "folk and roll".

One of the main issues is that the sound grille on an accordion is quite long, typically the entire length of the instrument and a single microphone is naturally going to pick up sound loudest from where it is placed on the grille. The other notes at the extreme ends of the scale will not be 'heard' as well by the mic.

This created a headache for the sound guy because it would be very loud in the middle notes and buried in noise for the rest of the reeds placed farthest from the microphone. To work around this, we tried adding shrouds (usually made of folded and shaped stiff card) in an attempt to even out the audio, but with only partial success.

Eventually, we settled on using two mics spaced out along the grille, and when mixed together, this provided the best solution. But it looked a right mess with the mics taped to the body and inconvenient cables dragging everywhere, making it a bit of a nightmare to play for the accordionist.

Whoever modified this one had crafted two small 'stands' for the microphones, but they had ditched the bulky mic bodies and used only the dynamic capsule still mounted in its housing. It was a bit rough around the edges, but the mics were pretty sturdy and solidly mounted to the body.

Items Covered This Month

- The accordion job
- Brightening up a clock radio
- Unorthodox Porsche parts
- Mobility scooter repair
- The misattraction of a nuclear magnetic resonance machine

Dave Thompson runs PC Anytime in Christchurch, NZ.

Website: www.pcanytime.co.nz

Email: dave@pcanytime.co.nz

We apologise for the lack of cartoons in this issue. Our cartoonist, Brendan Akhurst, is currently trekking in the mountains of Nepal searching for evidence of past alien civilisations after their presence was revealed to him in a dream.

Each capsule was permanently wired with shielded cables for the short run to the Jiffy box, which was taped onto one of the shoulder straps. There was an XLR connector mounted in the back end of the Jiffy box, and a single standard microphone cable would connect the whole shebang to the snake and off to the mixing desk.

Apparently, this part of it was not working, nor were several of the bass buttons, which are mechanically operated by the player to open and close bass reeds on that side of the instrument. So there was a lot going on, and I decided to tackle the non-electronic part first.

That was relatively easy; opening a hatch on the bottom of the accordion revealed all the mechanics of the bass buttons, a complicated system of springs, levers, actuators and push-rods. It was 'literally' choked with dust, grime, what looked like animal hairs and other detritus picked up over decades of being played in dingy lounges and smoky bars.

A good going-over with a decent brush, a bit of low-pressure compressed air and a good lube job with

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USB Cable Tester



The image shows a white and green Silicon Chip Automatic USB Cable Tester. The device has a green front panel with various USB ports labeled: USB-A, USB-C, USB-B, USB-C, Micro-B, and Mini-B. The USB-A, USB-C, and USB-B ports are grouped under 'Downstream Facing Ports', while the other three are under 'Upstream Facing Ports'. A small LCD screen on top displays 'USB CABLE TEST', 'Ready For Cap', and 'Battery 4.7V'. The Silicon Chip logo is on the right side of the front panel.

Test just about any USB cable!

USB-A (2.0/3.2) USB-B (2.0/3.2)
USB-C Mini-B Micro-B (2.0/3.2)

Reports faults with individual cable ends, short circuits, open circuits, voltage drops and cable resistance etc

November & December 2021 issue
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VINTAGE RADIO



Tasma 305 'rat radio' from 1936

By Fred Lever

Manufactured by Thorn & Smith (Tasma) in Mascot NSW, the Lawrence 305 is a superhet console radio. It was purchased in a slipshod initial condition, with missing components or oddball replacements. A full rework was needed, of course keeping to the time period.

I purchased a derelict Tasma radio chassis from eBay, shown in Fig.1. The chassis was rusted, missing parts and in sad condition. Over its life, it had acquired replacements such as the odd IF coils, but one nice original item was the Tasma dial (Fig.2). I refurbished the radio using the gang and dial, and as many of the original parts as I sensibly could.

The chassis took some sorting out, with some engineering to fit later-series front-end valves; as part of this process, I needed to fabricate bits and pieces such as coils and shield cans. I arrived at a working chassis and used a 12-inch 1960s Rola permanent magnet speaker fitted with an output transformer and a choke to replace the original electrodynamic type.

