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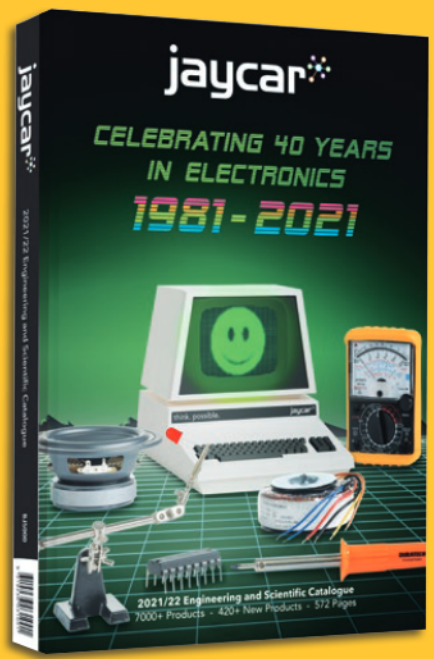

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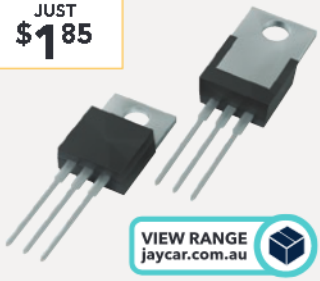

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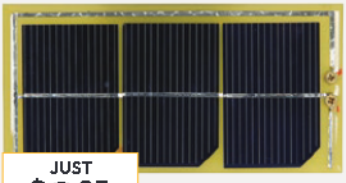

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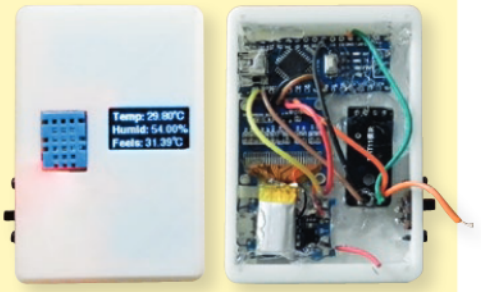
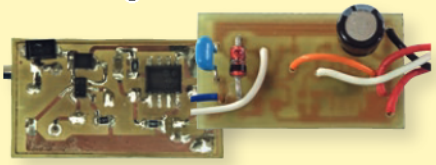
"If you aren't paying for it, you're the product". Companies such as Facebook, Google and others collect huge swathes of information about their users. So why is it done, what do they collect and how can you prevent or reduce it? – Page 16

Cables with USB Type A, Type B, USB-C, Micro-B and Mini-B connectors can be tested with our new project. It detects and reports faults with the cable, or if the cable is power-only – Page 28



Built into a 3D-printed case, and using an Arduino Nano, this Pocket Weather Station is the perfect project for beginners due to requiring only basic soldering skills – Page 56



Measuring just 28 x 16mm and shown at actual size, this Carriage Lights driver can easily fit inside most model trains to provide some extra decor to your railway layouts. It is powered from AAA batteries or a small LI-ion cell – Page 60

NOVEMBER

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Editorial Viewpoint

Standardising on USB-C: a great idea

The EU is again looking at forcing manufacturers to standardise on a single charging connector, almost certainly USB-C this time. They have been discussing this since 2009; I'm not sure why it is taking so long to finalise. In the time they have been considering it, several 'standard' USB connectors have come and gone, with mini-B giving way to micro-B and now Type C.

I don't like the idea of governments forcing manufacturers to use particular technology for a host of reasons. For example, industry leaders are likely to have a much better idea of suitable technologies than those in government. Also, imagine the nightmare if different governments (eg, EU & USA) introduced conflicting requirements.

But ignoring all that, standardising on USB-C for charging the vast majority of portable devices is a fantastic idea.

Most phone and tablet manufacturers have already switched to USB-C. It is superior to the connector used on fruit-themed phones, giving higher transfer rates and much higher power delivery. Having a connector standard across all devices would mean that we all only need to buy one type of charger to power and charge virtually all our devices.

Even low-cost gadgets are switching to USB-C for power and charging these days, and I think pretty soon, power-only Type-C connectors will cost little more than a micro-B connector. It's also nice that the cables can be symmetrical, with Type-C plugs on each end.

The only people that such standardisation would not benefit would be those who are dead-set on using proprietary connectors to lock consumers into using their products. Ahem.

The USB-C connector is much easier to insert and remove. It also has higher power delivery capability with USB-PD, much higher data transfer rates and significantly less chance of damaging the connector if you yank the cable. It's certainly a lot better overall than either micro-B USB or Lightning connectors.

While the USB-C connector was introduced with USB 3.0, it also supports Thunderbolt and USB4. So it clearly is the way forward.

Our USB Cable Tester (which I think is a brilliant project, starting on page 28) features two USB-C sockets to test cables with these connectors at one or both ends. I will definitely be building one of those as I have lots of USB cables, and I'm unsure which ones are good.

The USB naming scheme is a disaster

When USB 3.2 was introduced, they decided to eliminate the USB 3.0 and USB 3.1 naming schemes and retroactively rename all these standards as variations on USB 3.2. USB 3.0 becomes USB 3.2 Gen 1, USB 3.1 becomes USB 3.2 Gen 2x1 and the newly introduced standard is USB 3.2 Gen 2x2.

How confusing! It would have made a great deal more sense if USB 3.0 was used for 5Gbps capable devices, USB 3.1 for 10Gbps capable devices and USB 3.2 for 20Gbps capable devices.

Worse still, USB 3.2 devices capable of either 10Mbps or 20Mbps will carry the "SuperSpeed+" designation, even though 10Mbps is no faster than USB 3.1. Most consumers will not understand this scheme and will be bamboozled, thinking that a slower device supports the faster technology.

Hopefully, the naming will become a lot simpler with the upcoming USB4, which will merge USB with Thunderbolt. Thankfully, USB4 also uses the Type-C connector.

by Nicholas Vinen

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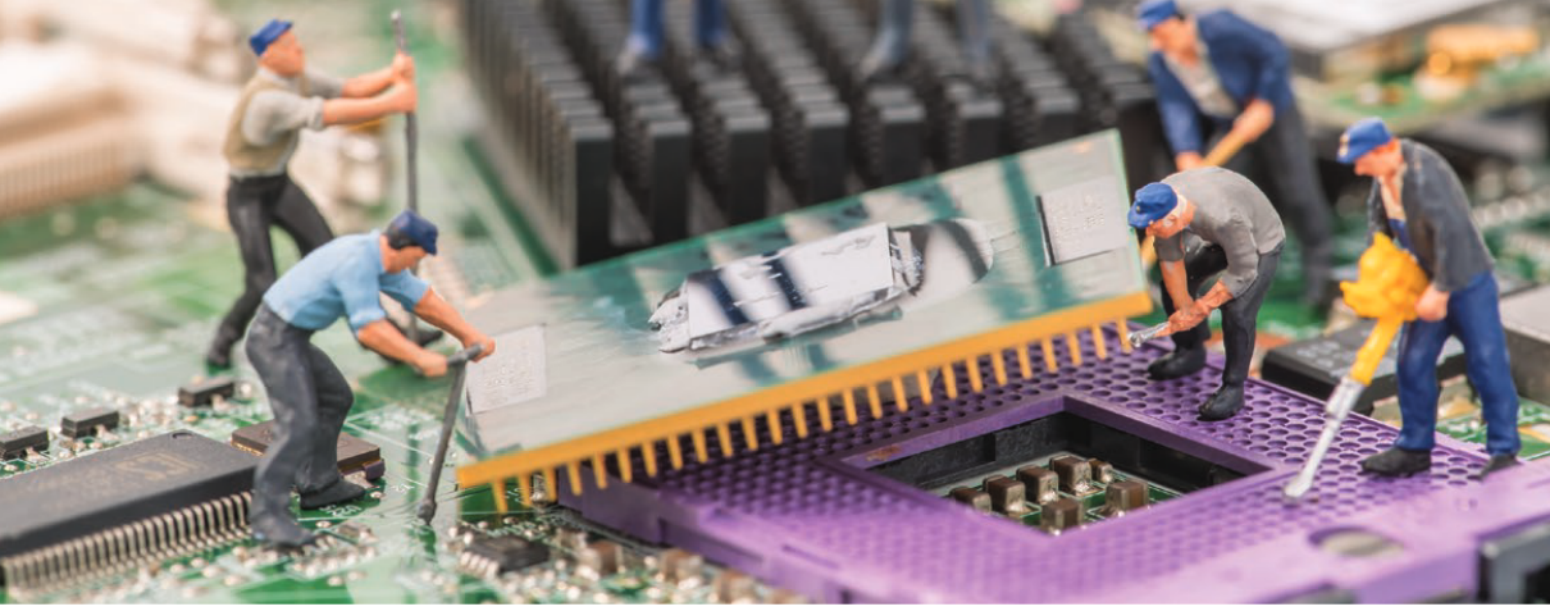

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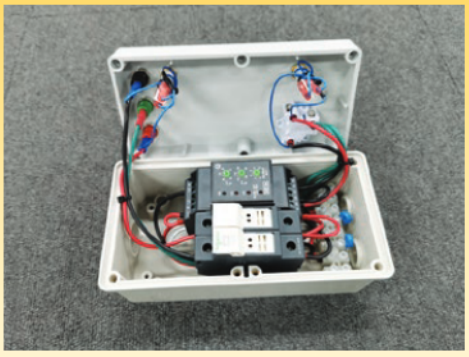

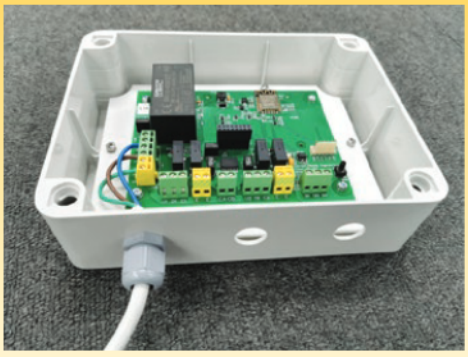

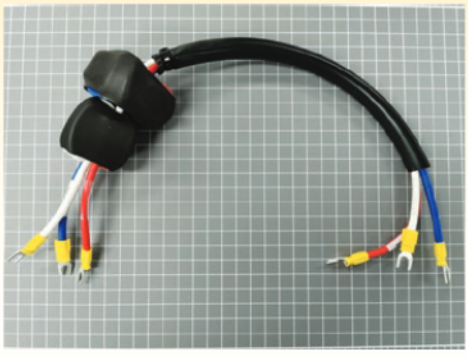

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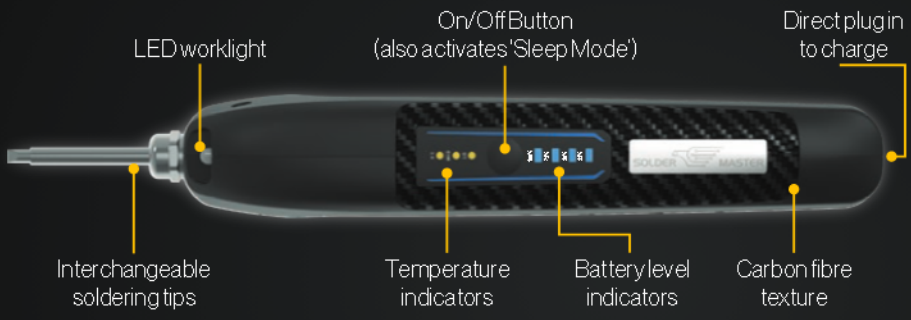

