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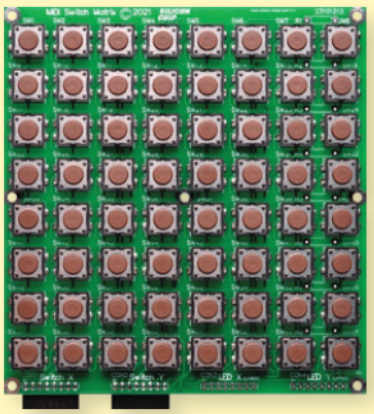

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Editorial Viewpoint

Adobe making our lives difficult

Once again, Adobe has made a bizarre decision which is causing lots of problems for their customers (and probably others too). They don't seem to care; they make these decisions, either without considering the hardships for users, or they do realise and simply don't care.

This time, they are getting rid of support for Type 1 fonts, and have given us almost no warning. The first I heard about it was just a few weeks before it started causing us profound grief.

Their beef with Type 1 fonts (and it is a valid criticism) is that this older format does not support Unicode; just the basic alphabet, numeric characters etc.

On the other hand, Type 1 fonts provide superior rendering because they support cubic Bezier curves instead of the quadratic curves implemented by TrueType. That is why we make (or made) heavy use of Type 1 fonts.

So, you may be thinking, what's the big deal? Either switch to using equivalent TrueType or OpenType fonts, or convert your Type 1 fonts to one of those other formats and use them. Oh, how I wish it were that easy.

You see, when you convert a Type 1 font to an OpenType font, two things happen. One is that it can sometimes look nothing like the original font. I don't understand why this is the case, but when we put the original and converted font side-by-side, they are often so different that you'd have trouble believing they came from the same file.

I think it has to do with how the different font rendering engines deal with kerning and hinting, but really, that shouldn't happen. Unfortunately, it does.

The other problem is that the converted font is often considered to have a different name than the original, meaning that our software will not recognise that it is the same. So when we open up one of the many hundreds of issues we need to maintain, we're presented with dozens of messages indicating "font not found", even though the appropriate fonts are installed on the system.

So thanks, Adobe. You've made our lives miserable and created a lot of work for us. And for what? Leaving Type 1 support in your software probably would have been less work than removing it. I can't imagine it's saving you much maintenance, either.

So if you notice that some of the fonts look slightly different in this issue compared to previous issues, now you know why.

Jaycar catalog delay

You might be expecting this issue to come with the 2021 Jaycar catalog; it is usually bundled with our April issue. Unfortunately, it has been delayed this year, no doubt due to COVID-19. I have been told that it should be ready later this year.

Staff retirements

We have just said goodbye to two long-term SILICON CHIP staff members, Ann Morris and Ross Tester. Both of them have been with us for more than 20 years – well before I was involved. They have contributed much to the success of the magazine and we wish them the best in their retirement.

Nicholas Vinen

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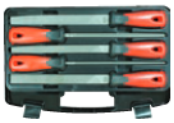

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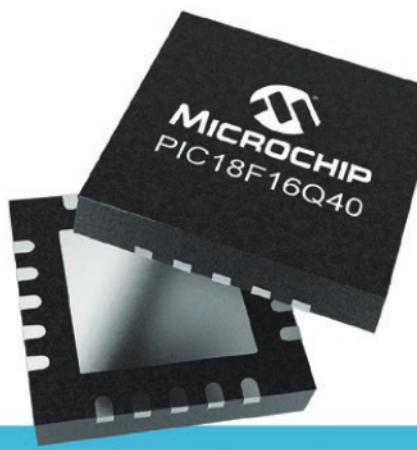

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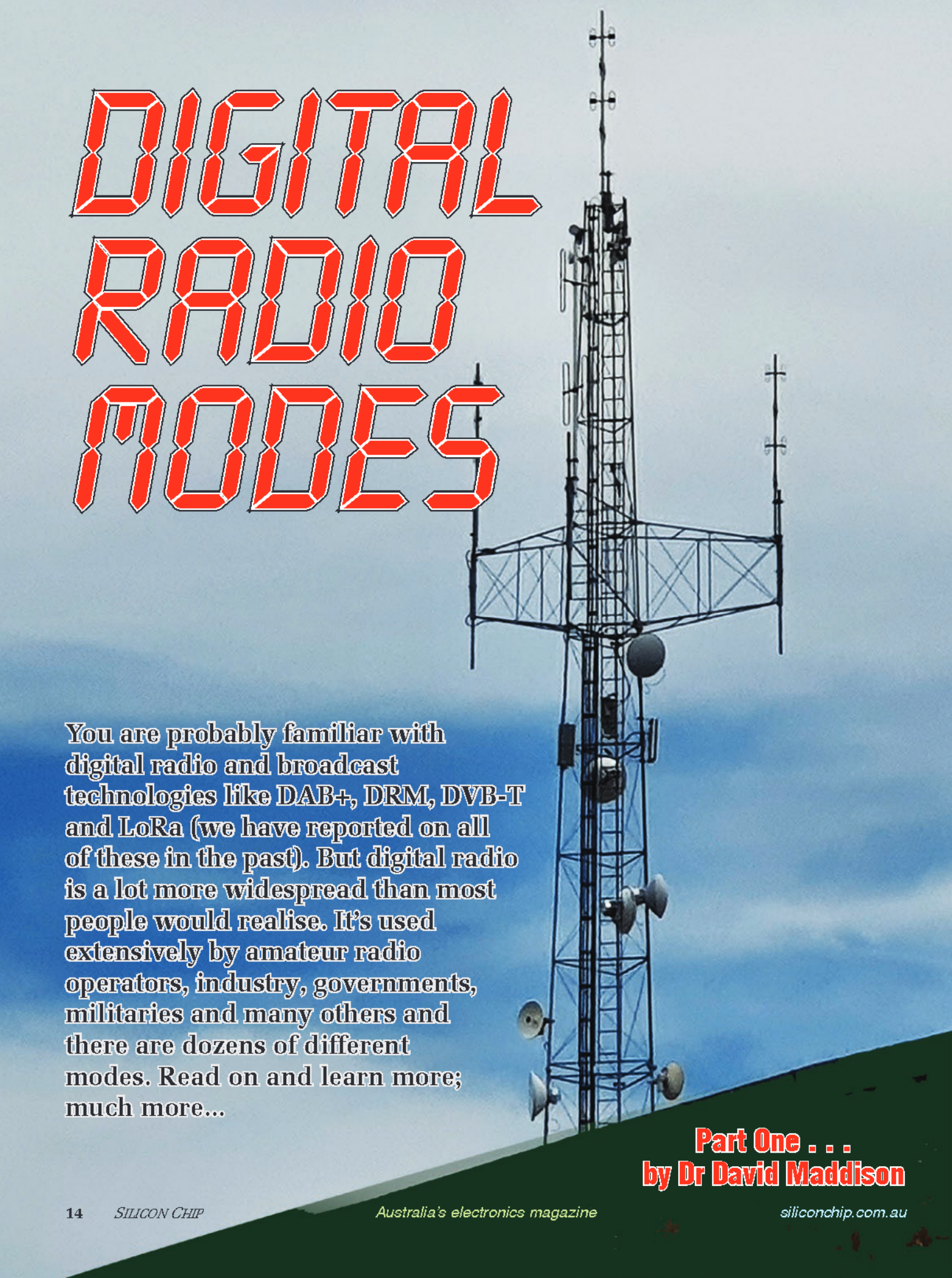
DIGITAL RADIO MODES



You are probably familiar with digital radio and broadcast technologies like DAB+, DRM, DVB-T and LoRa (we have reported on all of these in the past). But digital radio is a lot more widespread than most people would realise. It's used extensively by amateur radio operators, industry, governments, militaries and many others and there are dozens of different modes. Read on and learn more; much more...

Part One . . .
by Dr David Maddison

Many analog radio communication modes are being phased out in favour of digital methods. Some relatively recent examples include the switch to digital TV (DVB-T) and the introduction of digital broadcast radio (DAB+) and digital radio modes for commercial, government and radio amateur use.

Advantages of digital radio modes include:

- greater voice clarity
- interference immunity
- proper encryption
- more efficient use of the radio spectrum
- greater channel capacity
- faster channel changing or searching
- the ability to add new functions to radios as new software and applications are developed

Disadvantages of digital radio include:

- more complicated software
- possibly higher costs compared to analog (especially with proprietary systems)
- intolerance of major RF interference (despite good tolerance to minor interference)
- the 'digital cliff' at extreme range, where communication suddenly drops out compared to analog, which gradually fades out

Analog radio still has some benefits such as relatively simple and well-understood equipment and hardware-only solutions with no software to go wrong.

Remaining analog radio in common use, for the moment, includes:

- AM and FM broadcast radio (although some other countries have already phased these out)
- HF and UHF CB (citizens' band)
- standard amateur radio modes
- commercial and government shortwave services
- various short-range transmitters such as baby monitors and wireless doorbells (which can be either digital or analog)

Of all the analog radio modes, it is most likely that broadcast AM and certain government-sponsored shortwave services will last the longest before being phased out, as the ownership of these types of analog receivers is vast worldwide.

