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36 | USB Power Delivery:
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46 | Level Crossing for
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Contents

Vol.34, No.7

July 2021

SILICON CHIP

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Features & Reviews

12 The 2020 mission to Mars

On July 30th 2020, the Perseverance rover and Ingenuity helicopter were launched into space. They arrived at Mars on February 18th 2021 to search for evidence of past life and find signs of habitable areas – by Dr David Maddison

36 How USB Power Delivery (USB-PD) works

With the introduction of the Type-C connector came a new power delivery specification called USB-PD. It allows 0.5-100W of power (20V at 5A maximum) to be delivered. This article describes how it works – by Andrew Levido

42 EI Cheapo Modules: USB-PD chargers

A quick look at three different USB-PD power sources, which includes the Comsol COWCC30WH, XY-PDS100 and Belkin F7U060AU – by Jim Rowe

73 Review: Tecsun PL-990 radio receiver

The Tecsun PL-990 is a high-performance AM, FM, shortwave (SW) and longwave (LW) portable radio all-in-one. The only downside is that it might be Tecsun's last high-end portable – by Ross Tester

Constructional Projects

26 20A DC Motor Speed Controller

This small speed controller can drive motors rated up to 24V DC and 20A, with adjustable soft-start time, variable PWM frequency and minimum duty cycle adjustments, along with many more features – by John Clarke

46 Model Railway Level Crossing

Moving barriers, flashing lights and a bell sound recorded from a real level crossing make this a realistic part of a model railway layout – by Les Kerr

64 Silicon Labs-based FM/AM/SW Digital Radio

Single-chip technologies, like the Si4730 and Si4732 from Silicon Labs, make it much easier to build a capable digital radio which receives FM, AM and SW signals with just a handful of components – by Charles Kosina

76 Advanced GPS Computer – Part 2

The second, and final article, has the construction details of the Advanced GPS Computer along with how to use it and, for those that are interested, how the software works – by Tim Blythman

Your Favourite Columns

61 Circuit Notebook

- (1) Coded door buzzer
- (2) Adding shuffle to a low-cost MP3 player module
- (3) DIY pulse oximeter

91 Serviceman's Log

I've repaired planes before, but never 'tanks' – by Dave Thompson

98 Vintage Jukebox

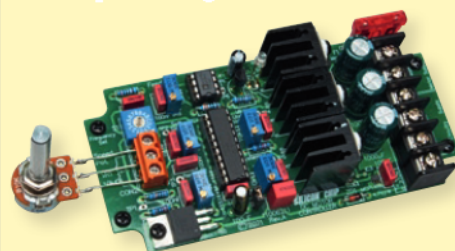
The Rowe AMI JAL-200 jukebox – by Jim Greig

Everything Else

- | | |
|------------------------------|-----------------------|
| 2 Editorial Viewpoint | 107 Ask SILICON CHIP |
| 4 Mailbag – Your Feedback | 111 Market Centre |
| 104 SILICON CHIP Online Shop | 112 Notes and Errata |
| 106 Product Showcase | 112 Advertising Index |



NASA's latest (and current) robotic visitors to Mars are the nuclear-powered Perseverance rover and its companion, the Ingenuity helicopter – Page 12



Our 20A DC Motor Speed Controller uses pulse width modulation (PWM) to drive motors rated from nearly 0 to 24V at 0-100% duty cycle – Page 26



USB 3.2 is the first standard to officially allow power sources and sinks to negotiate the supplied voltage and current. This powerful feature is named USB Power Delivery – Page 36



This new FM/AM/SW Radio is smaller and uses fewer components than the previous BK1198-based model. It can use the Si4730 IC for AM & FM reception; or the Si4732 which also includes SW reception – Page 64

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Editorial Viewpoint



Software: too many bugs, too many updates

I can't be the only person who is sick and tired of the barrage of constant software updates. Between Windows updates, Android updates, Adobe updates, Mozilla updates, App updates, and all the other software packages I use, I spend way too much time dealing with them every day.

With some software packages I use only intermittently, they bother me about updating virtually every time I open up a file! And that's the worst time to do it; I'd much rather they ask me whether I want to update when closing the software than opening it. I'm opening it because I have a task to complete, and I don't want to stop that task to install another *\$(!&#@ update!

It wouldn't be so bad if these updates fixed bugs, but so often, not only do they fix nothing, but they introduce new bugs. Windows updates are the worst. Some of our staff suffered for weeks from constant 'blue screens' and reboots when printing files caused by a Windows update that initially they didn't even realise had been installed.

It cost us a lot of lost productivity until one smart guy figured it out and managed to uninstall that update on the affected machines (one of which was brand new; we thought it might be defective). Microsoft apparently knew about this bug and quickly released a patch to fix it, but the fix didn't work!

I hate to be negative and sound like I'm complaining, but this situation is just ridiculous.

One of my pet peeves is how software companies – including the largest, richest ones in the world – prioritise adding features to their software rather than fixing bugs. This sometimes results in serious bugs that cause frequent crashes or otherwise break the software persisting for years, while they are busy adding useless new doo-dads that we don't need.

They are also far more interested in adding bells and whistles than addressing severe performance problems, making the software virtually unusable. For example, I have some software that can take literally hours to perform certain functions, depending on the complexity of the files I am working with.

I have developed workarounds to accomplish these tasks in a reasonable timeframe, such as manually splitting the job into smaller chunks, then reassembling it later. I shouldn't have to do that. I believe these operations could be completed in seconds (or faster) if the algorithms the software used were implemented in an even vaguely intelligent manner.

I don't know the solution to this, but I believe whether through user pressure, legislation or otherwise, the behaviour of software companies has to change.

If you bought a car and it broke down several times a day, frequently slowed down to unusable speeds and needed to be brought back to the dealer for modifications every week to keep it roadworthy, you would ask for your money back. Yet we pay hundreds or thousands of dollars for a piece of software and then accept that it behaves in the same manner. That is totally unreasonable.