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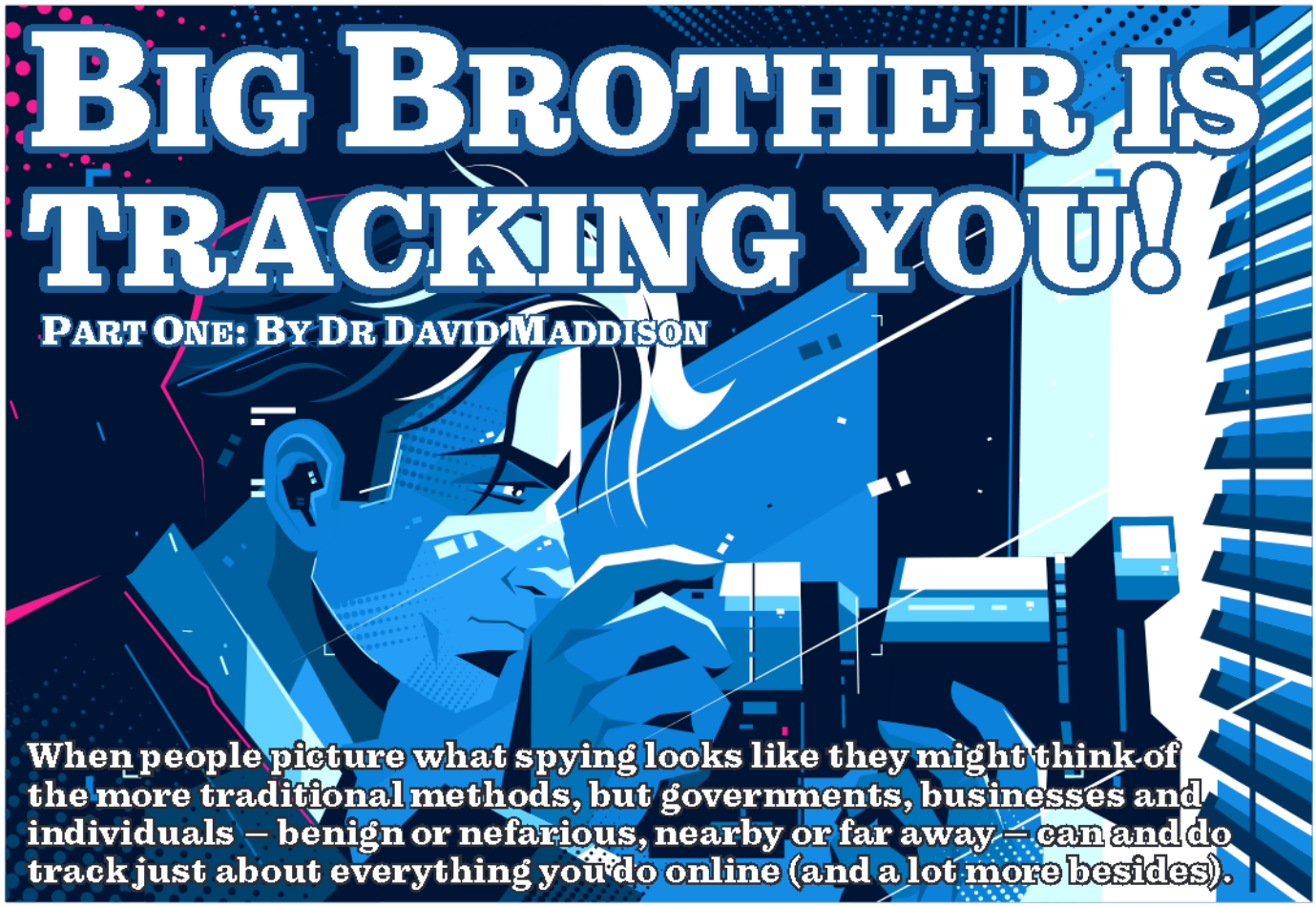

When people picture what spying looks like they might think of the more traditional methods, but governments, businesses and individuals – benign or nefarious, nearby or far away – can and do track just about everything you do online (and a lot more besides).

Human society has never been under as much surveillance as it is today. This is partly because the widespread use of computers means that every transaction, interaction and movement can be recorded. It's also because many governments and businesses have an insatiable lust to surveil their subjects, often with very few protections to guarantee any sort of privacy.

Many private organisations and criminals seek advantage from watching you as well.

While this all sounds pretty sinister, please note that surveillance itself is not necessarily illegitimate. There are good reasons (or excuses) to watch certain people, for example, violent criminals.

But the ease with which surveillance data is collected from people, both by government and corporations (especially 'social media giants'), makes it likely or even inevitable that such information will be misused.

Put it this way: it's much easier to trawl the ocean with a giant net, pull it up and see what you've caught than it is to catch a particular fish with a rod and line. But what if the net catches more than is intended? Perhaps some tasty but endangered fish. Can we trust the fisherman to throw those ones back?

Big problems can arise when the collected data is sold to third parties (usually for profit – how do telemarketers get your phone number?). Or when government(s) or corporations want to dictate what you see and hear.

Do you accept the adage "if you have nothing to hide, you have nothing to fear"? Famous whistleblower (or, depending on whom you ask, criminal leaker) Edward Snowden said that "Arguing that you don't care about the right to privacy because you have nothing to hide is no different than saying you don't care about free speech because you have nothing to say."

As you read the following, note that all the information presented in this article is readily available from public sources.

We won't discuss old-fashioned surveillance methods like reporting on your neighbours, as is standard in dictatorships. We will restrict ourselves to providing a taste of some of the more interesting and current electronic methods. We say taste because there is so much digital surveillance going on that we can only scratch the surface (and not all of it is public knowledge).

Facebook, Google, Twitter and LinkedIn are examples of 'free' services which collect user information. It's a matter for the individual whether the information they give out is worth the benefit from the platforms they use.

On related topics, see our past articles on the History of Cyber Espionage and Cyber Weapons in the October and November 2019 issues (siliconchip.com.au/Series/337).

Tracking privacy concerns can be broadly divided into two categories: governmental & non-governmental. Given that the government makes the laws (and often can ignore them), clearly there is more scope for losing privacy to government actors.

Part one of this article will concentrate on investigating non-government actors (typically large corporations) and will also discuss some options you have for enhancing your privacy.

Next month, the follow-up article will detail how governments, including ours, can and do track their citizens.

Free services

Pretty much nothing is truly free – as the old saying goes, "there ain't no such thing as a free lunch". 'Free' services offered on the internet and via your phone usually compromise your privacy with extensive recording and analysis of almost everything you do. One of the objectives is to use your information for targeted advertising or other purposes.

You may be receiving a 'free' service but giving away an extensive profile of yourself. There's another, more modern saying which goes something like, "If you are not paying for it, you're not the customer; you're the product."

How people are surveilled or tracked

We should first consider some ways that surveillance is possible before we discuss specific technical details.

The following, at a minimum, allows you to be surveilled:

- Using an internet connection (wired or wireless), or other network connection such as Bluetooth or a mesh network.
- Using a wired or wireless phone.
- Connections established via Internet of Things devices ("IoT").
- Making purchases with a credit card, debit card or mobile phone.
- Being subject to facial, voice or car number plate recognition (see our April 2019 article at siliconchip.com.au/Article/11519).
- Being listened to or observed by microphones or cameras on your smart TV, mobile phone or PC.

Until the universal adoption of mobile phones, the main ways people could be surveilled was by inspection of telephone and banking transaction records (eg, credit card purchases). But with smartphones, everyone has their own personal tracking device, and many details of one's life is frequently recorded on it (or on other nearby devices).

In addition, effective facial and car number plate recognition technologies mean that you can be recognised anywhere there is a camera or anywhere a picture is posted online.

EXIF data

It is often possible to tell where a photo is taken. Many photos posted online contain so-called EXIF data, which often includes GPS coordinates. Even if it doesn't, it is possible to use Google Earth (or other) imagery to work out where a photograph was taken.

Sometimes even if an image file lacks EXIF data, it might be possible to find another copy of the image online with the EXIF data intact by using a "reverse image search" (described later in this article).

Now virtually the whole Earth has been mapped, including street views, in visual databases such as Google Earth. So there is enough data available that a skilled person can use Google Earth to determine the location a photo was taken using only visual clues.

Some see this as a challenge; there is a YouTube channel by "GeoWizard" (www.youtube.com/c/GeoWizard) who, in his "Geo Detective" series, invites viewers to submit random photos of themselves. He then uses his Google Earth skills to work out where the photo was taken.

See "Can I pinpoint the EXACT location of my fans using a single image?" at https://youtu.be/k-5J0kL7aRs

If one had high-level access to the Google Earth database (or similar), this could possibly be done automatically, using scene-matching algorithms without human intervention.

Other tracking methods

Every smartphone has a GPS, but even if this is deactivated, mobile phones can still be tracked by signal triangulation or via nearby WiFi networks, regardless of whether you have connected to them. Some Apps track your location this way.

Voice recognition is now good enough to work reliably, without training, in real-time. A stream of your voice converted into plain text can be easily searched by anyone who has access to it.

Social media companies have been known to search speech-to-text logs for 'forbidden' topics they wish to censor, blocking posted videos and the like, regardless of the author's qualifications.

Global Positioning System	
GPS Altitude	31.9 m
GPS Latitude	6deg 14' 7.620"
GPS Longitude	106deg 49' 30.210"
Image Information	
Date and Time	2018:08:24 15:47:27
Manufacturer	Apple
Model	iPhone 6s
Photograph Information	
Aperture	F2.2
Exposure Bias	0 EV
Exposure Mode	Auto
Exposure Program	Auto
Exposure Time	1/874 s
Flash	No, auto
FNumber	F2.2
Focal Length	4.2 mm
ISO Speed Ratings	25
Metering Mode	Multi-segment
Shutter speed	1/874 s
White Balance	Auto

EXIF (exchangeable image file format) data is created when taking photos using a camera, phone or other system. It stores some identifiable information such as GPS co-ordinates, the date & time when the photo was taken along with camera information such as focal length, aperture etc.

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USB Cable Tester

It's frustrating when a USB device doesn't work, and you don't know if it's a problem with the device itself or the cable. This is a huge problem if, like us, you have a drawer full of USB cables and don't know which ones are good or provide power only. Bad cables can also cause intermittent problems. Now there is an easy way to test all manner of USB cables; this USB Cable Tester is so handy, we think you will find it indispensable!

Part 1: by Tim Blythman

There is not much worse than an intermittent fault when it comes to checking and diagnosing faulty gear. It's worse if it is due to a dodgy cable because you can never be completely confident that you have ruled out other problems. So it's crucial to be able to test cables for this reason.

These days, a lot of gear connects with USB cables and not just when it's attached to a computer. Practically all mobile phones use USB for charging, and they've also found many niche uses due to their ubiquity, even for devices like shavers and toothbrushes.

So we've designed a USB Cable Tester that can check practically all standard USB cables. If you're like us, you probably have a mix of the latest cables (such as USB-C) and a good number of older types (such as mini- and micro-USB).