Digital radio history

Overall, though, the advantages of digital radio greatly outweigh analog radio. On 27th July 1896, Guglielmo Marconi first publicly demonstrated 'wireless' signals, and in March 1897, he transmitted Morse Code signals over 6km. That was interesting because Morse Code is arguably a form of digital radio transmission, so the concept of digital radio isn't altogether new.

Early digital radio modes such as RTTY (radioteletype) were successfully tested as early as 1922, and have been in commercial use since 1932. However, the data throughput at the time was relatively low, typically 60 words per minute (wpm) for RTTY45 mode at 45.45 baud (bits per second) to 100 wpm in RTTY75 mode at 75 baud.

Much higher data rates have become possible because of large increases in computing power and digital signal processing technology. Computers can also compress data, conserving radio bandwidth.

There are vast numbers of digital radio modes, and we can't cover all of them in this article. So we will describe the most interesting or unusual techniques.

Digital radio basics

With digital radio (or TV), information is transmitted via radio waves in discrete steps, rather than with the continuous gradation of values used for analog transmissions.

The advantage is that the original data can be precisely reproduced at the receiving end with close-to-ideal reception. In contrast, an analog signal is always subject to some degradation of the original signal (eg, noise).

Just like analog radio, which uses a variety of modulation schemes such as SSB (single sideband), AM (amplitude modulation), FM (frequency modulation) etc, various digital modulation schemes can be used. There's also the option of digital compression, which is applied to the data before it is transmitted and reversed upon reception. This reduces the amount of data that needs to be transmitted.

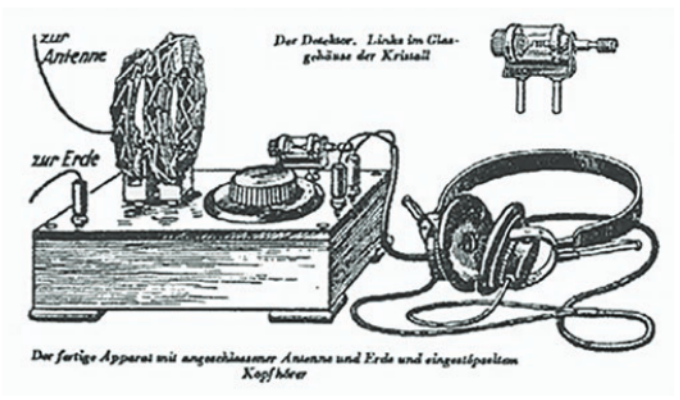
i) Early Digital Modes

1) Morse code

Arguably, the first digital mode was Morse code (also known as CW), first used in 1844. Information is sent as a short "dot" (normally refrred to as a dit), or longer "dash" (known as a dah), with spaces being delineated by a lack of transmission. The "dah" is nominally three times the duration of the "dit". There is a one-dit-length gap between each dit or dah within a group, a three-dit-length gap between 'letters', and a seven-dit-length gap between each word.

What is not commonly realised today is that the "American" code Morse developed (originally for the US telegraph service), and the "Continental" or "International" Code we know today, bear only a passing resemblance to each other.

Some letters are the same but the American code also has long daaaaahhhhs and spaces within letters. It has all but died out these days; even the



Guglielmo Marconi (1874-1937), acclaimed as "the father of radio". He is shown at left with his apparatus assumed to be set up on the Isle of Wight around 1897/8. At right is the illustration from his radio patent.

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Digital FX Unit

Part 1
by John Clarke

Make like a pro muso with this Digital FX (Effects) Unit. It will produce unique sounds when connected to a variety of instruments . . . like an electric guitar, bass, violin or cello, even the output of a microphone preamp or within the effects loop of an amplifier or mixer.

It's very common for musicians to add effects to the sound of their musical instruments. These are used to add depth, ambience and tonal qualities and to personalise the sound.

Effects can be subtle or extreme, and can be tailored to produce a unique sound.

Purely analog audio circuitry can be used for effects units such as in the Overdrive and Distortion Pedal from March 2020 (siliconchip.com.au/Article/12576). But for complex effects, digital signal processing (DSP) is more convenient and flexible.

Our Digital FX Unit utilises a digital signal processing integrated circuit (IC) that is designated the SPN1001 FV-1 (or FV-1 for short). This is preprogrammed with eight effects, and while one of these is a test function, the remaining seven provide flange, chorus and tremolo as well as pitch shift and reverb effects.

A further eight extra effects are stored within an external EEPROM that connects to the FV-1. These effects have been chosen by us. However, you can change the stored effects patches.

The FV-1 has been available for many years, and has been used in many commercially available effects units. The FV-1 has a somewhat cult following amongst digital effects enthusiasts. This has led to the production of numerous freely-available effects patches and software to enable the writing of your own unique effects.

For our Digital FX Pedal, the preprogrammed EEPROM is filled with eight effects that add to the seven usable effects preset within the FV-1. These individual effects are selected using a rotary control knob, while the parameters of each effect are adjusted using up to three rotary controls.

Many effects have already been created for the FV-1 IC, and these are free to use. These effects include chorus, echo, flange, phase shift, vibrato, limiter, wah, various reverberation effects, distortion, octave shifts and a ring modulator.

For information on what some of these effects are and how they are achieved, see www.spinsemi.com/knowledge_base/effects.html We will explain some of the basic effects at the end of this article.

There is also an assembler and a graphical software package to help you write your own effects if you feel inclined to experiment. The software can then be assembled and programmed into the EEPROM.

This requires an EEPROM programmer; we will have more details on where to get effects patches, how to store

Features

- 15 different effects including chorus, echo, flange, vibrato, wah, reverb & distortion
- Each effect has up to three adjustable parameters
- Provision to experiment by adding new effects
- Rugged enclosure, suitable for stage use
- Power supply reversed polarity protection
- High input impedance to suit piezo pickups etc
- Low power consumption
- Battery or DC plugpack power
- True bypass switch
- No signal phase inversion

Fifteen different effects are available, with the option to change eight of the effects to your liking. You can choose them from a list of many freely available effects, or create them yourself using freely available tools.

them in EEPROM and how to use the assembler and graphical software later.

Presentation

Our Digital FX Pedal is designed for live music use, and so is housed in a rugged diecast aluminium case. On the top, it has a footswitch, eight rotary controls plus indicator LEDs.

The signal inputs and outputs are two 6.35mm (1/4in) jack sockets at the rear, along with a DC barrel socket for power. The unit can also be powered via an internal 9V battery. Its power is automatically switched on when a jack plug is inserted into the output socket.

Operating principle

The block diagram, Fig.1, shows the signal flow of the Digital FX Pedal. The original signal is applied to CON1, and this is connected to the bypass switch (S2a).

When not bypassed, this signal goes to the high input impedance buffer (IC1a) and is then filtered with a 19kHz low-pass filter. This prevents unwanted artifacts in the subsequent digital signal processing (DSP) stage, by removing RF and ultrasonic signals.

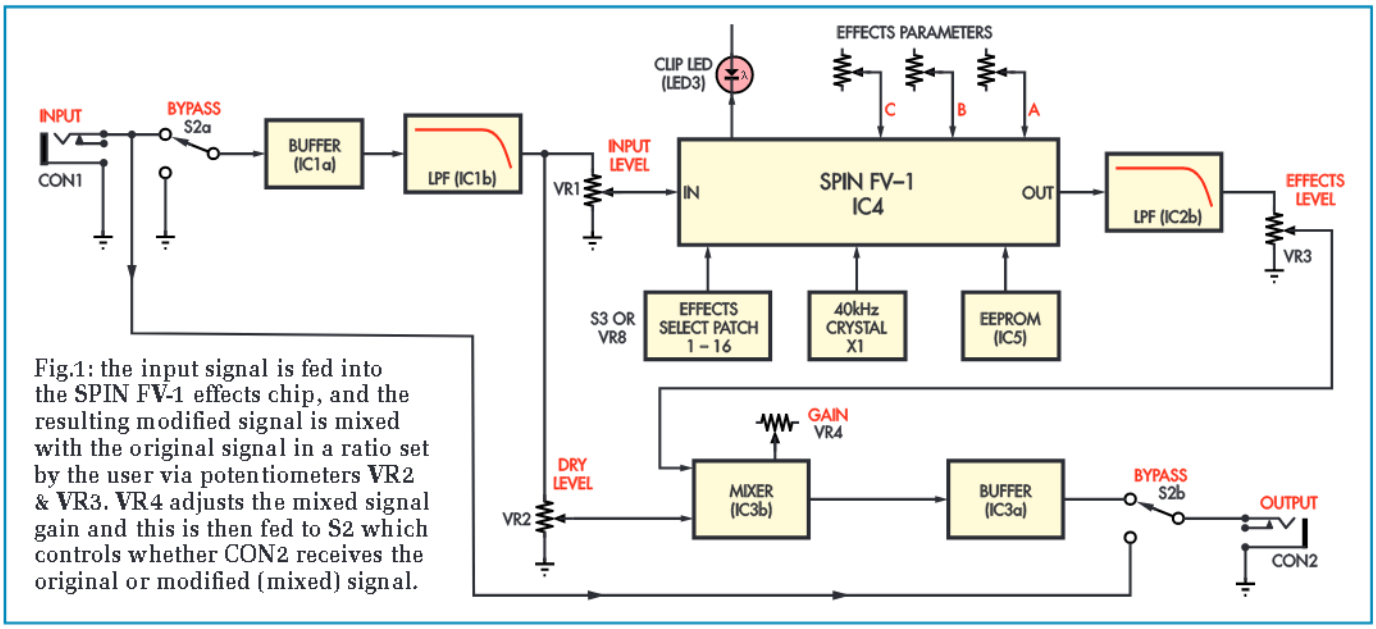

Fig.1: the input signal is fed into the SPIN FV-1 effects chip, and the resulting modified signal is mixed with the original signal in a ratio set by the user via potentiometers VR2 & VR3. VR4 adjusts the mixed signal gain and this is then fed to S2 which controls whether CON2 receives the original or modified (mixed) signal.