Perhaps the open-source software movement will save us from this life of misery. In some areas, there are already excellent free pieces of software that provide most functions of their commercial equivalents, and they are often less buggy. If the commercial vendors don't get their collective acts together, they might find themselves losing a lot of business to those alternatives.

by Nicholas Vinen

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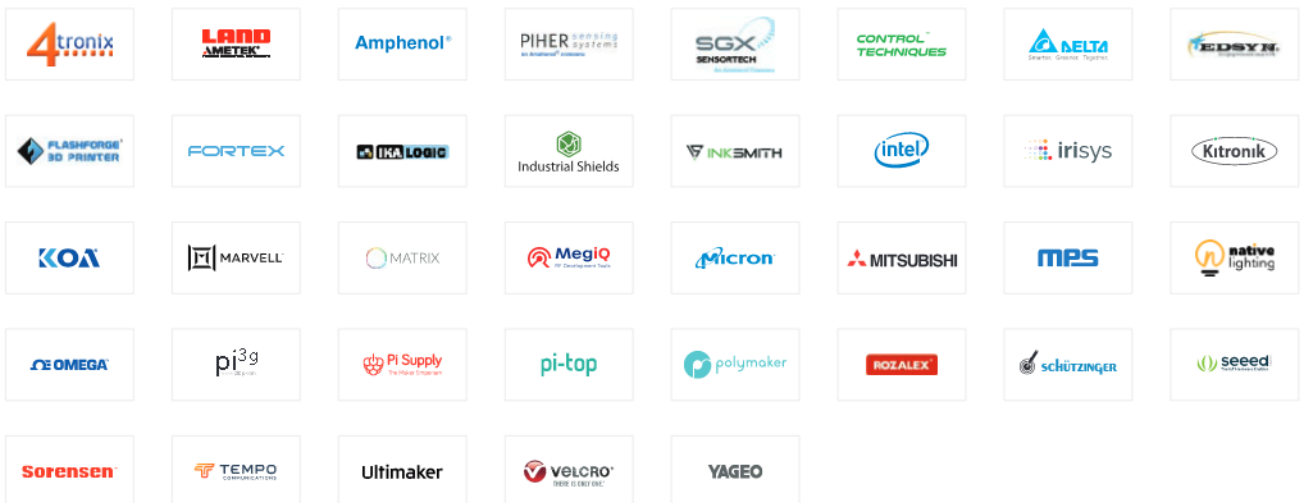
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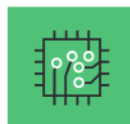
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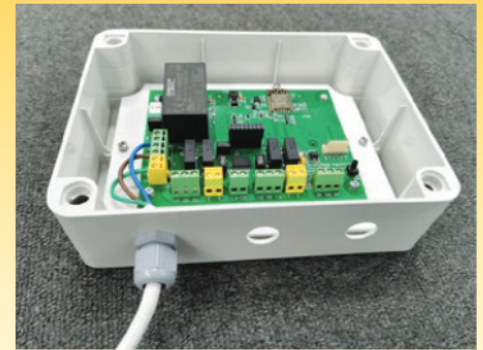
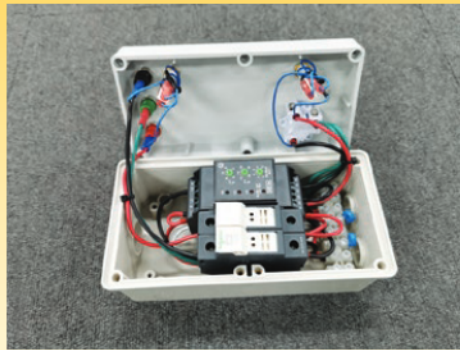
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Source: <https://mars.nasa.gov/resources/25640/mastcam-zs-first-360-degree-panorama/>

Are we alone? We came here to look for signs of life, and to collect samples of Mars for study on Earth. To those who follow, we wish a safe journey and the joy of discovery.”

These words are written on the Perseverance rover as a message for future human explorers, or other intelligent lifeforms that might find the machine in the future.

The Mars 2020 mission involved landing the Perseverance rover vehicle and the Ingenuity helicopter on Mars. Planning for the mission started in 2012, and the Atlas V rocket launched

on July 30th 2020 (see Fig.1). Touchdown occurred on February 18th 2021.

The mission has a strong astrobiological emphasis, looking for evidence of past or present conditions suitable for lifeforms on Mars, or the actual lifeforms themselves. The landing is in an area thought to have once had conditions suited to life.

Great care was taken to ensure no lifeforms from Earth were accidentally transferred to Mars.

The lander will also collect and cache samples for a later Earth return mission, planned for 2031, for further analysis. It will also demonstrate technologies for future robotic missions (such as the helicopter), and future manned exploration such as oxygen production from the CO₂ atmosphere of Mars.

Perseverance is the fifth NASA rover to land on Mars after Sojourner (1997), Opportunity (2004), Spirit (2004) and Curiosity (2012). The first three were solar-powered and no longer function, while Curiosity is nuclear-powered via a radioisotope thermoelectric generator (RTG). Curiosity, which landed on August 6th 2012, is still operational, having travelled more than 25km so far.

Perseverance is based on Curiosity

and is also powered by an RTG.

The spaceflight and landing

Launch dates and times are chosen carefully to fulfil numerous requirements such as:

- Earth and Mars being in suitable locations within their orbits to minimise travel time.
- an existing Mars orbiter be over the proposed landing site to relay data to Earth during the Mars entry and landing.
- suitable weather conditions at the launch site.

There were seventeen days over which the launch could have occurred, with available launch windows on each day from 30 minutes to two hours long (see siliconchip.com.au/link/ab8f for details).

After launch (Fig.2), the next phase was interplanetary cruise (Fig.3), which started as soon as the spacecraft separated from the launch vehicle. During this time, checks were run on various spacecraft systems and several trajectory correction manoeuvres were made, especially on the final approach to Mars.

The final phase was the entry, descent and landing (EDL) – see Fig.4. Ten minutes before this happened,



Fig.1: the Mars 2020 launch on an Atlas V rocket at 11:50am UTC on July 30th, 2020.

Mars is currently the only planet we know of occupied only by robots. This article is about NASA's latest robotic visitors to Mars, the nuclear-powered Perseverance rover and the groundbreaking Ingenuity helicopter. Shown in the background is Perseverance's first 360° panorama, taken by the Mastcam-Z instrument. This panorama was stitched together from 142 individual images. The rover looks distorted because of the 360° view.