The USB Cable Tester will test any cable with either a USB-C or USB-A (2.0 or 3.2) plug on one end and any USB-C or USB-B plugs (such as 2.0, 3.2, micro or mini) on the other end. With some basic adaptors, you can also test common variants such as OTG ('on-the-go') cables and non-standard cables, such as those with USB-A plugs at both ends.

This device is compact and automatic. Simply plug a cable into the appropriate sockets, and it immediately gives you an assessment. You will know straight away if the cable is suitable for your purpose.

Testing

The USB Cable Tester performs two primary tests. Initially, the various conductors in each cable are tested for continuity at low current.

This test can pick up whether, for example, a given lead has the appropriate internal data connections for USB 2.0 or USB 3.2, or whether it can carry power only.

It can also detect internal short circuits which can interfere with normal operation.

The Tester can also perform a high-current test on the VBUS and GND leads to establish how much current the cable can handle without dropping excessive voltage.

Checking the ability of the cable to carry current is arguably the most useful test, as it allows detection of the most subtle and intermittent faults. These are the faults where the device seems to operate normally but fails when a burst of current is needed. The device resets due to its supply dropping out and might even immediately start working again.

Devices like portable hard drives, which often require significant current, are especially prone to this problem.

None of these tests characterise the high-speed data performance of the cable; much more specialised equipment is needed to do this. Still, these tests are performed very quickly and can be used to give a very fast 'go/no-go' assessment on a cable.

With the rise of the Right To Repair movement, we think that the USB Cable Tester will become indispensable in places like Repair Cafés. We shudder to think how much good gear has been discarded due to having a faulty USB cable.

Background

Before delving in, you might like to look at some recent articles we have published. The June 2021 article on The History of USB (siliconchip.com.au/Article/14883) describes the connectors and wiring that the USB Cable Tester needs to work with.

That would be a good article to read if you're interested in understanding and repairing USB cables.

The front panel gives access to the six USB sockets: two downstream facing ports (DFPs) at left and four upstream facing ports (UFPs) at right. To test a cable, you plug one end into either of the DFPs and the other end into one of the UFPs. It does the rest automatically.

The July and August 2021 issues also included articles on How USB-C Power Delivery (USB-PD) Works (siliconchip.com.au/Article/14919), the operation of USB-PD Chargers (siliconchip.com.au/Article/14920), and USB-PD Triggers (siliconchip.com.au/Article/14996).

USB power delivery is a relatively recent addition to the USB standards and is not something our unit tests; these power delivery features are usually built into devices rather than cables.

Both this article and the USB Cable Tester use USB 3.2 to refer to any cables that you might know as USB 3.0 or USB 3.1, since the USB 3.2 standard replaced (and is backwards compatible with) both USB 3.0 and USB 3.1. This is a similar situation to the way that USB 2.0 encompassed and replaced USB 1.0 and USB 1.1; it's now common to refer to devices compatible with these as USB 2.0.

Design

Before delving too deeply into the circuit details, we'll mention some of the design considerations that we made along the way. We designed the USB Cable Tester to be economical to build, easy to use and robust enough for regular use.

While it certainly would be possible to do this job without a microcontroller, that would entail a complicated design.

Add in the fact that the nature of the test results are often more than a simple numeric result or basic binary go/no go, and a microcontroller is an inevitable part of the circuit.

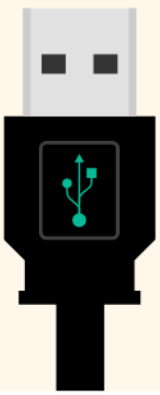
With that in mind, we've used a 40-pin PIC microcontroller. Any fewer pins would require a multiplexer or switch, adding complexity and cost. Rather than fall back on one of the old-fashioned 40-pin micros like the PIC16F877, we've decided to get with the times and use its modern descendant, the PIC16F18877.

The microcontroller displays the test results on a 20x4 character LCD, allowing simple 'human-readable' assessments to be delivered. Thus the USB Cable Tester can be used by even those with no electronics experience.

The low-power features of this new microcontroller mean that a power switch can be omitted. This may seem like a small saving, but it's one fewer part to consider during design and construction and shaves a few dollars off

Features & specifications for the USB Cable Tester

1. Test just about any USB cable
2. Current pulse tests at 100mA, 500mA and 1A
3. Downstream facing ports can accept USB-A (2.0/3.2) or USB-C (3.2)
4. Upstream facing ports can accept USB-B (2.0/3.2), USB-C (3.2), Micro-B (2.0/3.2) or Mini-B (2.0)
5. Reports faults with individual cable ends (eg, plug with bare wires or detect OTG cables)
6. Can differentiate between power-only, USB 2.0 & USB 3.2 cables
7. Will report short circuits, open circuits and other faults
8. Reports voltage drop and cable resistance at usable currents



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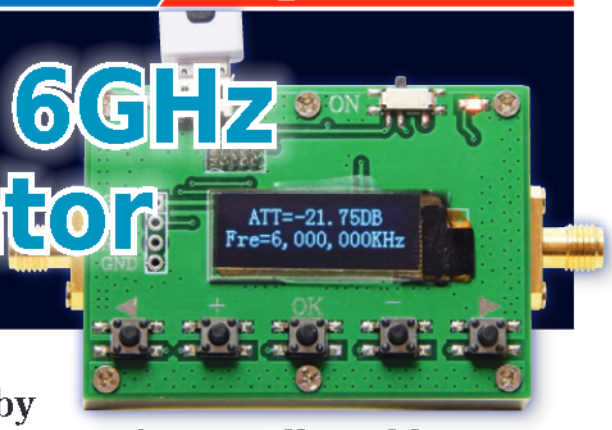
By Jim Rowe

Self-Contained 6GHz Digital Attenuator



This new digitally-programmable module can attenuate signals from 1MHz to 6GHz by 0 to 31.75dB in 0.25dB steps. You control it using five small pushbutton switches, while a tiny OLED screen shows the current setting.

I recently reviewed a new and small digitally-programmed UHF step attenuator module that could attenuate signals from 1MHz to 3.8GHz by 0-31dB in 1dB steps (October 2021; siliconchip.com.au/Article/15067). It has an inbuilt microcontroller, and the attenuation is set using four small pushbutton switches.

The results were quite respectable overall, although there seemed to be a bit of contact bounce with the pushbutton switches and the RF output and power input connectors were too close together.

As I finished writing that review, I became aware that a slightly larger digital attenuator had become available, with a broader frequency range and 0.25dB attenuation steps rather than 1dB.

New module

The new module is likely available from several suppliers on the web, but I ordered the one shown in the photos from Banggood, catalog code 1648810. Currently, it's priced at $51.80 plus $6.70 for shipping to Australia. Like the earlier 3.8GHz module, it's almost certainly made in China.

The new module measures 56 x 40 x 16mm overall, not counting the SMA connectors at each end for RF input and output.

The digital attenuator section is on a small PCB fitted down inside a 56 x 40 x 10mm CNC machined aluminium block which forms the module's 'case'. The rest of the module's circuitry is mounted on a second PCB measuring 56 x 40mm, which forms the top of the case.

The OLED panel is mounted on the top of this PCB in the centre, along with the micro-USB power socket, the mini slider power switch and a tiny SMD power LED. Then along the PCB front are the five small pushbutton switches used to select the attenuation setting. Presumably, the rest of the controller circuitry is mounted on the underside of this PCB.

The UHF attenuator chip is probably the Analog Devices HMC1119, a 'big brother' to the HMC472 used in the aforementioned 3.8GHz attenuator.

According to the Analog Devices data sheet, the HMC1119 has a range of 100MHz to 6.0GHz and seven control bits, giving a setting range of 0 to 31.75dB in 0.25dB steps. It has a specified insertion loss of 1.3dB at 2.0GHz, drooping to around 1.5dB at 3.5GHz and a whisker below 2.0dB at 6GHz. Pretty impressive!

As with the 3.8GHz attenuator, I couldn't find a full circuit for the new module, so I could only work out a basic block diagram for it, shown in Fig.1.

The RF1 input and RF2 output pins of the HMC1119 chip are coupled to the SMA input and output connectors via capacitors. Apart from various bypass capacitors, that makes up all of the actual attenuator section.

Below is the control section, based on a microcontroller (possibly an ST-

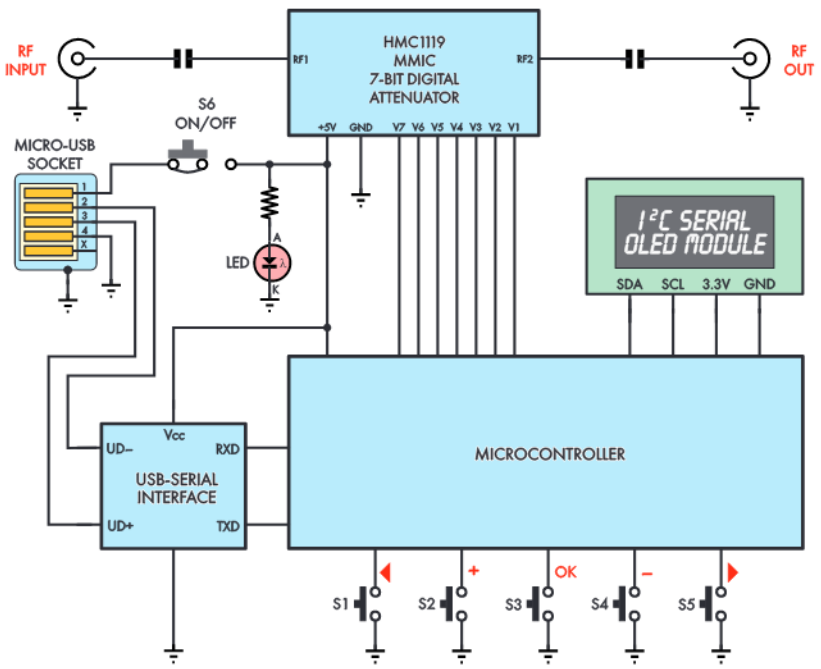


Fig.1: a simplified version of what we expect the block diagram the 6GHz attenuator to look like, as there is no full circuit diagram available.

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Review by Andrew Woodfield

R80 Synthesised Aviation Band Receiver Kit

This moderately priced receiver kit (about $50) is easy to build, simple to use and ideal for monitoring local airport traffic. It uses digital frequency synthesis for excellent stability and ease of tuning, and has a digital frequency readout.

Commercial aviation uses HF, VHF or even satellite frequencies to serve their communication needs. The majority of voice calls use the 118-136MHz VHF aviation band. This band extends to 137MHz in many countries, including Australia.

Conversations between pilots and airport towers, air traffic controllers, ground services and local aero club aircraft traffic are all routinely heard on this band. It has long been a very popular band for those interested in monitoring local radio services.

Amplitude modulation (AM) is used on this VHF band, rather than either frequency modulation (FM) or one of the new digital modes, which are usually encountered with commercial VHF and UHF mobile radio or amateur ('ham') radio services.

While some perceive AM as outdated, it improves communications safety and has proven to be very reliable over many decades. Even today, AM is also surprisingly spectrally efficient.

This R80 aviation band receiver is a recent entry targeting this band. Offered primarily as a DIY kit, it features a digital phase-locked loop (PLL) tuning system and digital display on a compact 120 x 85mm PCB.