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Full Wave Universal Motor Speed Controller

Want exceptionally smooth speed control over the entire range for your power tool? You want our new Universal Motor Speed Controller. It is ideal for use with mains-powered electric drills, lawn edgers, whipper snippers, circular saws, routers or any other appliance with universal (ie, brush-type) motors, rated up to 10A.

By JOHN CLARKE

Our latest Full Wave Universal Motor Speed Controller is an upgrade on the one we published in March 2018. That one worked very well, but we identified several upgrades and improved features that could be made to the design.

One of the main drawbacks of the previous design was that the feedback gain control was located inside the Controller's housing. That control set the amount of compensation for maintaining motor speed under load.

Once set, the Controller was only suitable for the appliance being used, since the feedback control would require changing for different motors.

This control is now externally adjustable via a control knob, making it easy to use the Controller across a range of different power tools and other devices.

We have also added the ability to switch the soft-start feature off, also via an external switch. Soft start is useful when the speed controller is set at a certain speed and the motor is switched on and off at the appliance. When the appliance is switched on, the motor speed is slowly and automatically brought up to the set speed. Without it, power to the motor is suddenly applied, and the motor can kick back.

Soft start is essential when using the Controller with a high-powered router or circular saw. For smaller appliances, and when the motor is switched on and off often, you might find that it limits how fast you can work, as you wait for the motor to come up to speed.

That would be the case when used with a whipper snipper and some hand drills. So we made it so you can easily switch the soft start feature off. While

WARNING!

This Speed Controller operates directly from the 230V AC mains supply and contact with any live component is potentially lethal. Do not build it unless you know what you are doing. DO NOT TOUCH ANY PART OF THE CIRCUIT WHILE IT IS PLUGGED INTO A MAINS OUTLET and never operate it outside its Earthed metal case or without the lid attached. This circuit is *not suitable* for use with induction motors and must only be used with universal 'brush type' (series-wound) motors or shaded pole (fan) motors with nameplate ratings up to 10A. For more information, see the section titled "What motors can be controlled". Power tools with inbuilt fans must not be operated at low speeds for extended periods; otherwise, they could overheat.

we were making those changes, we took the opportunity to improve its ability to maintain motor speed under load, especially at low speed settings and for low-power appliances.

The Full Wave Universal Motor Speed Controller can be used with mains supplies over the range of 220-250V AC at 50Hz or 60Hz. This means that it can be used in many different countries, although it is not suitable for use with 100-120V AC mains supplies.

The Controller is mounted in a relatively low-profile diecast aluminium case with mains plug and socket leads attached to one end, through cable glands. A panel fuse is also provided on the same end of the case.

The speed control and feedback gain potentiometers, and soft start switch, are mounted on the lid.

Features

- **For universal and shaded-pole motors rated up to 10A**
- **Runs from 220-250V AC at 50Hz or 60Hz**
- **Full-wave motor speed control**
- **Full speed range (from nearly zero to close to 100%)**
- **Current feedback for maintaining speed under load**
- **Feedback gain adjustment**
- **Optional soft start from zero speed and at power-up**
- **Optimised control for inductive loads such as motors**

Why do you need speed control?

Most power tools will do a better job if they have speed control. For example, electric drills should be slowed down when using larger drill bits as they make a cleaner cut.

Similarly, it is useful to be able to slow down routers, jigsaws and even circular saws when cutting some materials, particularly plastics, as many will melt rather than be cut if the speed is too high. The same comments apply to sanding and polishing tools, and even electric lawn trimmers; they are less likely to snap their lines when slowed down.

What motors can be controlled?

This Controller suits the vast majority of power tools and appliances. These generally use universal motors which are series-wound motors with brushes. They're called universal motors because they can operate on both AC and DC.

You cannot control the speed of any universal motor which already has an electronic speed control built in, whether part of the trigger mechanism or with a separate speed dial.

That does not include tools such as electric drills which have a two-position **mechanical** speed switch. In that case, you can use our speed controller with the mechanical switch set to fast or slow. The slow selection usually drives the motor with a half-wave voltage.

Induction motors (except shaded-pole types, which are often found in fans and such) must not be used with this speed controller. How do you make sure that your power tool or appliance is a universal motor and not an induction motor? One clue is that most universal motors are quite noisy compared to induction motors. However, this is only a guide, and it's certainly not foolproof.

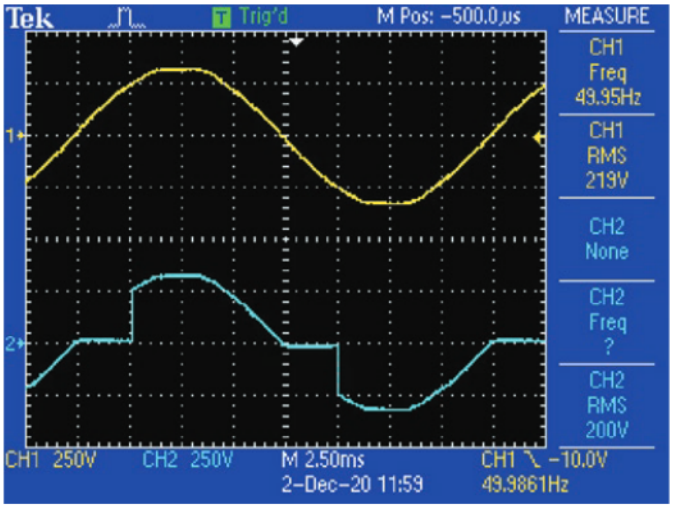
In many power tools, you can see that the motor has brushes and a commutator (usually through the cooling vents) and you can see sparks from the brushes during operation. That indicates that the motor is a universal type. But if you can't see the brushes, you can also get a clue from the nameplate or the instruction booklet.

Most induction motors used in domestic appliances will be 2-pole or 4-pole types which operate at a fixed speed, typically 2850 RPM for a 2-pole unit or 1440 RPM for a 4-pole unit. The speed will be on the nameplate. Bench grinders typically use two-pole induction motors.

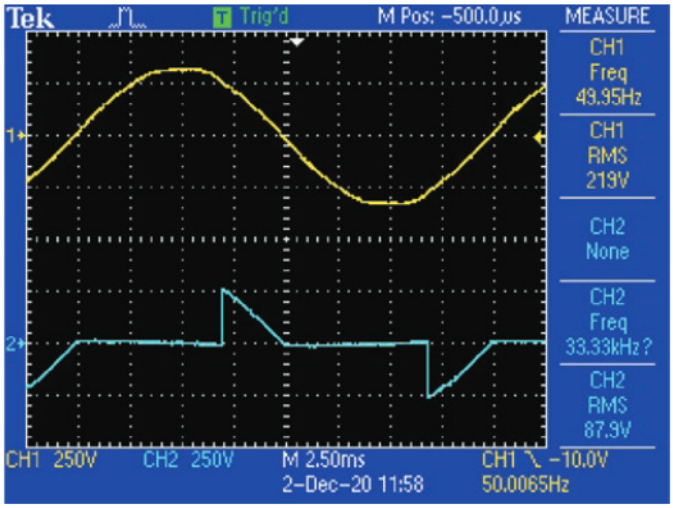
If you do need to control the speed of this type of motor, use the 1.5kW Induction Motor Controller published in April and May 2012 (siliconchip.com.au/Series/25) with important modifications in the December 2012 issue.

Phase control

The AC mains voltage closely follows a sinewave. It starts at 0V, rises to a peak, falls back to 0V, then does the same



Scope1: the output waveform (Active voltage, in cyan) at a higher speed setting with a resistive load (a light bulb). You can see that the output voltage matches the input voltage most of the time, so the attached load will receive almost full power and, if a motor, will run at high speed.