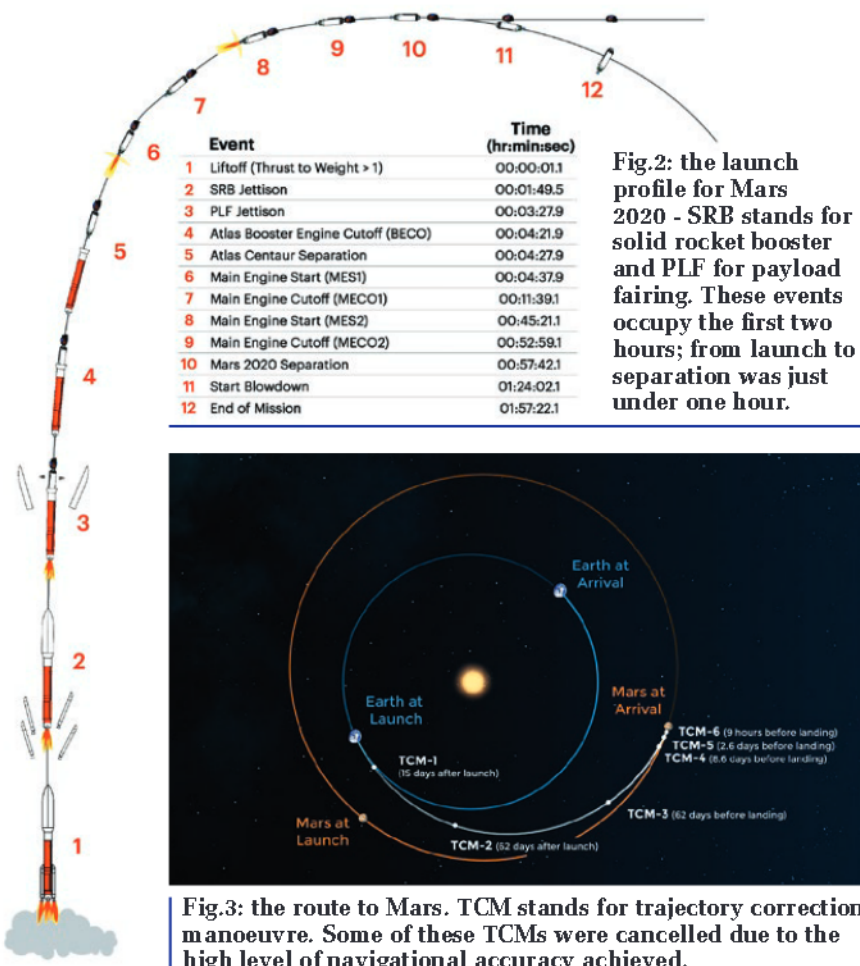
By Dr David Maddison

the cruise stage was jettisoned. EDL began when the spacecraft, protected by an "aeroshell" heat shield, entered the top of the Martian atmosphere at 19,500km/h. During entry, small thrusters on the aeroshell were used to manoeuvre the spacecraft to its target landing location.

Peak heating occurred 80 seconds into the entry, with parts of the craft reaching about 1300°C. Four minutes after entry, a parachute was deployed. The parachute is 21.5m in diameter and deployed at an altitude of 9-13km and a speed of 1512km/h. Twenty seconds after parachute deployment, the heat shield separated from the underside of the spacecraft.

Another 30 seconds after that, the radar and Lander Vision System were activated at an altitude of about 7-8km. At 4km and 6m30s, the Terrain Relative Navigation (TRN) system, using inputs from the Lander Vision System (LVS), had determined the spacecraft position and the desired landing target. More on the TRN and LVS later.

This was followed by back-shell and parachute separation at 6m50s, at an altitude of 2.1km and speed of 320km/h, followed by a powered descent. The descent vehicle, with the rover attached, used manoeuvring



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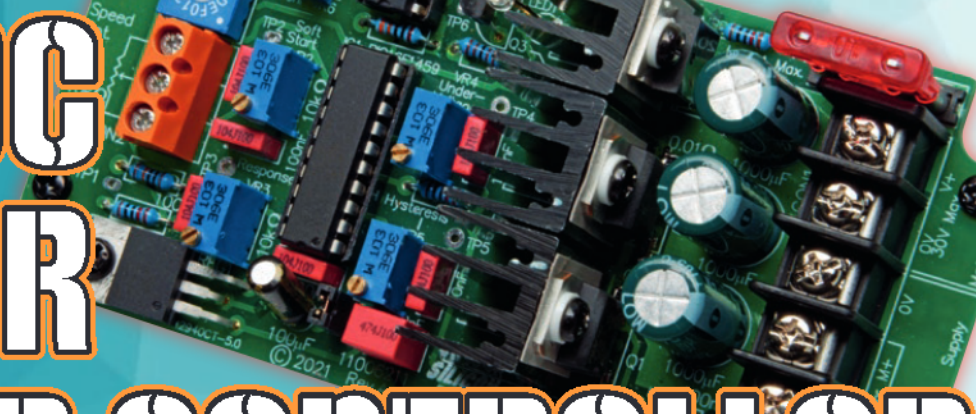


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BY JOHN CLARKE

20A DC MOTOR SPEED CONTROLLER



This small but powerful speed controller has a 20A rating and is packed with features. It suits a wide range of applications, and is simple to build and use. Features include low-battery protection, soft starting and adjustable pulse frequency. It can handle DC motors that run from near 0V up to 30V.

There are a great many applications for DC motors where speed control is desired or necessary. Since DC motors can be run directly from batteries, they are used in golf carts, electric scooters, bikes and skateboards, remote-controlled cars and boats – the list goes on.

In most of those applications, you need a way to control the speed of the motor. Going flat out all the time isn't always a good idea!

A speed controller like this one is the ideal solution. It can handle DC motors with a rated voltage of up to 24V (30V maximum) and continuous currents up to 20A.

The controller is presented as a bare electronic module built on a PCB that can be installed within a standard UB3 plastic case if required. It includes heavy-duty terminals for the power supply and motor connections, plus additional terminals for the speed control potentiometer that mounts off the PCB.