This kit offers several improvements over older aviation receiver kits, which typically used traditional analog tuning and lacked any form of frequency display.

Kit delivery

While it is available from various internet suppliers (including on eBay and Amazon), I bought mine from a seller on AliExpress. It was well-packed with all of the parts and PCBs in plastic bags. A couple of layers of bubble wrap had been wrapped around the kit before placing it inside a cardboard box.

The parts supplied are of good quality, with the seven ICs shipped in pin-protecting foam. It is not anti-static foam, but that's still a lot better than getting a bag full of loose ICs (and that is, sadly, all too common when you order from places like AliExpress these days). Most of the chips supplied are not static-sensitive, only the PIC microcontroller.

Assembly instructions must be obtained by email from the kit supplier. These were in Chinese, but most details were fairly obvious. The schematic, also partly annotated in Chinese, was included in these instructions. A detailed English translation is available can be downloaded from siliconchip.com.au/Shop/6/5950

Three PCBs are supplied in the kit: the main receiver PCB, a smaller display PCB and a PLL PCB. SMD parts are pre-fitted on these PCBs, saving builders from any anxiety on that issue.

One minor point: the 7-segment LED display driver SMD IC had its part number sanded off. If it fails, finding a replacement could be a problem.

Checking against the parts list in the instructions revealed that two parts were missing: a 100µF capacitor and a 10-way right-angle pin-strip connector for the display PCB. Three extra ceramic capacitors were supplied. To avoid delay, I purchased replacements from a local retail supplier and set the extra parts aside.

How the receiver works

Fig.1 shows a block diagram of the receiver. It's a double-conversion superhet with a first intermediate frequency (IF) of 10.7MHz and second IF of 455kHz. The incoming signal passes first through a bandpass filter (BPF) and the NE5204 10dB gain RF amplifier, then into the first mixer, an NE602.

The oscillator for this mixer uses the popular Si5351a digital PLL chip. Its 25MHz reference crystal delivers both excellent stability and tuning accuracy. One of the three square-wave outputs of this chip is filtered via a five-pole low-pass filter to give the desired sinewave signal for the mixer.

A Motorola MC3361 FM mixer/demodulator chip contains the second mixer. This converts the 10.7MHz first IF signal down to the second IF of 455kHz using a 10.245MHz crystal oscillator. The receiver's selectivity is mainly provided by 15kHz bandwidth 455kHz ceramic IF filter.

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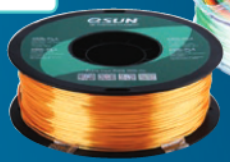

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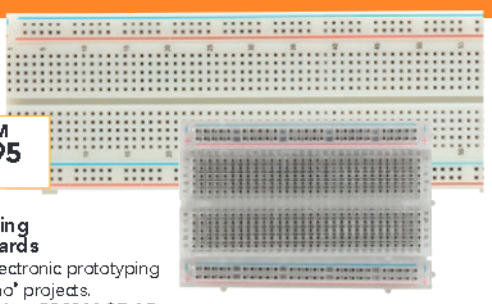

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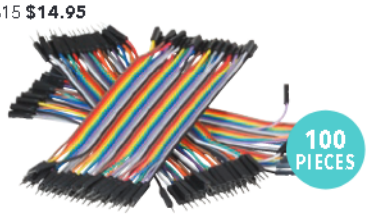

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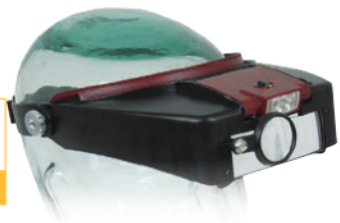

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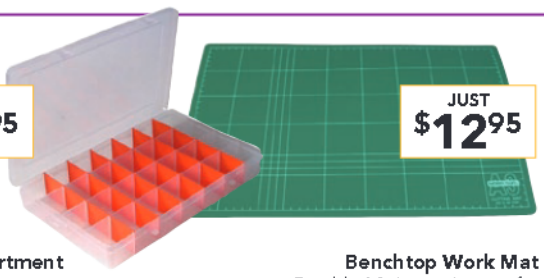

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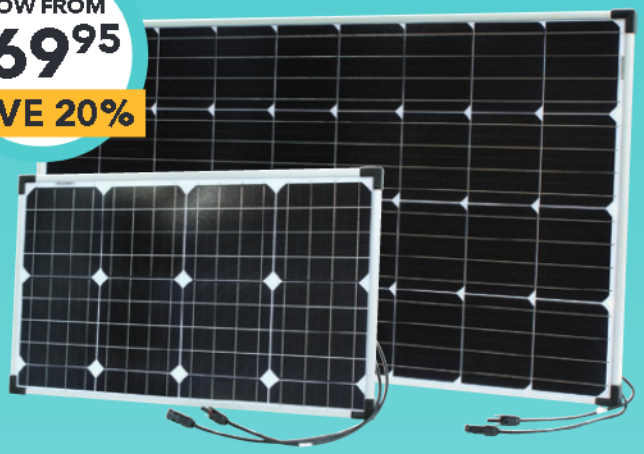

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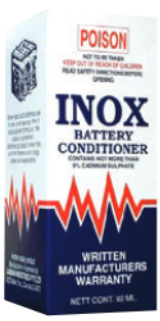

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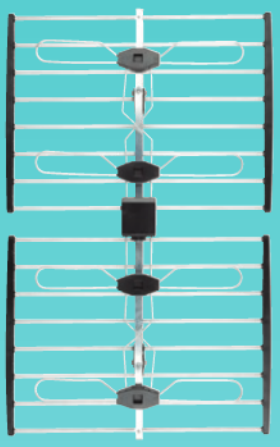

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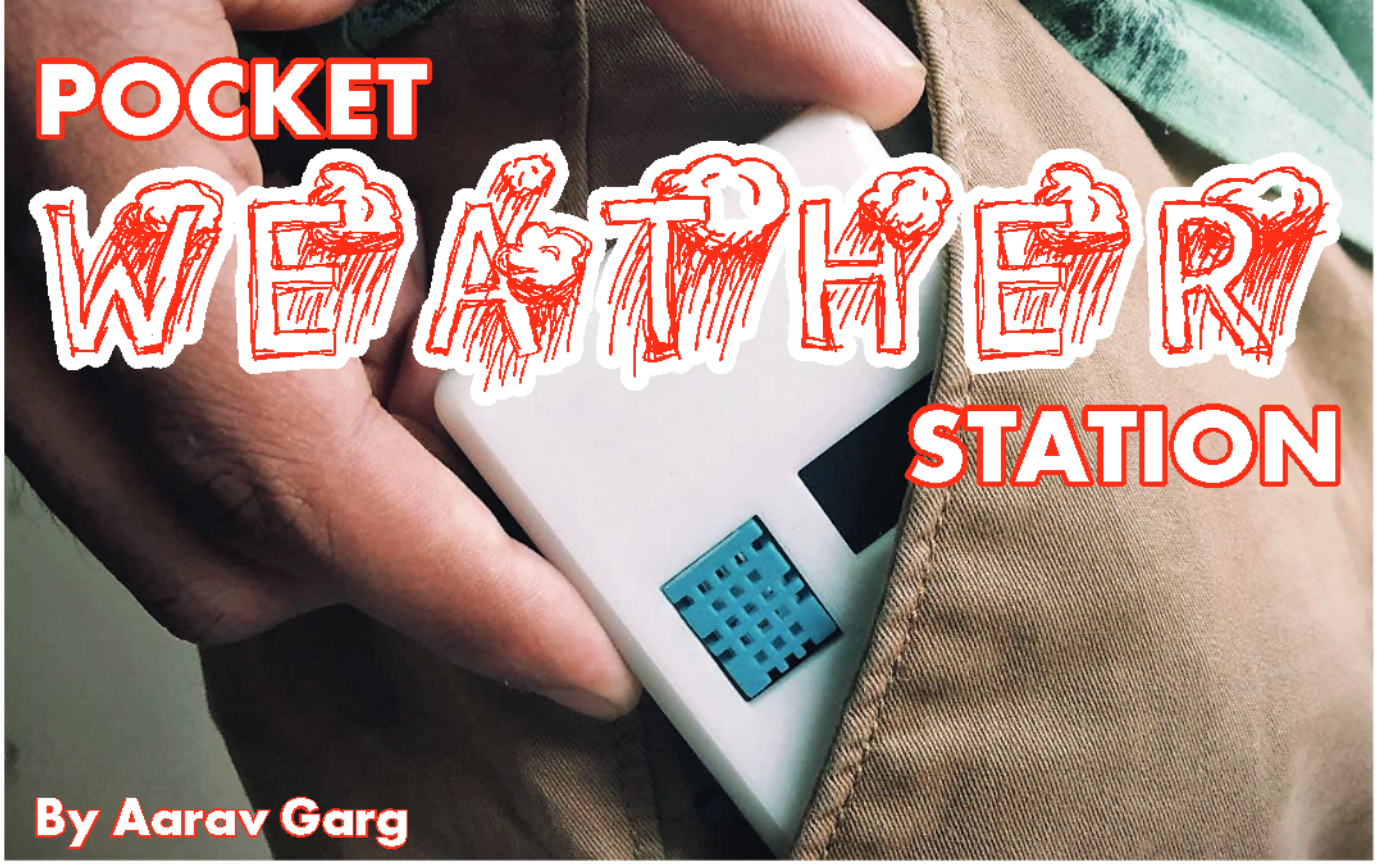

POCKET WEATHER STATION

By Aarav Garg

We're often describing how you can buy and use very low-cost electronic modules. They're great because they save you a lot of assembly time and soldering work, and they usually cost less than the parts you would need to build them! Here is an excellent beginners' project that uses five such modules to make something useful – a mini weather station you can carry everywhere with you.

Is it hot in here, or just me? That's a question you don't have to ask anymore with this Pocket Weather Station.

It is a compact device, powered by an Arduino Nano board, that you can carry anywhere, right in your pocket. It displays the current temperature and humidity on its OLED screen. Sure, you may have the local weather report on your phone, but it's amazing how much local temperatures can vary from those recorded elsewhere in your area.

Plus, knowing the indoor temperature and humidity can be pretty helpful, as how hot or cold it 'feels' is strongly affected by humidity, not just temperature. Even with moderate temperatures, high humidity can make you sweat more than a more intense dry heat!

One reason it's so portable is because of its integrated, rechargeable 160mAh LiPo battery.

It is an excellent project for learning and is also really fun to make. It even comes in handy sometimes!

Sound interesting? Then let's dive right in!

First steps

The first thing to do when beginning with any project is gathering the required components. The required components are listed in the Parts List. They are mostly available from online marketplaces like eBay, AliExpress and Amazon.

While they are inexpensive, chances are they will come from overseas, so allow a few weeks (or even months) for delivery.

By the way, the DHT11 is a smaller, less accurate version of the DHT22 temperature/humidity sensor that we have used in the past and described in the February 2017 issue (siliconchip.com.au/Article/10529). Its small size is useful in a pocket device.

As it incorporates both temperature and humidity readings, we only need the one sensor. The other parts are the Arduino board to query it, the display to show the readings and the charger to keep the battery topped up.