Scope2: by triggering the Triac later in each mains half-cycle, the output voltage (cyan) is zero most of the time, and the load power is greatly reduced. This will cause an attached motor to spin quite slowly, as the average applied voltage will be low.

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SERVICEMAN'S LOG

I hope the purists won't spit their dummies

Dave Thompson

I love a good restoration; it's great when old gear is kept working into the 21st century in original condition. But sometimes that just isn't possible, and it's a good enough result to get something working again while keeping it *looking* original. So what did I do that will get certain knickers in a twist? Read on to find out...

As I mentioned last month, all these lockdowns are (generally) bad for business, but they do give us time to do those jobs that were waiting for the shipment of round tuits to arrive.

One of these jobs is a 1940s Gulbransen valve radio a friend had given me a while ago to check over. It has been sitting in a corner of my workshop gathering dust for a while, simply because it looked like a huge mountain to climb.

This is one of those large mantel radios with an oak-veneered timber case. It has a gently-glowing dial displaying the many short and long-wave bands available at the time, a nifty 'magic-eye' tuning indicator and a sizeable built-in speaker, all giving it a typically warm valve radio sound and aesthetic.

The problem with this radio is it had been stored in an outside shed for the last 40 years, and the moisture has really gotten into it. The timber finish has cracked, faded and lifted in places, and the fawn-coloured grille-cloth and paper speaker cone now almost

Items Covered This Month

- The week old vintage
- The self-made (repair)man
- Yamaha E303 keyboard repair
- Peak Instruments component analyser repair

**Dave Thompson runs PC Anytime in Christchurch, NZ.*

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

~I IMAGINE DEDICATED RESTORERS/COLLECTORS FROTHING AT THE MOUTH AT WHAT I'M SAYING. BUT I SUSPECT THE VAST MAJORITY OF THESE HAVE ENDED UP IN REFUSE TIPS ALL OVER THE COUNTRY.

Preview only.

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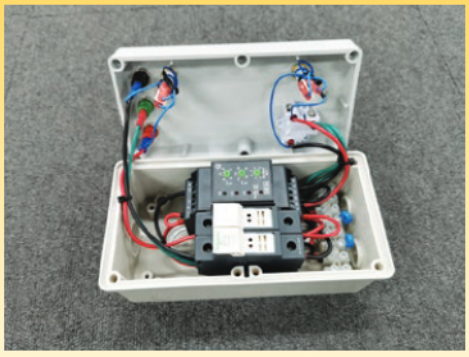

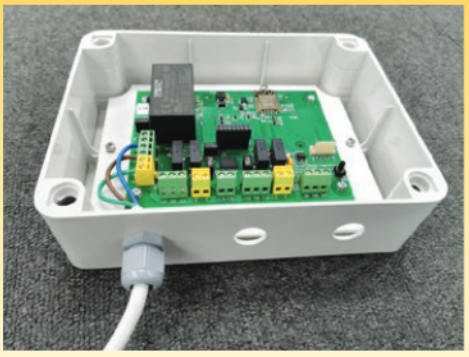

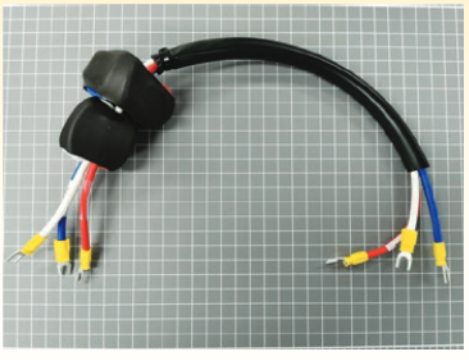

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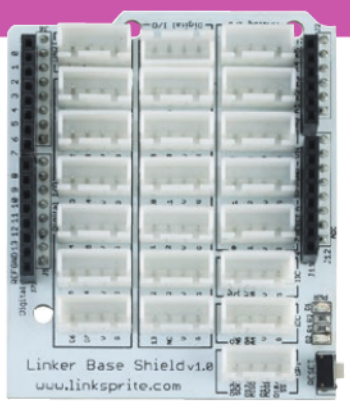

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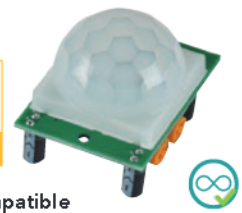

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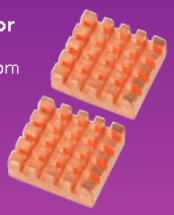

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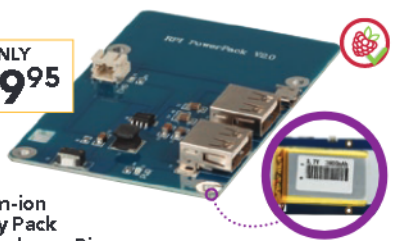

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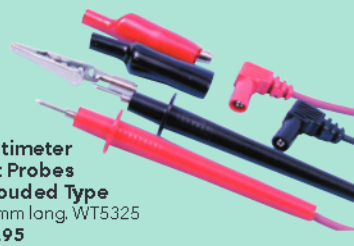

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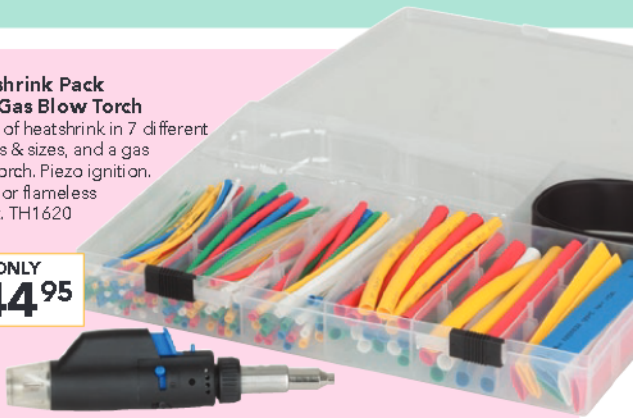

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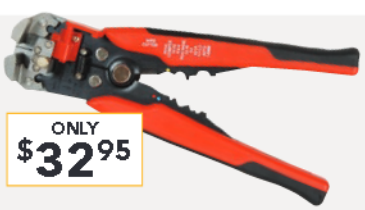

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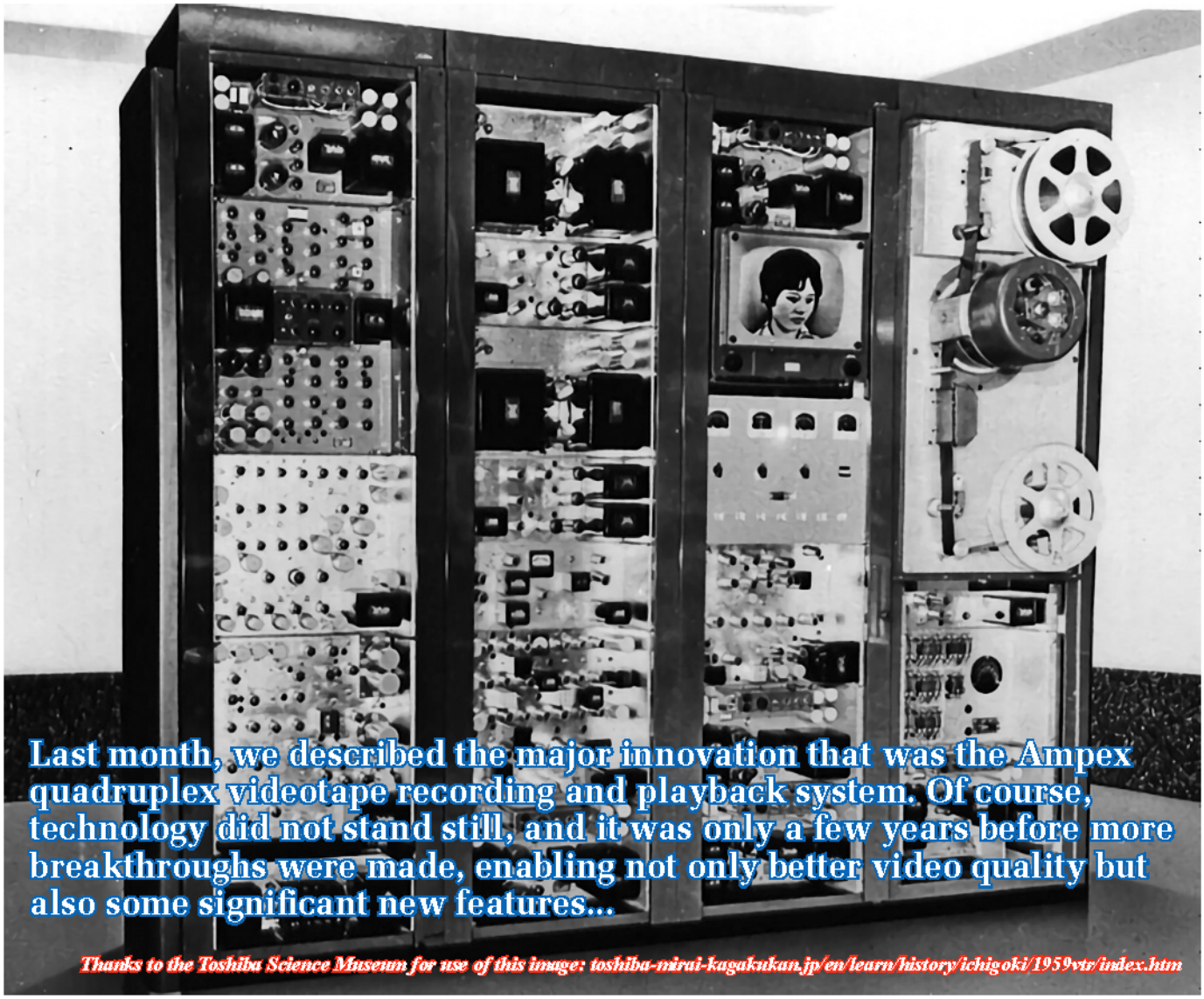
The History of Videotape – part 2
Helical Scan