The motor driving components are mounted on substantial heatsinks for cooling. The adjustable features like soft-start rate and feedback gain are set using onboard multi-turn trimpots with voltage test points. An onboard LED indicates the speed setting, as

well as faults like low battery or motor disconnection.

Speed controller design

While we have published many DC motor speed controllers in the past, this version has more features and better performance. The motor speed is controlled using Pulse Width Modulation (PWM). That means that the motor is driven by a series of on and off voltage pulses rather than a variable DC supply, making it more efficient.

Speed control of the motor is done by varying the pulse width. The ratio of the pulse width to the interval between pulses is the duty cycle. A low duty cycle will only provide a voltage to the motor for a small portion of the time, and the motor runs slowly.

As the on-pulse duration increases, this greater duty cycle makes the motor run faster until it reaches 100% duty cycle and is driven continuously.

Oscilloscope traces Scope 1 & Scope 2 show how this PWM scheme works.

In Scope 1, the top (yellow) trace is the gate drive signal for Mosfets Q1 and Q2. When it is high, the motor is powered. In this case, the duty cycle is very low at about 9.5%, so the motor runs slowly. The lower cyan trace is related to the motor current. This is

used to maintain motor speed with a variable load.

Scope 2 has the same two traces, but this time the duty cycle is much higher, and the motor runs faster. The motor is loaded less than in Scope 1, so the current reading is lower despite the higher duty cycle.

What's new

One of the problems with controlling DC motors using PWM is that the motor can make extra noise due to the motor windings and other mechanical parts vibrating at the PWM frequency. This can be alleviated to some extent by adjusting the PWM frequency to produce minimal noise.

That noise tends to be reduced as the PWM frequency is increased, and is mostly eliminated at PWM frequencies above 20kHz (around the upper limit of human hearing).

But increasing the frequency can cause problems too. It becomes harder to maintain the motor speed against a varying motor load using the traditional back-EMF feedback system. Very high PWM frequencies can also cause a loss of motor torque.

These problems and solutions are described in more detail in the separate section entitled "PWM motor

driving pitfalls at higher frequencies”.

This controller gives you the ability to adjust the PWM frequency beyond audibility while addressing the problems of limited low-speed motor torque and control at elevated frequencies.

Other features that are incorporated include soft starting, low-voltage cut-out, LED status indication and optional motor disconnected detection. These features are easy to set up and adjust via trimpot adjustments.

Soft starting

This is where the motor is slowly increased in speed, up to the setting of the speed pot. Soft starting reduces the surge of current and rapid build-up of motor torque compared to applying power suddenly. The PWM duty cycle is ramped up over a longer period, so the motor starts more smoothly.

The maximum soft-start period is two seconds for the full range from 0% duty to 100%. This period can be adjusted from between zero and two seconds in 255 steps.

Soft starting can be initiated in several ways. It applies when the controller is initially powered up, or when the speed control is started from the fully off position, and finally, after returning to regular operation from low-voltage shutdown.

Low-voltage detection

The low-voltage detection feature is included to prevent over-discharging a battery supplying power to the motor. Most batteries, including lead-acid and lithium chemistry types, will be damaged if discharged beyond a certain voltage.

This feature switches off the motor drive at a pre-set threshold voltage. This is indicated with a 65ms flash of the indicator LED at 1Hz.

The voltage must be below the threshold for more than ten seconds before the drive to the motor is switched off. This prevents any nuisance low-voltage trips that would otherwise switch off the controller due to a short-term voltage drop when the motor starts up.

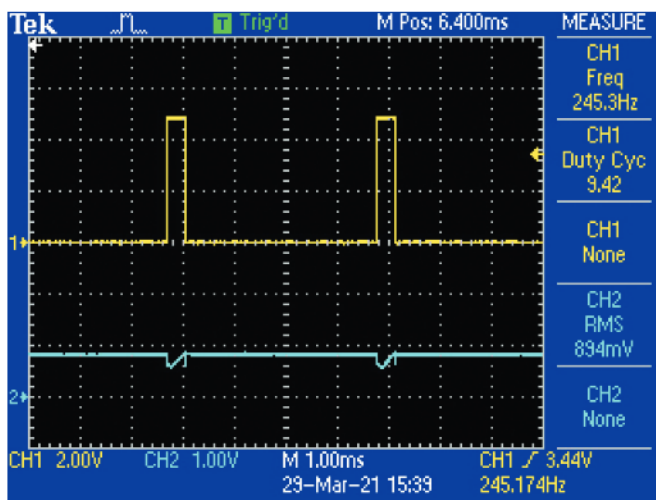
Once shut down, the voltage needs to rise above the low-voltage detection threshold by a certain amount before it will start up again. This hysteresis prevents constant switching on and off as the battery voltage recovers with the motor load removed, only to switch off again once the motor restarts.

Features

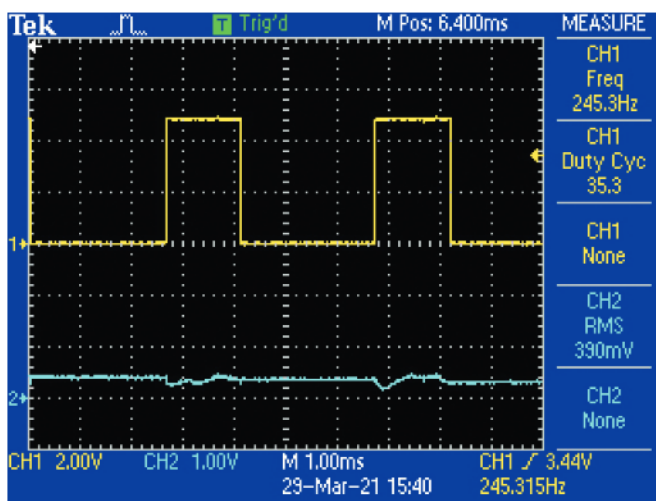
- DC motor PWM drive
- Can drive motors rated up to 24V and 20A DC
- Motor and controller supply voltage can be separate
- 16 PWM frequency choices
- Motor load feedback control & gain adjustment
- Adjustable soft-start rate
- Motor speed curve adjustment
- Under-voltage cut-out with LED indication & adjustable hysteresis
- Duty cycle LED indicator
- Optional motor disconnect detection