You need a few basic tools to build the Pocket Weather Station: a soldering iron, hot glue gun (or even better, a tube of neutral-cure silicone sealant and a caulking gun) and, if you're going to make the optional case, a 3D printer.

Preparation

Now we need to plan the position of all the components inside the enclosure. I wanted to keep the device as thin as possible, so it is actually convenient to carry in a pocket. Thus I spread all the components out and did not go with a layered structure. That would decrease the width and height, but increase the thickness.

Fig.1 shows how I stacked the components inside my Pocket Weather Station. I used an Arduino Nano board because of its size, which is perfect for this project. You could also come up with your own method of stacking the components in ways that reduce the

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MODEL RAILWAY CARRIAGE LIGHTS

BY LES KERR

It's nice to have carriage lights on a model train, to add to the realism. These model train carriage lights (designed for OO-gauge) are battery-powered and can be switched on and off with an external magnet.

It might seem trivial to add lights to a model railway carriage, but there are a few considerations that make it a bit more difficult than that. One important factor is that the battery must be small, so the circuit must avoid discharging it when the lights are off. Also, you need a way of switching the lights on or off easily.

This little circuit powers five white LEDs and only draws a couple of microamps when off, and just 8mA when on. The low off-current puts a negligible load on the battery. The low 8mA operating current means that you can use two AAA batteries (cells, really) in series giving 3V this will power the circuit for about 100 hours. If you lack the space for that setup, you can use a single 3.7V Li-ion 800mAh battery such as the Jaycar SB2300.

The carriage size determines which batteries can be used. The circuit stops working when the battery falls below 2V.

Until recently, lights in model railway carriages were powered from the track. This is because small incandescent lamps required a relatively large current, so they couldn't be battery powered. To obtain the power, the carriage needed to have metal wheels with some form of voltage pickup attached to them, and they had to be insulated from each other.

Today, most carriage wheels are made of plastic, so they need substantial modification to pick up power from the track. Also, it isn't that easy to make a reliable pick up.

Now that efficient white LEDs are available, it is practical to power them from a small battery inside the carriage. The problem then becomes how to switch the lights on and off.

My simple solution is to mount a normally-open reed switch inside the carriage, either under the roof or on the floor. When a magnet is placed near the reed switch, its contacts close, signalling the circuit to toggle the lights on or off.

You can see a video of the prototype's operation at siliconchip.com.au/Videos/Carriage+Lights

With this arrangement, you can add a magnet on the tracks just outside a tunnel so that when the train approaches, it switches the lights on. Another magnet placed near the tunnel exit switches off the lights when the train leaves the tunnel. If you want to use the train at night, you can mount the reed switch under the roof so that you can manually switch the lights on and off by waving a magnet across it.

Circuit description

Fig.1 shows the full circuit diagram. The LT1932 IC2 constant-current DC-to-DC LED driver provides a fixed current that drives the series LED lights from the battery. It is about 70% efficient and will work down to a battery voltage of 2V. It has a shutdown input that, when taken low, switches off the LEDs and reduces its current draw to less than 1µA.

I have specified high-intensity white LEDs which give adequate light when driven with 1mA. The 70% efficiency figure given above is for a 10mA LED current. To reduce this to the 1mA required without unduly affecting the efficiency, the shutdown pin is fed with a 10% duty cycle (1-to-9 mark-space ratio) PWM waveform.

The driver oscillates at 1.2MHz and uses inductor L1, schottky diode D1 and a 1µF ceramic capacitor to step up the battery voltage to the 15V or so needed by the LED string. To protect IC2 in case the LEDs are accidentally disconnected, 24V zener diode ZD1 clamps the maximum output voltage. The peak current through the LEDs is

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VINTAGE RADIO

Stromberg-Carlson 1936 model 496 mantel radio

By Associate Professor Graham Parslow

After many years at the masthead of Vintage Radio, finally, here is an article on the feature radio! It's an early superhet with Art Deco styling. You can see the dramatic change between its pre- and post-restoration appearance.

This radio was a one-family treasure until it came to me for restoration from Peter Lockhart (retired from careers in electronics and IT). Peter wrote:

"My first recollection of this Stromberg Carlson 496 was that it belonged to my great aunt, Beatrice Krentzin, who lived in Perth most of her life. She grew up in the goldfields of WA at the turn of the 19th century. It was used as a mantelpiece set. Though not very loud, it had a 'lovely tone'."

"For a long time, it was the family radio (ie, the only one). I recall it was not particularly sensitive to radio stations, particularly as the ABC 50kW 6WF transmitter was only 6km away. The fact that it could not play 'pop music' loudly added to its general appeal. It was a trusty deliverer of the news and sports and world events over a long period."

"The radio passed to my mother in the 1970s and was fully functional at that time. It then became something of a favourite ornament. I have carted this radio around for more than 30 years with good intentions to restore it. Unfortunately, the opposite occurred, and suboptimal storage only added to the woes of the poor old 496."

The circuit

Fig.1 is the radio's circuit diagram. Later superhet radios used dedicated converter valves with functionally distinct oscillator and mixer sections. Instead, the model 496 uses a 6C6 6-pin pentode as an autodyne oscillator with the signal introduced at the top-cap grid, at the frequency selected by the aerial coil and tuning capacitor. The coupled oscillator coils are drawn below the 6C6 valve.

Local oscillator (LO) action is accomplished using anode-cathode feedback. The mixing function is created by the LO-modulated electron stream from the cathode interacting with the input signal at the control grid

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The cover price of the October issue onwards is now $11.50 in Australia. The New Zealand cover price remains the same at $12.90.

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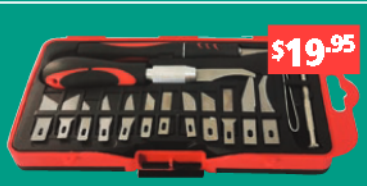

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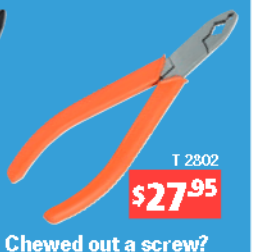

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P2176	Dual M8 Black	$12.95
P2182	Single M10 Red	$10.95
P2183	Single M10 Black	$10.95
P2177	Dual M10 Red	$14.95
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A0346

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Tobbie is back and he's had an upgrade! Powered by the popular BBC micro:bit board, this version has unlimited scope for self programming. Front screen displays text & symbols. Great for teaching kids coding. Requires 4xAAA batteries & micro:bit board. **Ages 8+**

Requires Z 6439A microbit ($27.95).

K 1150
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Assemble 4 robot designs which teach kids about geared movement in a fun way! Requires 1xAA battery. No soldering required. **Ages 7+**

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Features a central coding ring which tells the robot directions and when to perform actions. Can be built and re-built 5 ways. Teaches kids about coding with no computers required! Requires 1xAAA battery. **Ages 8+**

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H 5030 3RU

SAVE $28
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S 0911 Green
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S 1148

USB Interface For Joystick & Buttons

A handy interface board for a joystick and up to 12 arcade buttons. Includes pre-terminated cables.

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S 1147

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SAVE $60
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Large Touchscreens For Raspberry Pi®

• Great for integrated projects, game consoles, information stands, mini PCs etc • Works with raspbian & ubuntu • HDMI connection.

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W 2431 Stranded. W 2430 Solid Core.

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6 colour hobby pack for project building. 10m of each colour.

NEW!
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A huge assortment of single row header connectors. Includes male & female pin headers, plus 2.54mm housings.

NEW!
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Straight boxed 2.54mm PCB connectors and plugs in 2, 3, 4 and 5 way. Plus crimp pins to suit plug housings. 150pcs total.

JUMBO value pack!

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$19
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171pcs of 75mm & 45mm lengths in a range of colours & sizes (3.2 to 12.7mm). 2:1 shrink ratio.

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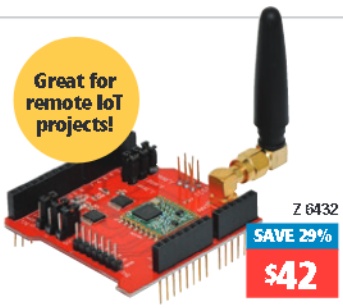
Add GPS location to a Arduino/Pi project, aircraft or drone. 3.3/5V logic level. Includes 6x20mm ceramic antenna. Also available as an Arduino shield with active 28dB antenna (Z 6332 $69.95).



Z 6432
SAVE 29%
$42

LoRa Arduino Data Shield

Allows long range communication with an Arduino without the need for a GSM 4G network - even over distances of up to several kilometres! 3.3/5V input.

SAVE 25%
$22
P 1018A
350pc

SAVE 23%
$12
P 1014A
140pc

Prototyping Wire Packs

Handy packs of pre cut and trimmed solid core wire for breadboarding your next design!

Breadboard for big designs!

Huge breadboard with aluminium base for those designs that are beyond the scope of your average breadboard! Easy power connection via binding posts.

P 1012A
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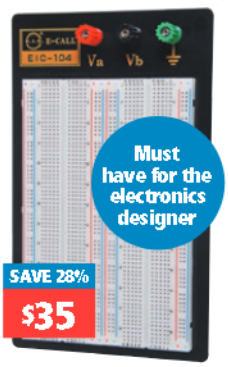

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$35

DIY Jumbo LED Signs

Z 6517 32 x 32 Was $59, NOW $30
Z 6518 63 x 32 Was $89, NOW $60

Link multiple panels together!

Order online @ altronics.com.au | **Sale pricing ends November 30th.**

Build & Experiment.

Build & code your own robot.

STEM bot is an easy to program 2 wheel obstacle avoidance and line tracking robot. Coding your program is easy using the standard BBC Micro:bit software. Simple construction with easy to follow instructions. Can also be controlled via Bluetooth. Runs from 18650 rechargeable lithium cells (S 4736 $18.50). **Ages 8+**

DIY Tinkerers Kit For Arduino

Includes an Arduino UNO compatible board, proto-shield, alphanumeric LCD, dot matrix LED module, 7 segment displays, two breadboards, stepper motor, servo, IR remote, connection leads, battery box and a variety of components, buttons and sensors.

MK2 Arduino MegaBox Kit by Altronics.

Developed in house by Altronics, this MegaBox has space for two shields, plus five 2A 5V relay outputs and eight opto isolated outputs. All UNO/Mega pins are broken out to header sockets for easy connection to other breakouts. A small 160 hole prototyping area is included for connecting to other sensors. *Arduino board & shields not included.

Robot Vehicle/Bug Base

A handy dual motor base for building your own mini robot design. Supplied with both wheels and rotating bug like legs.

Vehicle Base Builder Kits

With individual motors for each wheel with acrylic base for mounting control and sensor boards. Ideal base for your own Arduino robo-car design. Includes battery holder.

Arduino UNO+Ethernet Board

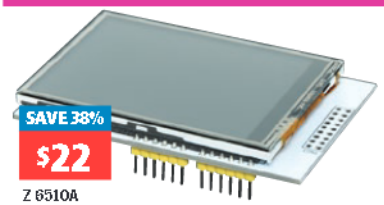
Connect your Arduino design to the internet-of-things with this handy W5500 ethernet board with atmega328p on board. Fully UNO compatible with USB download & micro SD slot.

ATDev Shield for ATTiny Kit

A powerful and versatile programming and breakout shield for ATtiny. Combine with a UNO for instant programmer and debugging.

Tried the new Pico Pi?