By Ian Batty, Andre Switzer & Rod Humphris



Last month, we described the major innovation that was the Ampex quadruplex videotape recording and playback system. Of course, technology did not stand still, and it was only a few years before more breakthroughs were made, enabling not only better video quality but also some significant new features...

Thanks to the Toshiba Science Museum for use of this image: toshiba-mirai-kagakukan.jp/en/learn/history/ichigoki/1959vtr/index.htm

Ampex's quadruplex video recording was a revolutionary technology. Casting off the existing linear tape paradigm, Alex Poniatoff's company invented a system where four tape heads, mounted on a spinning disc, scanned the tape transversely.

Coupled with the adoption of frequency modulation, 'quad' established videotape recording (VTR) machines as television broadcasting's workhorse for replay, editing, distribution and archival work.

Yes, the first VTRs were horrendously expensive, and the size of a few refrigerators. And yes, the tape is not entirely robust – it can break and distort. But its added flexibility was well worth it for news and broadcast companies. For the rest, videotape recording was out of reach.

But the principles established by quad were sound: rotating head scanners and frequency modulation were clearly the way ahead. If only someone could devise a simpler, cheaper system. And it would be helpful for it to produce a picture in pause, or at slow or fast picture search; things impossible with quad.

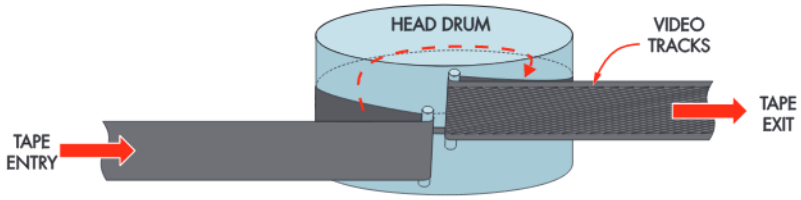
Enter Toshiba

Dr Norikazu Sawazaki at Toshiba's Matsuda Research Laboratory developed a prototype helical scan recorder in 1953. The first experimental VTR-1 was completed in 1958 and demonstrated to the public in September 1959. Commercial production of the new videotape recorder followed.

At around the same time, Eduard Schuller of Telefunken had also devoted himself to the recording of television signals. Having already invented the "ring-shaped" audiotape head still in use today, he was awarded a 1953 patent for magnetic recording and playback of television pictures using helical scanning.

The tape runs around the head drum, giving much longer video tracks

Fig.9: the basic concept of helical scan recording. The tape is wrapped around a drum head at an angle so that as the head spins, it scans diagonal strips. This means that the diagonal tracks overlap continuously along the length of the tape, avoiding the segmentation necessary with the quad system.



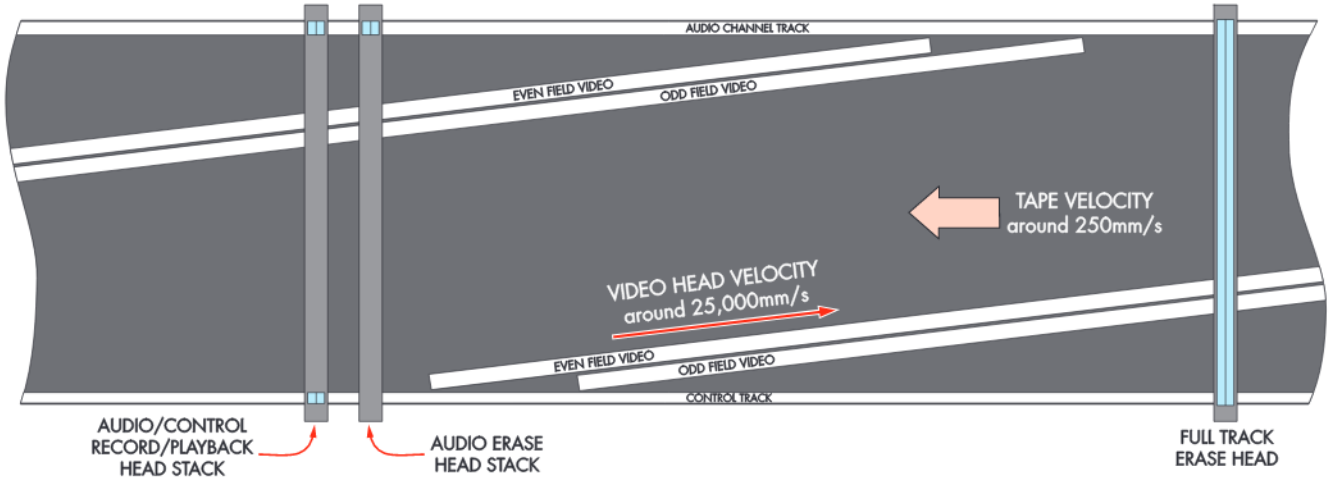


Fig.10: this gives you an idea of how the tracks are laid down on the tap in a helical scan system. While they are diagonal when the tape is laid flat, when the tape is wrapped around the drum, the tracks actually form a helix shape.

than was possible with quadruplex. Figs.9 & 10 show a simplified single-head system.

The tape engages the head drum (the scanner) high and exits low, so the system records a number of slanted tracks at a shallow angle of perhaps 5°. Viewing the tape on the drum, the video tracks appear as a series of spirals, a bit like a coil spring, hence the term "helical scanning".

Early helical-scan VTRs used the available 2-inch tape. Despite not needing vacuum air to form the tape path, they were hardly more compact than their quad predecessors. A slower tape speed of 3.7ips allowed five hours recording or playback on 12.5-inch tape reels.

Video recording and playback demand continuous head-to-tape contact. Quad solved this by always having one of four heads engaged with the tape, and switching to the active head, but this resulted in the possibility of mismatches causing head banding.

Helical scanning aimed to record an entire field of 312.5 lines over 20ms in a single scan over the tape. This demanded a much longer track length than quad's 46mm, with its 16 lines per scan. Quad systems were able to record signals in the megahertz range by virtue of the high headwheel speed, and helical scan would also need high head-to-tape speeds.

Helical scan needed to use realistic tape speeds, say 7.5ips, but the head-to-tape speed needed to be in the order of 20m/s. The solution was to use a head drum with a large enough diameter to give the required head-to-tape speed for FM recording.

The Ampex 5800~7900 series VTRs (Fig.11) used a head drum diameter of 135mm, creating a track length of some 425mm. This gave a writing speed of just over 11m/s, adequate for FM recording.

They matured with the 7950, a time-base-corrected VTR capable of broadcast performance. Using a single head with one field for each scan of the tape, this system's head drum rotated at 50 revolutions per second (3000 RPM) for our CCIR/PAL standard. But with such a long track, tape tension has much more effect on the horizontal rate.

Television broadcasters had been the market for the first generation of VTRs, and broadcast demands very stable images.

With a track length of only 46mm laid across the tape (and thus much less affected by tape stretch), quad's greater immunity to tape variations meant that it remained the preferred format. Helical systems would have to play catch-up for some time.