Specifications

- Speed adjustment range: 0% to 100% duty cycle
- Motor supply: from near-zero to 30V maximum
- Controller supply: 10.5V to 30V maximum (5.5-26V with ZD1 linked out)
- Speed indication: LED1 brightness varies with PWM duty cycle
- PWM frequency: 16 steps from 30.6Hz to 32.4kHz (see Table 1)
- Soft-start rate: 0-2 seconds in 255 steps for 0% to 100% duty cycle
- Speed curve adjustment: minimum speed can be set to 0-33% duty cycle
- Under-voltage (UV) threshold: 0-30V in 29.6mV steps
- UV hysteresis: 0-5V in 29.6mV steps
- UV indication: LED1 flashes on for 65ms at 1Hz
- Motor disconnection detection: motor is shut down if monitored current drops to zero while driving motor; indicated with 2Hz/50% duty cycle LED flashing
- Speed pot disconnection detection: indicated with a dimly illuminated LED



Scope 1: a pulse-width modulated (PWM) drive signal at a low duty cycle, about 9.5%. Current has little time to build during each pulse, so the motor runs slowly.



Scope 2: another PWM drive signal, this time with a duty cycle of 35.5%. This is roughly equivalent to driving the motor at 1/3 of the supply voltage, so it will run faster but not nearly at full speed.

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How USB-C Power Delivery Works

By Andrew Levido



USB has come a long way from when it was introduced in the mid-1990s. The widespread adoption of USB 3.2 introduced the Type-C connector, plus a new Power Delivery (PD) capability that allows up to 100W (20V @ 5A) to be delivered. It is quite a bit more complicated than previous USB power schemes, but well worth a look.

Our article in the June issue on the “USB Explosion!” described the USB Type-C (USB-C) connector in a fair bit of detail and touched on the new USB Power Delivery mechanism (siliconchip.com.au/Article/14883). However, there’s quite a bit more to say on both topics, so this follow-up article will fill in the gaps.

We also have an article starting on page 42 which describes some low-cost USB Power Delivery (PD) compliant power sources. Next month, there will be a follow-up article that discusses ways to negotiate and monitor the voltage and current supplied by a USB-PD source. But first, read below to get an idea of why you would want to use those devices.

As described in the May article, the USB 3.2 standard is the first that officially allows power sources and sinks (and the cable!) to negotiate the voltage and current supplied.

But before we get into the details for how all this works, we need to get a few terms straight. Things have gotten more complicated since the days when there were only two possible things you could plug a USB cable into: a host, which sourced power and controlled communication, and a device, which consumed power and responded to host communication.

Now USB ports can have three possible data roles and three possible power roles. Data roles include:

- Downstream-facing ports (DFPs) – typically a host or hub

- Upstream-facing ports (UFPs) – typically a device
- Dual-role ports (DRPs), which can switch between device and host roles

USB-C ports also have a power role:

- Source role, supplying power
- Sink role, consuming power
- Dual-role power port

Dual-role power ports can switch between source and sink roles. A good example of this is the USB-C port on a laptop, which can be a sink when connected to a power brick (or a monitor which can supply power) to power or charge the device, or a source when connected to a peripheral such as a USB hard disk.

On attach, DFPs are source ports and UFPs are sink ports; however, this can be changed later by mutual agreement.

The USB-C connector

USB 3.2 introduced the new Type-C

connector, which is used on both ends of a USB-C cable. This connector can be inserted either way around, and the connectors can optionally contain electronics that allows the system to identify specific cable capabilities.

The USB-C connection includes a dedicated Configuration Channel (CC), used to detect cable attachment, plug orientation, cable capability, and to negotiate ‘Power Contracts’ between source and sink.

In addition, USB-C has two super speed full-duplex differential channels for high-speed data communication, and two sideband use lines. We will focus on the CC for this discussion.

The two rows of contacts in the receptacle are shown in the middle of Fig.1, with the two possible plug orientations (un-flipped and flipped) shown above and below respectively.

The GND and VBUS pins are sym-

PLUG UN-FLIPPED

GND	TX1+	TX1-	VBUS	CC	D+	D-	SBU2	VBUS	RX2-	RX2+	GND
GND	RX1+	RX1-	VBUS	SBU1			VCON	VBUS	TX2-	TX2+	GND

RECEPTACLE

GND	TX1+	TX1-	VBUS	CC1	D+	D-	SBU2	VBUS	RX2-	RX2+	GND
GND	RX1+	RX1-	VBUS	SBU1	D-	D+	CC2	VBUS	TX2-	TX2+	GND

PLUG FLIPPED

GND	TX2+	TX2-	VBUS	VCON			SBU1	VBUS	RX1-	RX1+	GND
GND	RX2+	RX2-	VBUS	SBU2	D-	D+	CC	VBUS	TX1-	TX1+	GND

Fig.1: the pin assignment of the USB Type-C receptacle is shown in the centre. Above and below are two possible plug orientations. The CC1 and CC2 pins on the receptacle connect to the CC and VCON pins on the plug; it can tell which way the plug is inserted by monitoring which of CC1 or CC2 connect to CC.

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USB Power Delivery Chargers



Left-to-right: the Comsol COWCC30WH, XY-PDS100 & Belkin F7U060AU

This article describes some low-cost modules that have appeared recently to take advantage of the dramatic growth in USB capability, especially in the area of power delivery (PD). This assortment includes PD chargers, cables and cable adaptors, while a follow-up article will look at ‘trigger’ or ‘decoy’ modules, used to configure the chargers, plus USB-PD testers.

As mentioned in my recent article on the ‘USB Explosion!’ (June 2021; siliconchip.com.au/Series/367), one of the application areas of USB which has grown dramatically of late is the delivery of DC power.

When USB first appeared in the late 1990s, it could provide just 5V of power at up to 100mA for a ‘low power’ device, or up to 500mA for a ‘high power’ device like a USB hard disk drive.