The latest Raspberry Pi microcontroller board. Get yours for just $8.95



2.8" Touch Arduino Shield

A 240x320px touchscreen shield for Arduino utilising the ILI9341 chipset. 3.3/5V input.

CAN-BUS Arduino Shield

Allows you to interface Arduino's with CAN-BUS control systems found in automotive electronics. Use an Arduino to build your own vehicle monitors.

Arduino Control Plate

Perfect for Arduino based automation projects, this handy wallplate has a atmega328p chip and is suitable for use with standard shields. K 9655

Arduino Keypad Plate

Perfect for Arduino based access control designs, this handy wallplate has a atmega328p chip and is suitable for use with standard shields.
K 9650

10 in 1 Electronics Lab Kit

A great way to pique a budding engineers interest with 10 exciting projects including a morse code generator, burglar alarm and a radio. Requires 9V battery.

200 in 1 Electronics Lab Kit

A huge array of fun projects to build for your little 'engineer of tomorrow'. Easy to read and follow instructions - teaches the fundamentals of electronics in a safe and fun way. Requires 6 x AA batteries.

300 in 1 Electronics Lab Kit

K 2222

The 'Rolls-Royce' model with all the bells and whistles. Teaches you about electronics from A to Z. You will learn about electronic parts, how to read schematics, and wiring diagrams. All this, while building up to 300 different projects. Requires 6 x AA batteries.

Order online @ altronics.com.au | **Sale pricing ends November 30th.**

Make your home smarter.

Wi-Fi RGB Strip Lighting Kit

This kit includes 5m of RGB strip lighting, power supply, controller unit and IR remote control allowing you to create colourful lighting effects around your home. Controller features a music sensor input allowing the lighting to trigger to music being played in the room. Great for home entertaining. Works with Alexa and Google Assistant. 60 LEDs per metre.

X3227*

$75.95

Answer the door when you're not home!

Wi-Fi Video Doorbell with Tuya smartphone app control and 2 way audio. This stylish doorbell connects to your wi-fi and notifies your mobile phone when a person arrives at your doorstep. Great for telling the postie where to put packages.

- Security camera mode
- Motion detect notification
- Includes power supply and indoor doorbell ringer unit.

$139

S9455A

HOT PRICE!

SAVE 13%

2 For $37

P8149

Automate your Xmas lights!

Switch any connected appliance on or off remotely from anywhere in the world. Set schedules, monitor and control via your using the Tuya Android/iOS app. Maximum 10A 2400W. Works with Google Home and Alexa

What is Tuya® Smart Home?

Tuya is a common application for thousands of products from the worlds leading Smart Home suppliers. It provides a single point of control for home security, lighting and appliance power allowing you to control everything you need from a the one smartphone app. The Tuya IoT platform powers over 250,000 home automation products across the globe!

Powered by tuya Intelligence Inside

Tuya® Compatible Cameras. NEW!

All Tuya cameras provide 1080p HD vision with audio and can be located anywhere you require camera coverage in your home.

$89.95

S9846

Mini Wi-Fi Cube Camera

- Internal battery - set it up anywhere! • Day/night with IR • USB rechargeable • 100 mins motion activated recording time.

$89.95

S9844

Wi-Fi Camera Module

- Ultra compact module can be built into custom enclosures • Completely wireless - set it up anywhere! • USB rechargeable • 100 mins motion activated recording time.

$169

S9850

Wi-Fi HD Camera Clock

- Real alarm clock function • Two-way audio (mic & speaker) • Motion detect recording • USB or battery powered (S4736 x 2 $18.50ea)

*Note: We encourage this item be used responsibly for legitimate CCTV use.

S9845A

$199

Outdoor Solar Powered Camera

- IP66 rated for outdoor use • Two-way audio (mic & speaker) • Motion detect recording • 2MP 1080p HD sensor • Day/night operation with IR • Battery powered (included) with solar recharging - mounts anywhere!

Cable Free Wi-Fi Surveillance

This handy 1080p camera can be installed just about anywhere indoors or out and has an in-built battery so you don't need to run any cables! Offers 4-6 months of motion detect recording. When it's flat, just take it off the wall & recharge via USB. Suits sheltered outdoor use.

$199

S9843B

Outdoor Pan & Tilt Wi-Fi Camera

Provides extra coverage to your outdoor spaces with motorised pan (355°) and tilt (100°). Auto-tracks moving objects within the frame. Constructed from UV stabilised plastic with weatherproof rating to IP66. 2-way audio with mic and speaker. 30m IR night time coverage. Requires 5V 2A USB power supply.

S9020

$139

Indoor Pan & Tilt Wi-Fi Camera

Makes a great baby or pet monitor, this camera features intelligent tracking of moving objects within the frame. 2-way audio with mic and speaker. 5m IR night time coverage. Requires 5V 1A USB power supply.

$79.95

S9017A

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» Midland: 1/212 Gt Eastern Hwy	08 9428 2169
» Myaree: 5A/116 N Lake Rd	08 9428 2170

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» Springvale: 891 Princes Hwy	03 9549 2188
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Find a local reseller at: altronics.com.au/storelocations/dealers/

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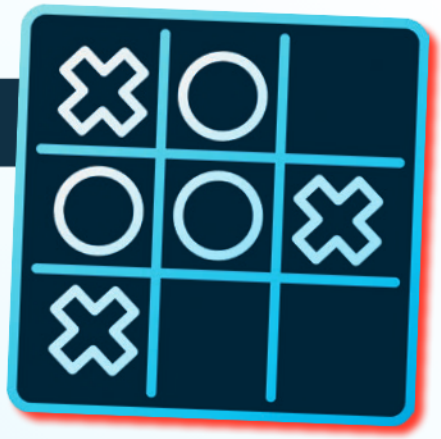
B 0091

Design Contest Win $500+



Dick Smith challenges you
Win $500 by designing a noughts-and-crosses machine that can beat 14-year old me!

Dick Smith has described in his new autobiography how one of the turning points in his life, at age 14, was succesfully building a 'noughts-and-crosses machine' (also known as tic-tac-toe) that could play the game as well as anyone. Keep in mind that this was in 1958, when nobody had computers; it was a purely electromechanical device.

Email Design to Enter

Design your own noughts-and-crosses circuit and send your submission to compo@siliconchip.com.au including:

a) Your name and address
b) Phone number or email address (ideally both)
c) A circuit or wiring diagram which clearly shows how the device works
d) The display can be anything as long as it's understandable
e) Evidence that your device can always play a perfect game (it never loses)
f) A video and/or supply images and text describing it
g) Entries requiring software must include source code

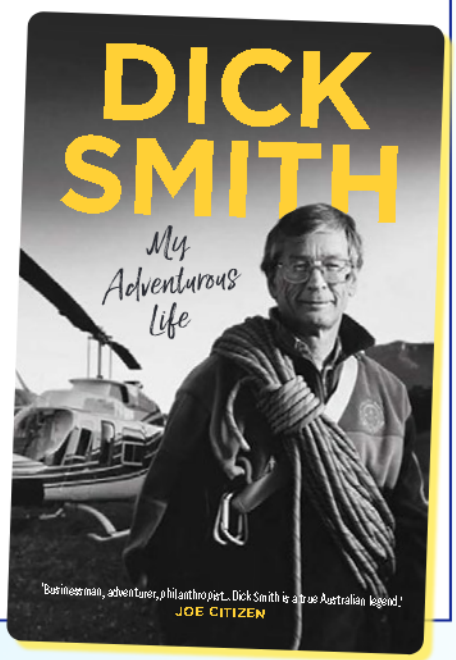
The deadline for submissions is the 31st of January 2022.

Win $500 + Signed Copy of Dick Smith's Autobiography

Four winners to be decided, one each for the following categories:

1. The simplest noughts-and-crosses playing machine
2. The most ingenious noughts-and-crosses playing machine
3. The youngest constructor to build a working noughts-and-crosses playing machine
4. The most clever noughts-and-crosses playing machine not using any kind of integrated processor

The entry we judge overall to be the best will also be featured in our Circuit Notebook column and receive an additional $200.



Conditions of entry

1) You must be a resident of Australia or New Zealand
2) One entry per family (Silicon Chip staff and their families are not eligible)
3) Submissions will be confirmed within 7 days. If you do not receive a confirmation of your submission, contact us to verify that we have received it
4) Chance plays no part in determining the winner
5) The judges' decision is final
6) The winners will be decided by the 3rd of February 2022 and will be notified immediately

Dick Smith writes

By 1958 I'd advanced from building crystal radio sets to designing and building what I called a noughts and crosses machine. It really was an early computer. I used second-hand parts from a telephone exchange to build it. It would play noughts and crosses against anyone and no one could beat it.

This was a great boost to me, because while I was no good at rote learning and theory, I was fine at practical things. The fact that my mind was capable of working out how to build this complex machine gave me confidence as I left school. Now I just had to find a job.

Because this was such a turning point in his life and he's so enthusiastic about youngsters learning electronics, he's putting up $2000 of his own money to award to people who can come up with a modern version of his noughts-and-crosses machine. Silicon Chip will judge the entries.

Winners will be announced in the March 2022 issue of Silicon Chip magazine and will also be contacted directly for payment information.

PART 2:
BY PHIL PROSSER

Low-cost Two- or Three-Way Active Crossover

This Active Crossover, described last month, is very flexible. It can be configured as a two-way or three-way crossover, runs from AC or DC supplies, has adjustable levels for all the outputs and has an optional subsonic filter. It's ideal for building two-way or three-way speakers with each driver powered by a separate amplifier, or it can be used as a signal conditioner for the Tapped Horn Subwoofer described in the September issue.

In the introductory article last month, we explained why you might need an active crossover, how they are used and how this design works. We also showed some performance graphs, indicating that it is suitable for use in a hifi system, plus listed the parts you need to buy in order to build it.

Picking up where we left off then, we'll go over the PCB assembly process, followed by information on how to set up and use it. There is also a troubleshooting section at the end of the article, in case you run into difficulties. There are a few different ways to build the Active Crossover; we'll explain which parts can be left off in some cases, and how to set up the jumpers for your particular application.

Construction

Fig.15 is the PCB overlay diagram, which should help you during construction. The Active Crossover is built on a double-sided PCB coded 01109211 that measures 176 x 117.5mm.

The assembly process is pretty straightforward. First, work out where it will be mounted and powered. If you can slip it into its own metal box with an internal power supply, that is ideal. Determine how you will power it and thus the parts you need. Refer also to the panel below on power supply options.

Second, select your crossover frequencies. Check the panel describing how to do this from last month. That will affect some of the resistor and MKT capacitor values needed. If you are not sure about the crossover frequencies you require, you could fit PC pins to those component pads and solder the resistors and capacitors to these, to make it easier to change them later.

If you only need a two-way crossover, none of the components in the high-frequency section are required (outlined with a red dashed line).

Top tip for soldering the resistors and capacitors

If you envisage yourself significantly 'tweaking' the crossover frequencies, we suggest that you select a resistor/capacitor (R and C) combination that is about right for your application and then mount the capacitors on the board. These are more expensive than resistors and do not need to change.

Then fit PC pins for all the resistor pads marked "R" and solder your resistors onto these, on the top side of the board. This will allow you to easily shunt them or change them later.

Remember that you can use E24-series or parallel resistor combinations to get the exact frequency that you want.