Broadcast vs non-broadcast video tape recorders

As described in the last article, broadcast VTRs must be locked to station sync, both in frequency (to prevent vertical rolling or horizontal drifting) and in-phase (to register VTR pictures over the station program). But if a VTR program is to be replayed on a local monitor, or sent

Fig.11: an Ampex helical-scan VTR which used 2-inch tape. One big advantage over the quad system was lower tape speeds, which meant longer recording and playback times (more photos at www.ebay.com/itm/182696338060). *Source: www.labguysworld.com/Ampex_VR-660.htm*

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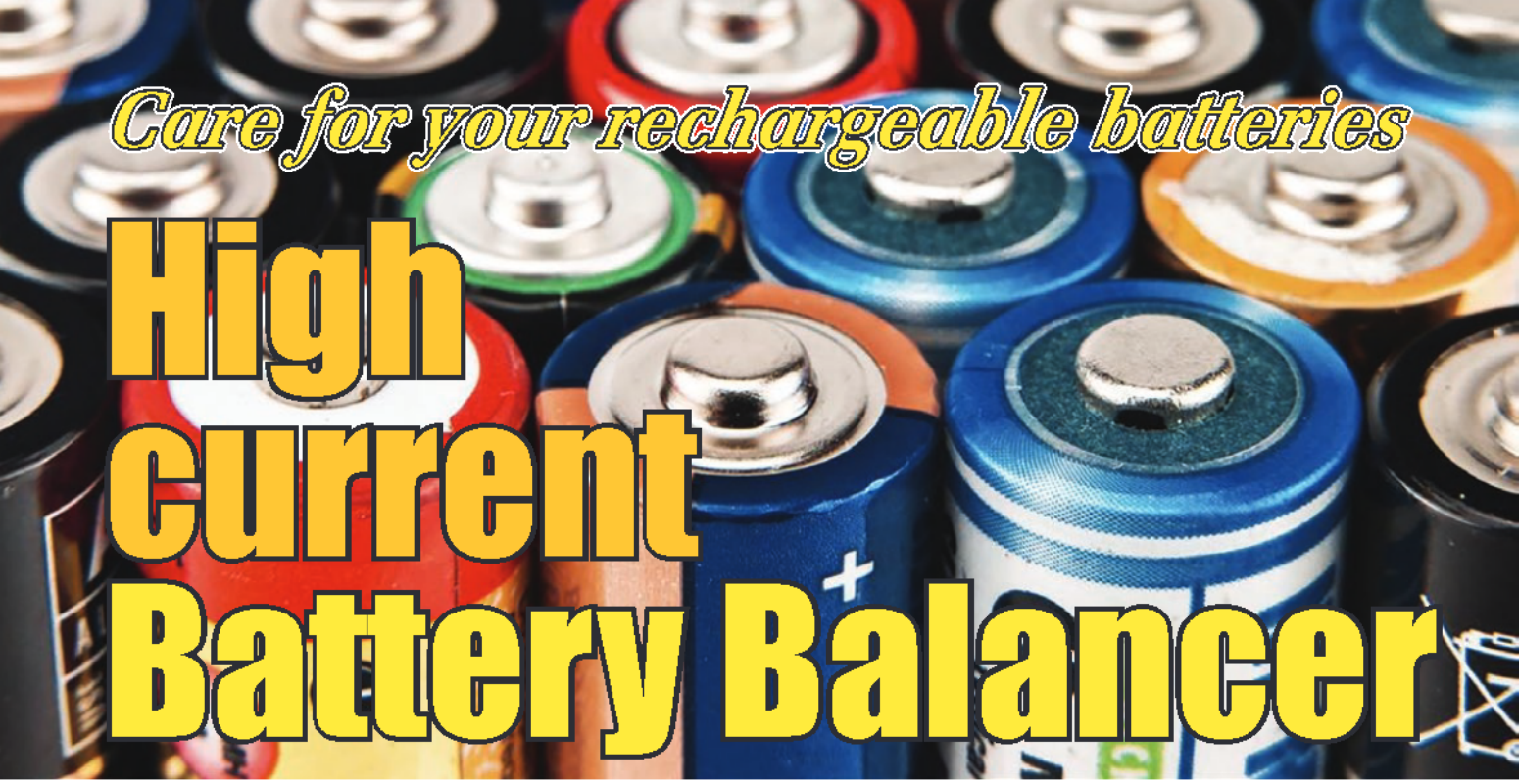

Care for your rechargeable batteries

High Current Battery Balancer

Our new High Current Battery Balancer, introduced last month, is an advanced design which provides high efficiency and fast balancing by efficiently transferring charge between the connected cells or batteries. It can handle cells or batteries up to 16V, and two units can be combined for larger installations. This second and final article describes the assembly and testing steps, and how to use it.

Part 2 – Construction – by Duraid Madina

We put considerable effort into keeping this design as simple as possible, while still providing excellent performance and many useful features.

As a result, the parts count is not especially high. However, we have had to use mostly SMD parts to keep the size reasonable, and also because many of the best part choices were not available in through-hole packages at all.

While the board assembly is not overly difficult, it is not suitable for beginners. Some SMD soldering experience is desirable.

You will need a decent temperature-controlled soldering station (and ideally a reflow oven or hot air rework station), a syringe of flux paste, some solder wick, fine-tipped tweezers, a magnifier and a strong light source.

None of the SMD parts are especially difficult to handle, although the smaller six-pin parts in SOT-363 packages are on the tricker side, along with QSOP-16 ICs, which have pins that are fairly close together. Finally, the transformers can present a bit of a challenge in making good solder joints due to their high thermal mass. But with a little care, the PCB can be built by hand.

Construction

The High-efficiency Battery Balancer is built on a four-layer PCB coded 14102211 which measures 108 x 80mm.

Refer to the PCB overlay diagrams, Figs.4(a) & 4(b) overleaf, for details on which parts go where. We suggest you start construction by populating the surface-mount components on the board's underside, followed by the SMDs on the top side, then finally, the through-hole parts.

As touched on earlier, you can use various assembly methods, including reflow soldering or hand-soldering. We will describe the hand-soldering method as it requires the fewest specialised tools, listed above.

The general procedure is to place each part (with the correct orientation for polarised parts, which is pretty much all ICs, diodes & Mosfets) and tack down one pin. You then check the alignment of the other pins and re-position the part by melting the tack solder and gently nudging the part if it is not perfectly aligned with its pads. Once aligned, it is a good idea to add flux paste to all the pins, as that greatly reduces the chance of solder not adhering.

You then solder the remaining pins, refresh the initially tacked pin (if you have added flux paste then all you need to do is touch it with the tip of the iron), then use solder wick and flux to clean up any bridges which might have formed.

The order in which components are placed is not critical, but we think it is best to place the most difficult parts on each side first, so that you do not have to deal with interfering adjacent components. The following procedure uses that method.

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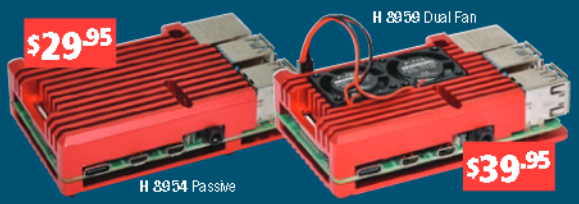

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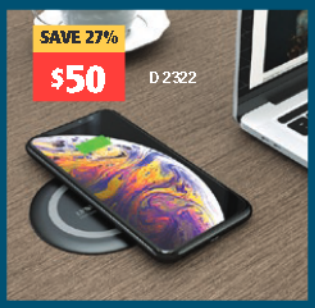

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04/21

64-KEY ARDUINO

This simple project turns an Arduino into a MIDI key matrix. These are popular with musicians for triggering samples, but commercial versions cost hundreds of dollars. Ours costs a fraction of that, and you can customise it by changing the Arduino software. It supports regular or illuminated buttons and can also be programmed to act as a MIDI pass-through, among other roles.

This project was inspired by a reader request to create something similar to the Infra-red Remote Control Assistant project from July 2020 (siliconchip.com.au/Article/14505) but for MIDI.

MIDI is a standard that allows musical instruments and computers to communicate. Just in case you didn't know, MIDI is an acronym for Musical Instrument Digital Interface.

A MIDI encoder takes inputs from a musical instrument (such as a keyboard) and converts them into MIDI format. Such a device could be connected to a computer to record playing, or to a synthesiser, to turn the MIDI data back into music.

Such devices commonly utilise 8x8 switch matrices to generate up to 64 different MIDI messages; they effectively emulate a five-octave keyboard with some keys to spare. This allows you to easily interface with a synthesiser or digital audio workstation (DAW) to generate music from real-world inputs.

The Arduino community has done a lot of the work for this already, creating libraries which can generate MIDI messages both in hardware (as serial data) and also as a virtual USB MIDI device (which many DAW PC applications can read).

The basic system can be implemented with not much more than an Arduino Leonardo development board. The Leonardo is based on an ATmega32U4 microcontroller, which has a USB peripheral. Along with an Arduino library, that makes this job much easier.

To do this, the Leonardo scans columns assigned to eight of its I/O pins and checks if they have been shorted against any of eight other I/O pins, assigned to the button rows, thus giving up to 64 combinations. These 16 I/O pins are then wired to an array of tactile switches or pushbuttons which form the keys.

This simple system cannot detect more than one 'closure' at a time, so any state that is identified as having more than one button pressed is reported as 'nothing pressed'. Some, but not all, combinations of multiple keys could be identified, but we have erred on the side of keeping this simple.

To be able to detect simultaneous keypresses correctly would require a diode to be fitted to each switch (and would also make our simple device considerably more complicated).