But as the data transfer capabilities of USB were expanded via USB 2.0, USB 3.0 and finally USB-C, the power delivery capabilities were expanded as well. For an in-depth discussion of how USB PD works, see the article on that topic starting on page 36 of this issue. We’ll give a quick summary here, before moving on to describe the modules.

USB 3.0 kept the 5V supply voltage but raised the ‘high-power’ current level to 900mA, allowing a downstream device to receive up to 4.5W (rather than just 2.5W).

When the USB-PD (Power Delivery) specification was finalised in 2012,

a device could receive 5V at up to 1.5A or 7.5W of power via a standard Type-A to Type-B USB cable.

The smaller USB-C 24-pin connectors appeared in 2014, and when the USB-PD specification was further revised in 2014, 2016 and 2017, they increased the power delivery voltage and current levels as well.

Now devices can request power at either 5V, 9V, 12V, 15V or 20V, and can draw up to 5A – corresponding to 100W with a 20V supply. And since the USB-PD 3.0 revision of 2017, devices can also take advantage of the

programmable power supply (PPS) protocol, which allows variation of the supply voltage in 20mV steps.

This expands the possible USB-PD applications dramatically, and that’s why we’re seeing so many low-cost modules designed to take advantage of this increased flexibility.

How USB-PD works

As mentioned earlier, this is described in detail on page 36. But there are some points that we can add here, and we will also summarise the basics of USB-PD negotiation.

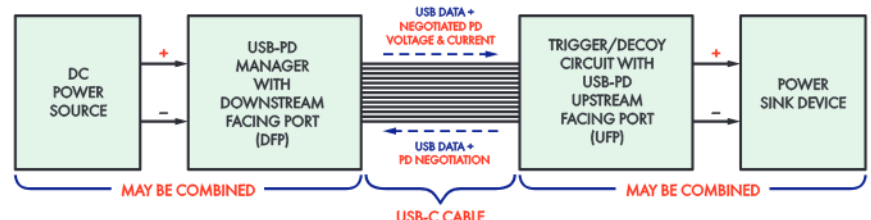


Fig.1: the USB-PD system consists of five elements: a primary DC power source, a USB-PD ‘manager’ with a downstream facing port (DFP), a USB-C cable, a trigger circuit fitted with an upstream facing port (UFP) and finally, the power ‘sink’. The USB-PD manager element could be combined with the primary DC source, and the trigger circuit may also be combined with the sink.

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MODEL RAILWAY LEVEL CROSSING

BY LES KERR

This scale model Level Crossing has realistic moving barriers, flashing lights and a bell sound recorded from a real level crossing. It can be triggered automatically when a model train approaches. It's controlled by a couple of low-cost PIC microcontrollers and can be built for a modest sum, assuming you have some basic model-making and electronic assembly skills.

During the COVID-19 lockdown, I decided to build a model railway layout in OO gauge. As time went on, I added buildings, a tunnel, a bridge, a pond, and many other items, including a level crossing. This level crossing can be triggered manually, or automatically when the train passes by; it includes arms that automatically lower and raise, flashing lights and a realistic bell sound (video at [siliconchip.com.au/Videos/Level+Crossing](https://www.siliconchip.com.au/Videos/Level+Crossing)).

This article describes how you can build your own level crossing just like mine.

OO scale is 4mm:1ft which works out to 1:76.2. I applied this scaling to images of signs taken from full-sized crossings. For other items like the red flashing lights, servos, barrier, and posts, I used slightly bigger parts than the scaled-down real-life items. The bell sounds were recorded from an actual crossing.

The Level Crossing project involves building two boxes with posts that sit on either side of the railway tracks

where a road meets them. When the train approaches, they drop their arms to block vehicles from crossing the tracks while simultaneously flashing their lights and sounding alarm bells. Once the train has passed, the lights and bells turn off, and the arms lift up again.

Initially, the arms/gates opened and closed at a speed determined by the servo motor manufacturer. This speed was excessive compared with the real-life version, so I developed a circuit to move the arms in small steps, with a delay between each.

The easiest way to do this was to use an inexpensive microcontroller programmed to produce the correct number of steps, with a delay between each, covering the angle that the arm needs to move through.

There are four red LEDs on each post: two facing each way, and they flash alternately in pairs (with the LEDs connected back-to-back illuminated together).

Due to the alternate flashing,

normally you would need three wires to connect them up – one to each LED and one common to both. But the hollow post is so small that it is only possible to fit one wire up the centre; using the brass post itself as a conductor gives just two wires.

The way around this is to put the pairs of LEDs to be illuminated together in series, then connect those pairs in inverse parallel. This way, if a current is applied across the set of four LEDs in one direction, two are illuminated, and if the current flow direction is reversed, the other two are illuminated.

The only problem with this is that you need a 'full bridge' type driving arrangement that can drive one end of the LEDs high while it drives the other low, or vice versa, to illuminate all the LEDs. Luckily, this is easily achieved with a pair of microcontroller digital output pins.

Circuit description

Refer now to Fig.1, the Level Cross-

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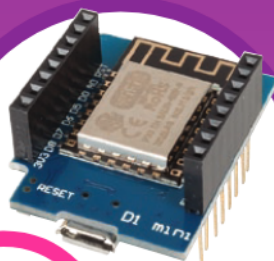
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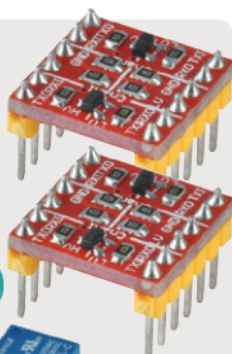


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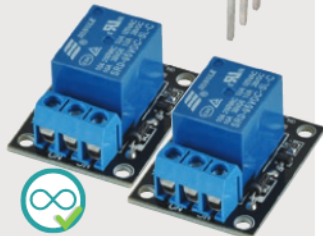
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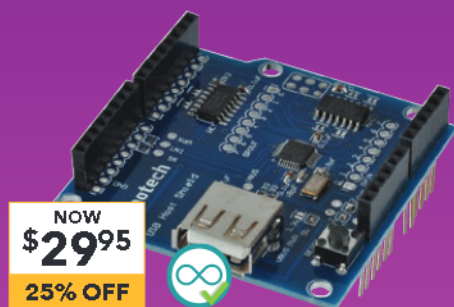