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SERVICEMAN'S LOG

That '80s gear and the art of printer repair

Dave Thompson

Regular readers of this column will know that I'm not one for throwing stuff away. They will also know that I'm a fan of stuff made a couple of decades ago. So when a client brought in his circa 30-year-old dot matrix printer, despite not normally repairing these things, I thought let's give it a shot. Especially since it was described as 'only' having a broken wire.

Don't get me wrong; I'm not one of those hoarders who has to stand up to sleep because there is no more room in the house. However, my workshop is, shall we say, quite 'busy' with bits and bobs I've collected over the years.

For example, a long-time client recently moved 'up north' *[to Yorkshire? – Editor]* and brought me a couple of presents before he left: a classic Avo meter and a Megger, both with original leather storage cases, user manuals and even leads.

I couldn't say no to those beauties, but they take up shelf space that I don't really have. Still, I'm not the only one in this position. I fondly recall visits to my uncle's electronics workshop in Melbourne when I could spend hours poking around, looking at all the gadgets and devices I'd not seen before. It was my idea of heaven.

Recently, another long-time client brought in some familiar devices for me to repair – again. He has several Swedish-made electronic gadgets, built in the early 80s, using that now-clunky analog technology. I have had these in the workshop several times over the years for things like broken RS-232 socket wires or buttons that no longer work properly.

Fortunately, the owner has a couple of extra similar devices that stopped working years before I was involved with them, and he now uses these for spares, especially as the buttons wear out frequently.

The gadgets look surprisingly similar to my dad's early HP calculator back in the 70s (Google tells me it was the HP-65 model). It boasted a swipe card with a magnetic strip that could 'program' the calculator's functions, something I was quite taken with at the time. The red, bubble-lens LED display also looks similar and was very much of its time as well.

When opened up, the Swedish gadgets contained three PCBs packed with EPROMS and other common chips of the time, plus room for a rechargeable 3V battery.

I'm still not sure what my client does with these devices, but as he is retiring soon, he just wants to keep things going until that happens. I know he goes to various establishments, plugs these gadgets into machines (pokies maybe?) and downloads information onto them.

He then takes the gadgets home and connects them via old serial-type cables to a green-screen computer I have also been keeping limping along. He can then print out the data he needs on a couple of old printers.

What they do isn't really important anyway; I just need to be able to keep them going. As with many handheld devices, he only uses a few of the keypad buttons to perform common tasks, so those wear out pretty quickly.

If the plastic button's top is popped off, a retained tension spring comes with it, and the contacts beneath are revealed. By today's standards, I think they are a bit basic, but they do the job.

Underneath the cap is a U-shaped copper spring contact about 15mm square overall but made from very thin metal, which looks quite flimsy.

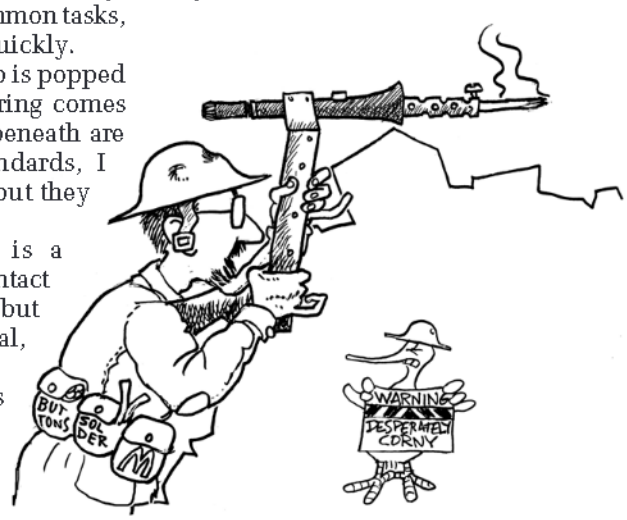
The top-left corner of this spring contact is connected through the plastic base of the switch to the button PCB underneath. When the button is pushed, the bottom right corner of this piece deflects and touches the other contact, which is also moulded into the plastic base of the button.

The obvious problem is that this main metal piece just wears out with use and eventually work hardens and breaks off, meaning the button stops working.

Sometimes, I can just use a fine-tipped soldering iron to re-join the primary spring contact to the broken piece in the base, but this is a temporary fix only; the usual procedure is to replace the button itself.

As I mentioned, he has several spare devices, and I have already used many of the buttons from these units. While the buttons are coloured and numbered, I just use the original plastic top from the broken one and put it onto the 'new' replacement base to restore functionality.

Unlike a lot of stuff from that era, I got the distinct impression these weren't designed to be worked on by anyone but the manufacturer. There is



THERE IS NO OTHER OPTION, THOUGH, WE JUST SOLDER ON...

Items Covered This Month

- That '80s gear
- Replacing the plugpacks in a dual-handset phone system
- A blown and charred mobile phone charger
- Repairing a 15-year-old Epson scanner

*Dave Thompson runs PC Anytime in Christchurch, NZ.

Website: www.pcanytime.co.nz
Email: dave@pcanytime.co.nz

Preview only.

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11/21

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PRE-PROGRAMMED MICROS

For a complete list, go to siliconchip.com.au/Shop/9

$10 MICROS

24LC32A-I/SN	Digital FX Unit (Apr21)
ATmega328P	RF Signal Generator (Jun19), Si473x FM/AM/SW Digital Radio (Jul21)
ATmega328P-AUR	RGB Stackable LED Christmas Star (Nov20)
ATtiny85V-10PU	Shirt Pocket Audio Oscillator (Sep20)
ATtiny816	ATtiny816 Development/Breakout Board (Jan19)
PIC10F202-E/OT	Ultrabrite LED Driver (with free TC6502P095VCT IC, Sep19)
PIC12F1572-I/SN	LED Christmas Ornaments (Nov20; specify variant) Nano TV Pong (Aug21), SMD Test Tweezers (Oct21)
PIC12F617-I/P	Car Radio Dimmer (Aug19), MiniHeart Heartbeat Simulator (Jan21) Refined Full-Wave Universal Motor Speed Controller (Apr21) Model Railway Level Crossing (two required – $15/pair) (Jul21)
PIC12F617-I/SN	**Model Railway Carriage Lights (Nov21)**
PIC12F675-I/P	Motor Speed Controller (Mar18), Heater Controller (Apr18) Useless Box IC3 (Dec18)
PIC12F675-I/SN	Tiny LED Xmas Tree (Nov19)
PIC16F1455-I/P	Digital Interface Module (Nov18), GPS Finesaver (Jun19) Digital Lighting Controller LED Slave (Dec20)
PIC16F1455-I/SL	Ol' Timer II (Jul20), Battery Multi Logger (Feb21)
PIC16F1459-I/P	5-Way LCD Panel Meter (Nov19), IR Remote Control Assistant (Jul20) Ultrasonic Cleaner (Sep20), Electronic Wind Chime (Feb21) 20A DC Motor Speed Controller (Jul21)
PIC16F1705-I/P	Flexible Digital Lighting Controller Slave (Oct20)
PIC16F88-E/P	Automotive Sensor Modifier (Dec16)
PIC16F88-I/P	Remote-controlled Preamp with Tone Control (Mar19) UHF Repeater (May19), Six Input Audio Selector (Sep19) Universal Battery Charge Controller (Dec19)

$15 MICROS

ATSAML10E16A-AUT	High-Current Battery Balancer (Mar21)
PIC16F1459-I/SO	Four-Channel DC Fan & Pump Controller (Dec18)
PIC16F18877-I/P	**USB Cable Tester (Nov21)**
PIC32MM0256GPM028-I/SS	Super Digital Sound Effects (Aug18)
PIC32MX170F256D-501P/T	44-pin Micromite Mk2 (Aug14), 4DoF Simulation Seat (Sep19)
PIC32MX170F256B-50I/SP	Micromite LCD BackPack V1-V3 (Feb16 / May17 / Aug19) GPS-Synched Frequency Reference (Nov18), Air Quality Monitor (Feb20) RCL Box (Jun20), Digital Lighting Controller Micromite Master (Nov20) Advanced GPS Computer (Jun21) Touchscreen Digital Preamp (2.8in/3.5in version) (Sep21)
PIC32MX170F256B-I/SO	Battery Multi Logger (Feb21), Battery Manager BackPack (Aug21)
PIC32MX270F256B-50I/SP	ASCII Video Terminal (Jul14), USB M&K Adaptor (Feb19)
PIC32MX795F512H-80I/PT	Maximite (Mar11), miniMaximite (Nov11), Colour Maximite (Sep12), Touchscreen Audio Recorder (Jun14)

$20 MICROS

dsPIC33FJ64MC802-E/SP	1.5kW Induction Motor Speed Controller (Aug13)
dsPIC33FJ128GP306-I/PT	CLASSiC DAC (Feb13)
dsPIC33FJ128GP802-I/SP	Ultra-LD Preamp (Nov11), LED Musicolour (Oct12)
PIC32MX470F512H-I/PT	Stereo Echo/Reverb (Feb 14), Digital Effects Unit (Oct14)
PIC32MX470F512H-120/PT	Micromite Explore 64 (Aug 16), Micromite Plus (Nov16)
PIC32MX470F512L-120/PT	Micromite Explore 100 (Sep16)

$30 MICROS

PIC32MX695F512L-80I/PF	Colour MaxiMite (Sep12)
PIC32MZ2048EFH064-I/PT	DSP Crossover/Equaliser (May19), Low-Distortion DDS (Feb20) DIY Reflow Oven Controller (Apr20)

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Short form kit with everything except case and AA cells

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Includes PCB, IC1 (programmed), IC2, D1, L1, SMD capacitors and resistors.
Does not include reed switch, magnet, LEDs or through-hole parts

SMD TEST TWEEZERS KIT (CAT SC5934) *(OCT 21)* — **$35.00**
PCBs, micro, other onboard parts and heatshrink (no cell or brass tips)

NANO TV PONG SHORT FORM KIT (CAT SC5885) *(AUG 21)* — **$17.50**
PCB and all onboard parts only (does not include controllers)

MODEL RAILWAY LEVEL CROSSING *(JUL 21)*
- Pair of programmed PIC12F617-I/Ps — **$15.00**
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- PCB-mount right-angle SMA socket (SC4918) — **$2.50**
- Pulse-type rotary encoder with integral pushbutton (SC5601) — **$3.00**
- 16x2 LCD module (does not use I^2C module) (SC4198) — **$7.50**

LED CHRISTMAS ORNAMENTS (CAT SC5579) *(NOV 20)* — **$14.00**
Complete kit including micro but no coin cell (specify PCB shape & colour)

RGB STACKABLE LED CHRISTMAS STAR (CAT SC5525) *(NOV 20)* — **$38.50**
Complete kit including PCB, micro, diffused RGB LEDs and other parts

MICROMITE LCD BACKPACK V3 KIT (CAT SC5082) *(AUG 19)* — **$75.00**
Includes PCB, programmed micros, 3.5in touchscreen LCD, UB3 lid, mounting hardware, Mosfets for PWM backlight control and all other **mandatory** on-board parts