The set was then a working radio,

just waiting for a cabinet to live in.

The chassis and speaker sat around for ages waiting for me to make my mind up on what cabinet I would make. I sketched some ideas based on photos of a model 305 and other similar Tasma sets. My thinking then swung around to making what someone in the 1950s or 60s might have made if they needed a second or 'shed' radio using a chassis from an old wrecked pre-war console radio.

I considered using distressed timber pieces from the scrap pile with old nail holes, warts and all, just like a "rat rod" vintage car where a modified engine and transmission are fitted to a fresh chassis but with a faded body, showing the patina of 80 years or so of use. Thus, my hotted-up Tasma 1936 model 305 chassis and speaker

became a "rat radio".

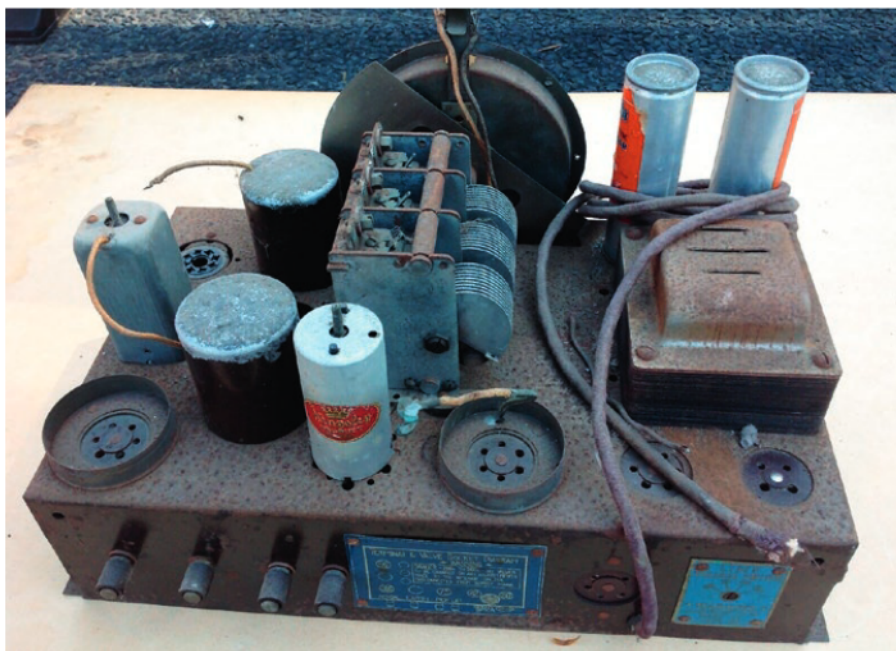
I have plenty of old scrap timber pieces. Most fit the technical description of firewood, having patina in spades! I set to and made up a small console cabinet. The whole process of chassis refurbishment and cabinet construction stretched over a long period. This article picks out just a few of the essential steps in the journey.

Refurbishing the chassis

The chassis is serial number 305141, ARTS&P rego B52187. The rust had set into the horizontal surfaces with deep pits; I removed the top parts (Fig.3) and discovered some very rough metalwork. Some butcher had chiselled out the original IF cutouts to put in an odd pair of 175kHz coils, one Kingsley KIF4 and one unknown type.

Fig.1: the chassis was in an abysmal state when I received it.

Fig.2: the dial didn't look too bad (besides the discolouration from the lamp's heat at the top), but it was pretty brittle. I added a protective layer to preserve it.



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ATtiny816	ATtiny816 Development/Breakout Board (Jan19)
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PIC10LF322-I/OT	Range Extender IR-to-UHF (Jan22)
PIC12F1572-I/SN	Nano TV Pong (Aug21), SMD Test Tweezers (Oct21)
PIC12F617-I/P	Range Extender UHF-to-IR (Jan22)
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• does not include the LM2575T as it comes with the CPU module parts

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(JAN 22)

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(DEC 21)

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(DEC 21)

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(NOV 21)

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(NOV 21)

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(OCT 21)

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(AUG 21)

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(JUL 21)

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