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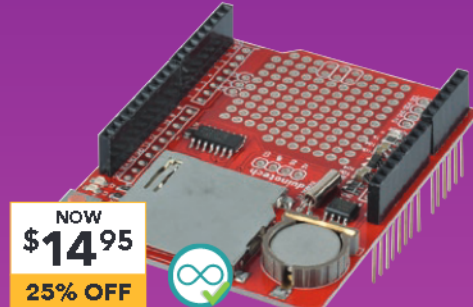
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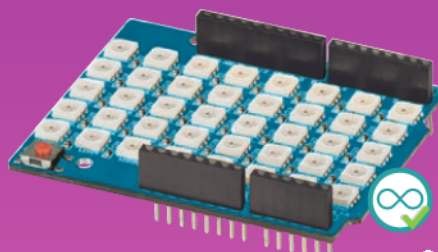
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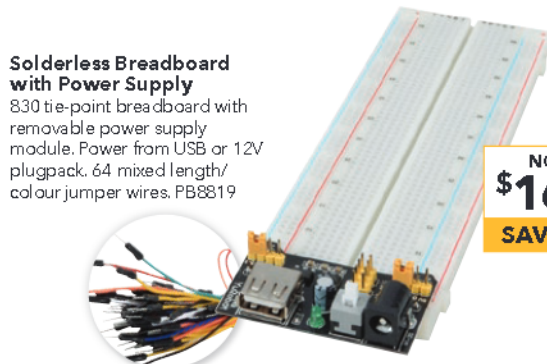
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Single-Chip Silicon Labs FM/AM/SW Digital Radio Receiver



By Charles Kosina

The ultimate in FM/AM radio reception technology is the single-chip solution. All you have to do is connect some antennas to pins on an IC, send it some serial commands, and stereo audio comes out the other end. As a result, these Silicon Labs chips make building a capable radio receiver a doddle. It's straightforward to set up and use, fits in a compact case and runs from a simple AC plugpack.

I was fairly pleased with my AM/FM/SW Receiver design from the January 2021 issue (siliconchip.com.au/Article/14704), at least in terms of how easy it is to build, ease of use, and coverage of multiple radio bands. But I still felt that its overall performance left a little to be desired. I was also not happy that I didn't have enough information for full digital control of the BK1198 radio chip.

While that radio design was relatively straightforward as radios go, it would have been a lot simpler if I could have gotten the digital control working.

In the last few years, several new chips have appeared that greatly ease radio receiver design. Many of these are from Silicon Labs; there are about 34 varieties of chips in the Si473x family, and you can download the main data sheet from siliconchip.com.au/link/ab7y

They have a similar architecture to the BK1198 chip I used for the January 2021 design. One major advantage of the Silicon Labs chips is the documentation; whereas information on the BK1198 is sparse, to say the least, the application note for the SiLabs chips

runs to 321 pages! (See siliconchip.com.au/link/ab7z).

The board that I have laid out is suitable for a prebuilt module with the Si4730 chip, or a standalone Si4732 chip. Both are available on AliExpress at quite low prices. The Si4730 only handles the standard AM and FM bands, whereas the Si4732 can be programmed to cover longwave and shortwave. Both can decode FM

stereo. The specifications give the following bands:

Worldwide FM band support: 64–108MHz

Worldwide AM band support: 520–1710kHz

SW band support (Si4734/32/35): 2.3–26.1MHz

LW band support (Si4734/32/35): 153–279kHz

But what about the gaps between the

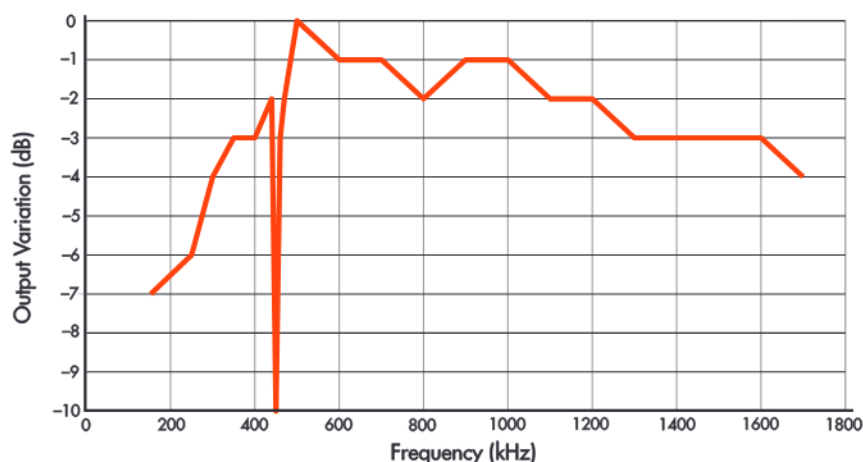
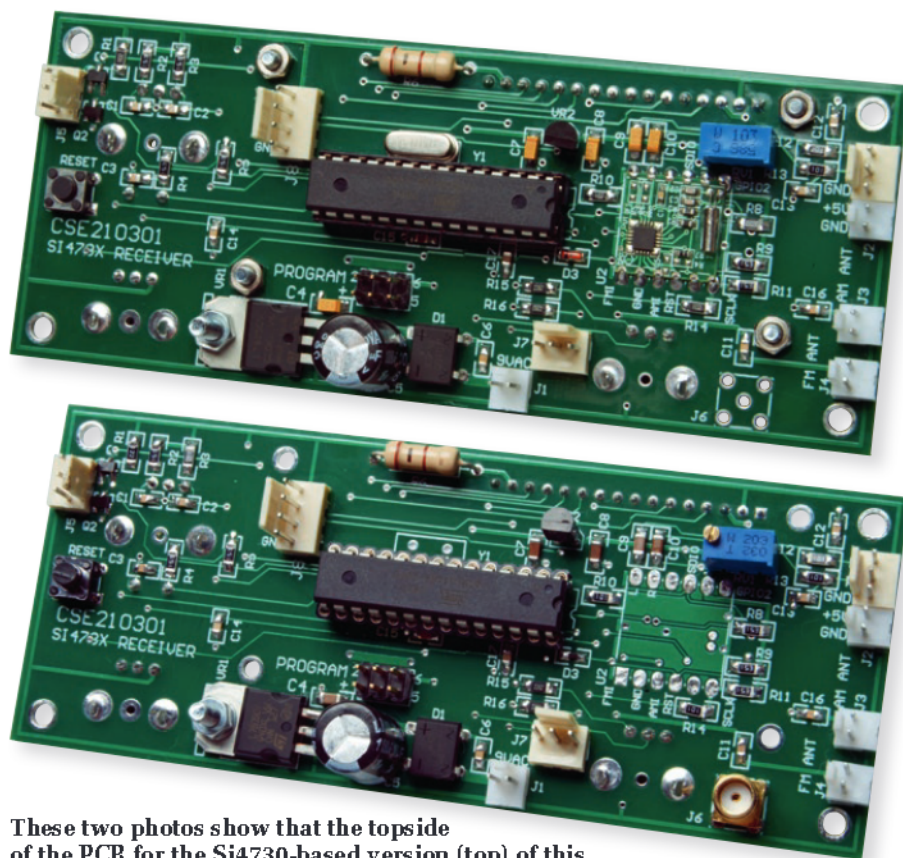