Separate/Optional Components:
- 3.5-inch TFT LCD touchscreen (Cat SC5062) — **$35.00**
- DHT22 temp/humidity sensor (Cat SC4150) — **$7.50**
- BMP180 (Cat SC4343) **OR** BMP280 (Cat SC4595) temp/pressure sensor — **$5.00**
- BME280 temperature/pressure/humidity sensor (Cat SC4608) — **$10.00**
- DS3231 real-time clock SOIC-16 IC (Cat SC5103) — **$4.00**
- 23LC1024 1MB RAM (SOIC-8) (Cat SC5104) — **$5.00**
- AT25SF041 512KB flash (SOIC-8) (Cat SC5105) — **$1.50**
- 10µF 16V X7R through-hole capacitor (Cat SC5106) — **$2.00**

VARIOUS MODULES & PARTS

- 64x32 pixel white 0.49in OLED (SMD Test Tweezers, Oct21) — **$10.00**
- pair of AD8403ARZ10 (Touchscreen Digital Preamp, Sep21) — **$35.00**
- Si4732 radio IC (Si473x FM/AM/SW Radio, Jul21) — **$15.00**
- EA2-5NU relay (PIC Programming Helper, Jun21) — **$3.00**
- VK2828U7G5LF GPS module (Advanced GPS Computer, Jun21) — **$25.00**
- MCP4251-502E/P (Advanced GPS Computer, Jun21) — **$3.00**
- pair of Signetics NE555Ns (Arcade Pong, Jun21) — **$12.50**
- 2.8-inch touchscreen LCD module (Lab Supply, May21) — **$25.00**
- Spin FV-1 digital effects IC (Digital FX Unit, Apr21) — **$40.00**
- 15mΩ 3W SMD resistor (Battery Multi Logger / Arduino PSU, Feb21) — **$2.50**
- DS3231(M) real-time clock SMD IC (Battery Multi Logger, Feb21) — **$3.00**
- Pair of CSD18534 transistors (Electronic Wind Chimes, Feb21) — **$6.00**
- IPP80P03P4L04 (Dual Battery Lifesaver / Vintage Radio Supply, Dec20) — **$5.00**
- 16x2 LCD module (Digital RF Power Meter, Aug20) — **$7.50**
- WS2812 8x8 RGB LED matrix module (Ol' Timer II, Jul20) — **$15.00**
- MAX038 function generator IC (H-Field Transanalyser, May20) — **$25.00**
- MC1496P double-balanced mixer IC (H-Field Transanalyser, May20) — **$2.50**
- AD8495 thermocouple interface (DIY Reflow Oven Controller, Apr20) — **$12.50**
- Si8751AB 2.5kV isolated Mosfet driver IC (Charge Controller, Dec19) — **$5.00**
- I/O expander modules (Nov19):
  PCA9685 – **$6.00** ; PCF8574 – **$3.00** ; MCP23017 – **$3.00**
- SMD 1206 LEDs, packets of 10 unless stated otherwise (Xmas Ornaments, Nov20):
  yellow – **$0.70** ; amber – **$0.70** ; blue – **$0.70** ; cyan – **$1.00** ; pink (1 only) – **$0.20**
- ISD1820-based voice recorder / playback module (Junk Mail, Aug19) — **$4.00**
- 23LCV1024-I/P SRAM & MCP73831T (UHF Repeater, May19) — **$11.50**
- MCP1700 3.3V LDO regulator (suitable for USB M&K Adapator, Feb19) — **$1.50**
- 1nF 1% MKP (5mm) or ceramic capacitor (LC Meter, Jun18) — **$2.50**
- ESP-01 WiFi Module (El Cheapo Modules, Apr18) — **$5.00**
- WiFi Antennas with U.FL/IPX connectors (Water Tank Level Meter with WiFi, Feb18):
  5dBi – **$12.50** ; 2dBi (omnidirectional) – **$10.00**
- NRF24L01+PA+NA transceiver, SNA connector & antenna (El Cheapo, Jan18) — **$5.00**
- ERA-2SM+ MMIC & ADCH-80A+ choke (6GHz+ Frequency Counter, Oct17) — **$15.00**
- VS1053 Geeetech Arduino MP3 shield (Arduino Music Player, Jul17) — **$20.00**
- MAX7219 red LED controller boards (El Cheapo Modules, Jun17):
  8x8 SMD/DIP matrix display – **$5.00** ; 8-digit 7-segment display – **$7.50**
- microSD card adaptor (El Cheapo Modules, Jan17) — **$2.50**
- DS3231 real-time clock module with mounting hardware — **$7.50**

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PRINTED CIRCUIT BOARDS & CASE PIECES

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PRINTED CIRCUIT BOARD TO SUIT PROJECT	DATE	PCB CODE	Price
LED CHRISTMAS TREE	NOV18	16107181	$5.00
DIGITAL INTERFACE MODULE	NOV18	16107182	$2.50
TINNITUS/INSOMNIA KILLER (JAYCAR VERSION)	NOV18	01110181	$5.00
↳ ALTRONICS VERSION	NOV18	01110182	$5.00
HIGH-SENSITIVITY MAGNETOMETER	DEC18	04101011	$12.50
USELESS BOX	DEC18	08111181	$7.50
FOUR-CHANNEL DC FAN & PUMP CONTROLLER	DEC18	05108181	$5.00
ATtiny816 DEVELOPMENT/BREAKOUT PCB	JAN19	24110181	$5.00
ISOLATED SERIAL LINK	JAN19	24107181	$5.00
DAB+/FM/AM RADIO	JAN19	06112181	$15.00
↳ CASE PIECES (CLEAR)	JAN19	SC4849	$.00
REMOTE CONTROL DIMMER MAIN PCB	FEB19	10111191	$10.00
↳ MOUNTING PLATE	FEB19	10111192	$10.00
↳ EXTENSION PCB	FEB19	10111193	$10.00
MOTION SENSING SWITCH (SMD) PCB	FEB19	05102191	$2.50
USB MOUSE AND KEYBOARD ADAPTOR PCB	FEB19	24311181	$5.00
LOW-NOISE STEREO PREAMP MAIN PCB	MAR19	01111119	$25.00
↳ INPUT SELECTOR PCB	MAR19	01111112	$15.00
↳ PUSHBUTTON PCB	MAR19	01111113	$5.00
DIODE CURVE PLOTTER	MAR19	04112181	$7.50
↳ UB3 LID (MATTE BLACK)	MAR19	SC4927	$5.00
FLIP-DOT (SET OF ALL FOUR PCBs)	APR19	SC4950	$17.50
↳ COIL PCB	APR19	19111181	$5.00
↳ PIXEL PCB (16 PIXELS)	APR19	19111182	$5.00
↳ FRAME PCB (8 FRAMES)	APR19	19111183	$5.00
↳ DRIVER PCB	APR19	19111184	$5.00
iCESTICK VGA ADAPTOR	APR19	02103191	$2.50
UHF DATA REPEATER	MAY19	15004191	$10.00
AMPLIFIER BRIDGE ADAPTOR	MAY19	01105191	$5.00
3.5-INCH LCD ADAPTOR FOR ARDUINO	MAY19	24111181	$5.00
DSP CROSSOVER (ALL PCBs – TWO DACs)	MAY19	SC5023	$40.00
↳ ADC PCB	MAY19	01106191	$7.50
↳ DAC PCB	MAY19	01106192	$7.50
↳ CPU PCB	MAY19	01106193	$5.00
↳ PSU PCB	MAY19	01106194	$7.50
↳ CONTROL PCB	MAY19	01106195	$5.00
↳ LCD ADAPTOR	MAY19	01106196	$2.50
STEERING WHEEL CONTROL IR ADAPTOR	JUN19	05105191	$5.00
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↳ CASE PIECES (MATTE BLACK)	JUN19	SC4987	$10.00
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RASPBERRY PI SPEECH SYNTHESIS/AUDIO	JUL19	01106191	$5.00
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SUPER-9 FM RADIO PCB SET	NOV19	06109181-5	$25.00
↳ CASE PIECES & DIAL	NOV19	SC5166	$25.00
TINY LED XMAS TREE (GREEN/RED/WHITE)	NOV19	16111191	$2.50
HIGH POWER LINEAR BENCH SUPPLY	NOV19	18111181	$10.00
↳ HEATSINK SPACER (BLACK)	NOV19	SC5168	$5.00
DIGITAL PANEL METER / USB DISPLAY	NOV19	18111182	$2.50
↳ ACRYLIC BEZEL (BLACK)	NOV19	SC5167	$2.50
UNIVERSAL BATTERY CHARGE CONTROLLER	DEC19	14107191	$10.00
BOOKSHELF SPEAKER PASSIVE CROSSOVER	JAN20	01101201	$10.00
↳ SUBWOOFER ACTIVE CROSSOVER	JAN20	01101202	$7.50
ARDUINO DCC BASE STATION	JAN20	09207181	$5.00
NUTUBE VALVE PREAMPLIFIER	JAN20	01112191	$10.00
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PRINTED CIRCUIT BOARD TO SUIT PROJECT	DATE	PCB CODE	Price
DIY REFLOW OVEN CONTROLLER (SET OF 3 PCBS)	APR20	01106193/5/6	$12.50
7-BAND MONO EQUALISER	APR20	01104201	$7.50
↳ STEREO EQUALISER	APR20	01104202	$7.50
REFERENCE SIGNAL DISTRIBUTOR	APR20	CSE200103	$7.50
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CAR ALTIMETER	MAY20	05105201	$5.00
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↳ THROUGH-HOLE VERSION	JUN20	01005202	$5.00
COLOUR MAXIMITE 2 PCB (BLUE)	JUL20	07107201	$10.00
↳ FRONT & REAR PANELS (BLACK)	JUL20	SC5500	$10.00
OL' TIMER II PCB (RED, BLUE OR BLACK)	JUL20	19104201	$5.00
↳ ACRYLIC CASE PIECES / SPACER (BLACK)	JUL20	SC5448	$7.50
IR REMOTE CONTROL ASSISTANT PCB (JAYCAR)	JUL20	15005201	$5.00
↳ ALTRONICS VERSION	JUL20	15005202	$5.00
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↳ BALANCED ATTENUATOR	NOV20	01106202	$7.50
SWITCHMODE 78XX REPLACEMENT	AUG20	18105201	$2.50
WIDEBAND DIGITAL RF POWER METER	AUG20	04106201	$5.00
ULTRASONIC CLEANER MAIN PCB	SEP20	04105201	$7.50
↳ FRONT PANEL	SEP20	04105202	$5.00
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LED XMAS ORNAMENTS	NOV20	16111191-9	$3.00
30 LED STACKABLE STAR	NOV20	16109201	$12.50
↳ RGB VERSION (BLACK)	NOV20	16109202	$12.50
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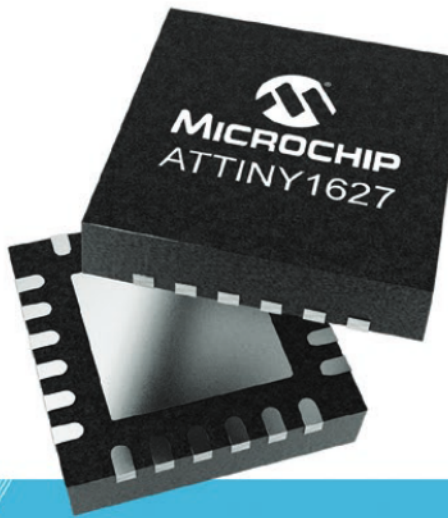

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