Each key (close or release) event results in a MIDI event being sent over USB. We are using the Leonardo's hardware serial port to generate a hardware MIDI signal. This can then be fed through our MIDI Shield, described below, to convert it to the correct electrical format to go to a synthesiser etc.

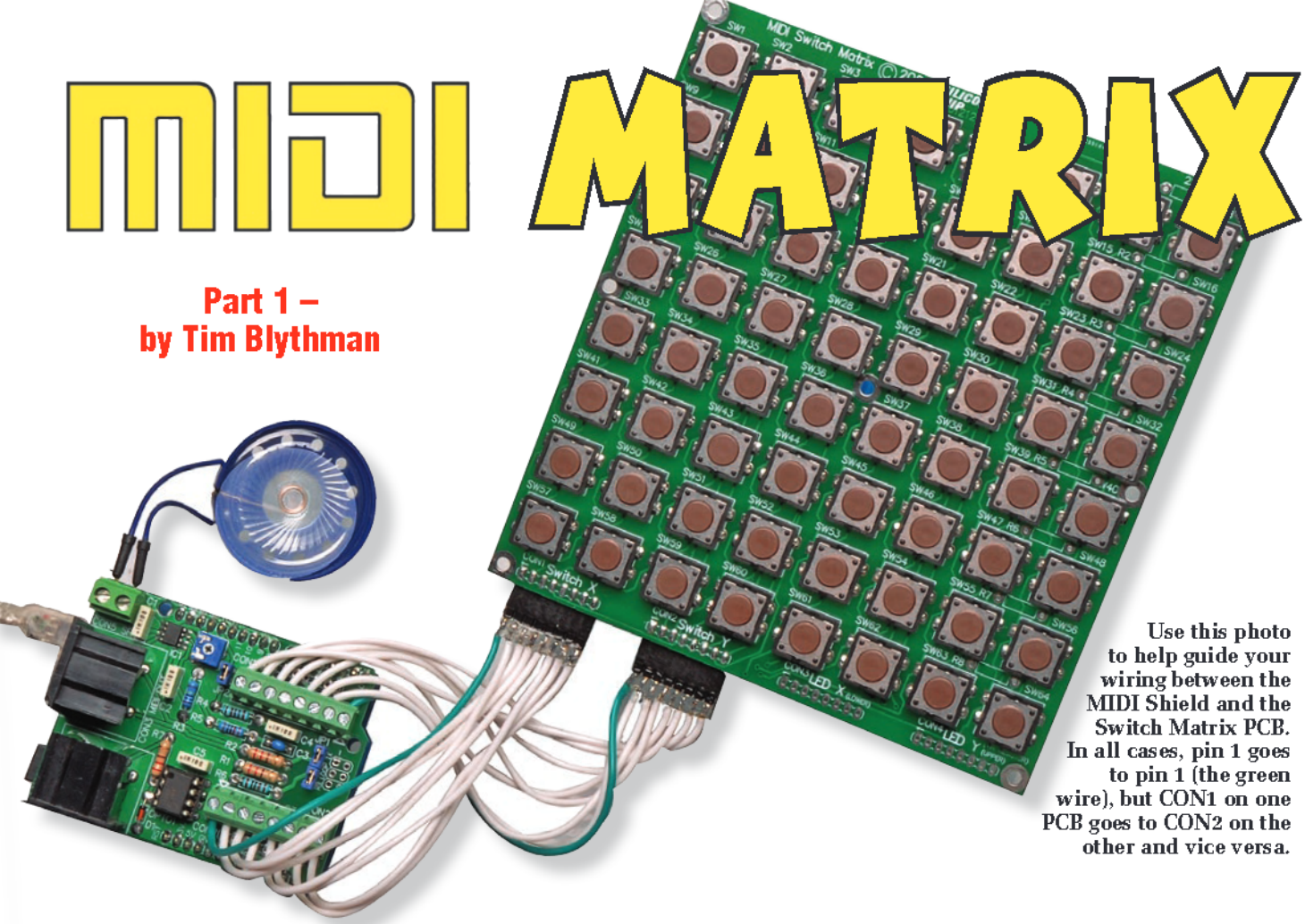
Note that if all you want to do is send MIDI events to a computer over USB, you don't even need to build the Shield. But you probably will want to assemble our Switch Matrix PCB, also described later, as wiring up the switches manually would be a lot of work!

To help make this project more useful, we've also added a very basic synthesiser to the Leonardo. A PWM signal is produced from pin 13, approximating a sinewave at the frequency of the note being played. The waveform shape is defined in an array, so it could be changed to produce a different sound.

This sound can be heard by connecting a piezo transducer between pin 13 and GND of the Leonardo, although these devices don't have a great re-

MIDI MATRIX

Part 1 – by Tim Blythman



Use this photo to help guide your wiring between the MIDI Shield and the Switch Matrix PCB. In all cases, pin 1 goes to pin 1 (the green wire), but CON1 on one PCB goes to CON2 on the other and vice versa.

sponse to lower frequencies. Hence, our MIDI shield also provides an audio amplifier which can drive a speaker (the larger the better – they're usually more efficient) for better audio quality.

While we were at it, we thought we'd also add a MIDI Input to the Shield. As presented here, all you can use that for is to replicate the received data directly to the MIDI Output, allowing this device to act as a basic extender. However, the hardware is set up to allow the micro on the Leonardo to receive and decode the incoming MIDI data, so with appropriate software, it could do a variety of other jobs.

The MIDI Encoder Shield

This small PCB is an Arduino 'shield' (aka daughterboard) which adds some useful hardware for interfacing with MIDI equipment.

The board effectively combines four different 'modules' which operate independently. That means that, if you don't need all of the functions, you can leave off some of the parts.

These four parts are the interface to the switch matrix, an audio amplifier, a MIDI transmitter and a MIDI receiver. The circuit diagram for the whole Shield, incorporating those four sections, is shown in Fig.1.

Switch matrix

Since the switches are intended to be mounted off-board, we have just provided some convenient connection points on the PCB.

CON1 and CON2 are standard 2.54mm (0.1in) pitch headers, and could be fitted with pin headers or sockets. For prototyping, we recommend header sockets, as these allow jumper wires to be plugged in.

CON1A and CON2A have a 3.5mm pitch and are sized to fit smaller screw terminals such as Altronics' P2028. This is a good way to rig up something more permanent. You could also solder wires directly to any of these pads.

Note that the pins marked with the arrows correspond to the 'lowest' ends of each row and column. Thus, shorting the two pins marked with arrows will give the lowest note. Shorting the two pads at the opposite ends will give the highest note.

You will probably not be able to install both of CON1 and CON1A or CON2 and CON2A, as the headers will foul the cable entries for the screw terminals. Thus, you should choose which of the two you will fit before starting construction.

Audio amplifier

The amplifier circuit is based around IC1, an SSM2211 class-AB amplifier IC, which we previously used in the AM/FM/SW Radio published in January 2021. It provides a push-pull output at up to 1.5W into 4Ω, so it is a good choice for low supply voltages. A 100nF capacitor bypasses its supply rails at pins 6 and 7.

Jumper JP2 can be used to connect Arduino pin D13 to the amplifier. If you want to use another I/O pin to feed the amplifier, it can be patched into JP2. IC1 is surrounded by components to condition the input signal (including filtering out any high-frequency PWM artefacts) and to set the gain.

The 1kΩ resistor and 100nF capacitor provide low-pass filtering to remove PWM switching harmonics from the generated audio signal. This results in the 180kHz PWM frequencies being attenuated by around 40dB.

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The MAX41400 (https://bit.ly/MAX41400_Product) instrumentation amplifier enhances sensor system accuracy by four times and extends battery life by 55% compared to the closest competitive offering. The MAX41400 provides low offset of 25µV, low noise and programmable gain with only 65µA current consumption.

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Review by Tim Blythman

Cordless Soldering Iron & Heatshrink kit

It's remarkable how far battery technology has come over the years. More and more devices that previously would have used some other power source have now become practical to run from battery power.

Wagner Electronics loaned us their new Cordless Soldering Iron Kit, and we found it to be a handy item that could well replace a gas-powered soldering iron.

The Cordless Soldering Iron comes as a Soldering Iron and Heatshrink kit, available as Cat SI50HSK from www.wagneronline.com.au, with a current RRP of $139.

There are also numerous different tips available, in addition to those that come in the kit.

The kit gives you a good set of mid-level tools, and would make an excellent portable standby kit. But it would also be quite adequate as a primary soldering tool.

The Iron itself measures 160mm long and 28mm in diameter. Roughly cylindrical, the grip is moulded rubber and quite comfortable to hold.

The kit includes three interchangeable tips. There is a 30W 4mm conical tip, a 50W 6mm conical tip and 30W radiant heatshrink tip. An assortment of smaller diameter pieces of heatshrink is included.

The kit comes with a protective cap for the Iron (which fits even with a tip installed), a USB-A to micro-USB charging cable and a small punched metal stand. All the parts are supplied in a simple plastic case with internal dividers.

A micro-USB socket at one end of the tool is used for charging, with a clearly marked ON-OFF switch at the other end near the grip.

The switch needs to be slid and a button held in to turn the Iron on, so there's little chance of it being left on inadvertently, even when resting on the button. The cap also forces the switch off when it is fitted – a thoughtful design touch.

There is a small white LED near the tip which lights up whenever the button is pressed. It doesn't quite illuminate the tip, so it is not very useful.

You would be in a tough situation if you had to rely on this light to illuminate your work.

While the Iron's hot!

With a prototype PCB to be assembled, we dove in to try it out. The PCB in question measures 123mm x 58mm and hosts nearly all through-hole parts; around 100 joints to solder. We didn't try the Iron on the surface-mounted parts as the smallest included tip is too large.

We used the smaller 30W tip, and as specified, the Iron takes about 10 seconds to come up to working temperature and holds the heat quite well.

For most parts, it was sufficient to simply give the Iron a short burst of power while applying solder.

Apart from the heat-up time after leaving the Iron idle, it felt no different to using a regular iron. The large tip is probably overkill for this sort of work; there is also a smaller 12W tip

Inside the SI50HSK Iron is a single 2400mAh Li-ion cell which will give up to 45 minutes of continuous use. For normal (intermittent) soldering use you could expect several hours of operation.

The SI50HSK can be recharged from an USB outlet with the USB cord included, but Wagner also offer an optional mains USB charger if required.

(Right): this kit includes a storage case, main heating tool body with two cone-shaped soldering tips, a heat radiator tip with focusing sleeve for heatshrink and a micro-USB charging cable (charger itself is optional). In addition, there are 200 pieces of 45mm long, red, blue, yellow and black heatshrink tube in diameters of 2.2mm, 3.5mm, 4.5mm and 7mm.

available and a finer 30W tip.

If we were purchasing this kit for our own use, we would undoubtedly pick up those two as well.

The shape is well-thought-out. It's uniformly cylindrical enough that whichever way it sits, the tip won't touch a flat work surface, while the moulded grip means that it won't roll away. In short, we had no problem simply putting it down between uses.

In use, the Iron feels well-balanced and sturdy. We tried the small stand, and though simple, it was effective. But we didn't find it necessary.

The battery life is listed at 45 minutes of continuous operation, so it could be expected to last for hours with intermittent use. We certainly didn't have any trouble with it going flat during our testing.

Each tip has a good-sized plastic collar which allows the tip to be handled, even while hot. The collar is wide enough that the tip can balance on it, so there's no need to worry about where to rest it.

We also tried the heatshrink tip. Those readers of a certain age might be reminded of an item that was once a feature of most cars; the electric cigarette lighter. The heatshrink tip is much like one of these, glowing red when turned on.

The heatshrink tip worked well on small pieces of heatshrink, but it was not as quick as something like a hot-air gun would be. This tip's radiant nature means it's not quite as easy to aim and use as a hot-air gun.

We did get that sense of something smelling a bit burnt, so the heat appears to be quite concentrated too. A small shroud that fits on the heatshrink tip is included.

Working with heatshrink is probably where a gas iron would win out, although the battery Iron is certainly adequate.

Accessories

A range of fourteen spare tips is available; they are each around $20. There are six different soldering tips (including the two included in the Iron kit) and tips for cutting plastic, pyrography (wood-burning) and styrofoam forming. The heatshrink tip is also available as a spare part.

Wagner Electronics also offers a suitable AC-USB adapter for charging purposes.

Verdict

As the kit comes, it is well-suited to replacing a gas soldering iron. There's certainly enough heat and runtime to handle most of those jobs you would use a gas iron for. And USB power is convenient and ubiquitous enough to allow the Iron to be topped up as needed. It would make a good emergency standby tool.

It's handy enough that it could become a replacement for a mains-powered iron if space is at a premium, unless you're the type who is running the iron for hours on end.

It does end up being a bit more expensive than similar gas irons, but has the advantage of being usable where flames or flammable substances are prohibited. And you avoid the fiddly refilling process that gas irons require.

For more information, or to purchase the kit and possibly some extra tips, go to http://siliconchip.com.au/link/ab71 (Wagner's online shop page for this product). SC

In addition to the seven soldering iron tips, Wagner also offer a range of tips for other hobby applications (as shown here).

VINTAGE RADIO

Philips 1948 table model 114K

By Associate Professor Graham Parslow

The 114K radio is one set in a series of similar radios made by Philips, and was among the last all-octal radio designs, due to decreasing stock in the post WW2 era. The radio is otherwise a fairly standard six valve superhet, but weighs in at a hefty 12kg.

For 12 years, this radio sat in my storage shed because I considered it an ugly duckling, but events conspired to change my opinion recently. So I got it out of storage to see if I could clean it up.

I purchased this radio in a lot with other radios which I was more interested in. Recently, a friend who worked for Philips some time ago told me that one of his managers used this model of radio at his house, and took great pride in having it.

That started me wondering if I had judged it unreasonably. The COVID-19 lockdown inspired me to look at my back shelf for a project. Hence, a large grubby radio entered my restoration queue, emerging resplendent, and much elevated in my estimation.

1948 was three years after the end of the Second World War, and radio manufacturers were slowly exhausting stocks of large 8-pin octal valves before moving to 7-pin and 9-pin miniature valves. At that time, many radios used a mixed lineup of octal and miniature valves to best utilise their inventory.

The model 114K is among the last of the all-octal radios. It is also among the last of the multiple timber veneer cabinets. Through the 1950s, almost all timber cabinets were simplified to single veneers (usually stained), and cabinets were changed to easily fabricated shapes; mostly rectangular.

The model 114K is a heavyweight table radio at 12.2kg, measuring 560mm wide, 245mm deep and 360mm high. It has an eight-inch Rola permanent magnet speaker (type 8K) that produces excellent sound from the baffle provided by the substantial cabinet. That sound is also optimised by circuitry that is consistent with a premium radio.

The 114K sold for £46/17s/00d, more than double the price of contemporary Bakelite kitchen radios, which were usually in the range of 15-20 pounds (£).

Unusual design

This radio conforms in style to a series of late-1940s Philips radios with the dial mounted at the top. As the premier model, this dial articulates so it can be laid flat for moving the radio. On lesser models, the glass dial was fixed, although it could be removed and slotted back in.

The advertising angle to promote this set was that while others fill the front with a dial and a small speaker, Philips builds in a large unobstructed speaker and puts the dial on top.

If you are unconvinced, then you have good grounds, because this was not a good idea. One indicator is that other manufacturers did not follow. The yellow screen-printed station information is difficult to read without

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Advertising Index

Notes & Errata

High-Current Battery Balancer, March 2021: in the parts list on p27, several Mosfets (Q11,Q12...) are listed as "S6M4" types. The correct type code is QS6M4.

Arduino-based Adjustable Power Supply, February 2021: while the specified SY4030 relay from Jaycar is rated to carry 1A, it only has a 500mA switch rating. The similar S4100 relay from Altronics specifies a 1A switching current. Power supplies built using the Jaycar part should set the current limit no higher than 500mA to avoid damage to the relay. Other similar relays are available with a 1A contact rating; it appears that this refers to the carry current only, and not the switching current, so check the data sheet if substituting a different part.

LED Party Strobe Mk2, August 2015: the link at lower-left should be positioned as shown in the photo on p87, not the overlay diagram (Fig.2) on p86, which incorrectly has it shown in the "MAX" position.

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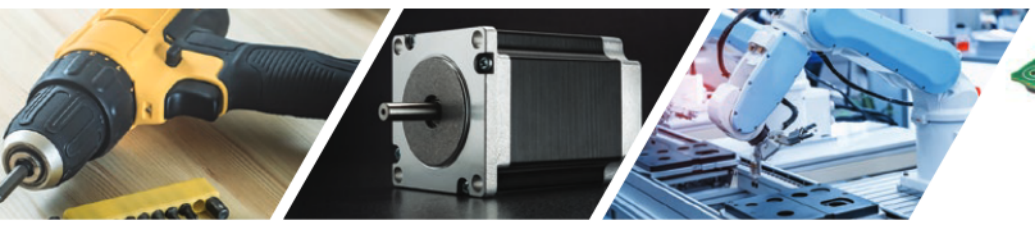

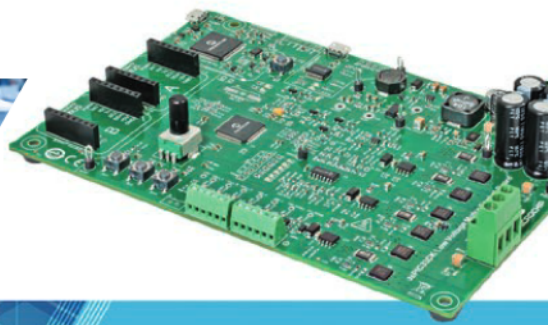

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