Fig.1: the radio's sensitivity across a widened AM band, from 153kHz to 1.7MHz. Except for a dip around 445-455kHz (typical intermediate frequencies), the result is pretty flat. Across the standard AM broadcast band of 550-1720kHz, there is only about 4dB variation.



These two photos show that the topside of the PCB for the Si4730-based version (top) of this project is barely different from the Si4732 version (bottom). Ignore the additional screws/nuts as those are just for mounting the screen.

bands? I decided to experiment and set frequencies in these gaps. And what a surprise; with the Si4732 chip, I could select any frequency from 153kHz up to 30MHz by sending the appropriate code to the chip. No gaps! Whether there is anything of interest in the gaps is another matter.

As a result, I have the AM band programmed from 153kHz to 1730kHz, and the SW band from 2MHz to 30MHz.

Performance

On the FM band, a short piece of wire inside the box will bring in most of the Melbourne stations with a good SNR.

With an outdoor long wire antenna connected directly to the AM antenna input, I could get many stations with an SNR of 25dB or better without any ferrite rod. This way, there is not a single inductor required in the circuit! Using a ferrite rod, the weaker

stations came through, but there was a lot of hash caused by all the electronics in my lab.

I made a plot of sensitivity on the AM band from 153kHz to 1700kHz, shown in Fig.1. Note the sharp dip at 450kHz. I have no idea why this is, but it is near the intermediate frequency of most superhet receivers, so it is of no consequence.

On shortwave, the sensitivity is comparable to the AM band (see Fig.2). This is not brilliant, but adequate. There were a few 'birdies' on some frequencies, eg, 8MHz, 14MHz and 16MHz, which made SNR measurement difficult. Above 22MHz, the SNR display did not seem to give sensible readings, although performance up to 30MHz seemed the same as at 20MHz.

The audio drive capability of the SiLabs chips is not stated in the data sheets. I determined experimentally that the minimum load resistance on the headphone output is 1.6k Ω . Any less and clipping will occur.

The maximum output with this load is 250mV peak-to-peak or about 88mV RMS for a sine wave, giving less than 1mW. It still works with low impedance headphones, although at maximum volume, there will be some distortion. Sennheiser 60 Ω headphones gave an acceptable listening level in a quiet environment.

Panasonic noise-reducing headphones with a 330 Ω input resistance (with the noise reduction turned on) gave a considerably higher sound level. Feeding the signal into external amplified speakers gave good-quality sound.

Because of this weak output, I have added an op amp buffer that provides drive capability for low impedance headphones, while also providing enough voltage swing for insensitive high-impedance 'phones. This is also useful if you're feeding the audio to a preamp or amplifier, as the signal is closer to 'line level'.

When the tuning knob is rotated, each pulse from the shaft encoder sends out six bytes via I²C and then receives seven bytes of status. This takes a significant time, so if you spin the tuning knob too rapidly, the encoder pulses are missed, and you only get a small frequency change. Just slow down the rotation.

Circuit description

The full schematic is shown in Fig.3. The Si4730 module includes the 32.7-

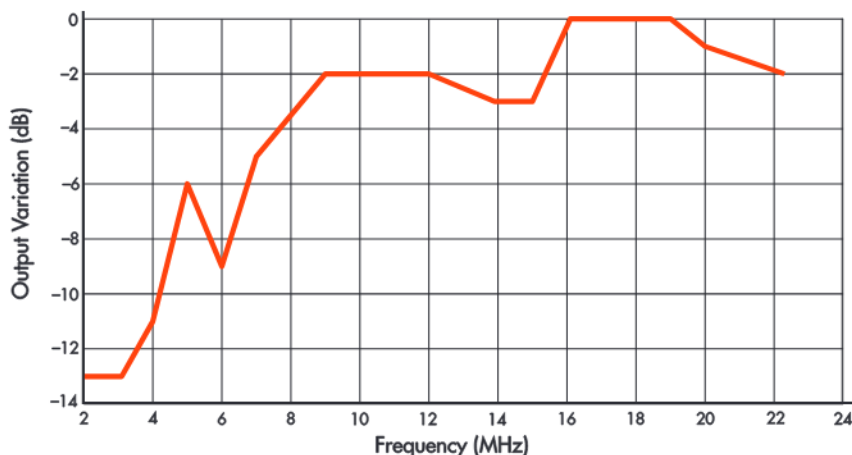


Fig.2: a similar 'frequency response' plot for the SW range from 2MHz to 22.3MHz.

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A first look at the “last” Tecsun radio receiver?



Tecsun's PL-990: SW/SSB, AM, FM, and LW Synthesised DSP Powerhouse

Tecsun Radios Australia recently submitted the latest iteration of Tecsun's “flagship”, the PL-990 multiband portable for review.

It is a most worthy successor to the PL-880 which has received many excellent reviews since its introduction almost a decade ago, and which we looked at in the December 2014 issue (siliconchip.com.au/Article/3203).

We have noted some comment on the net that the PL-990 will be the last high performance multiband portable that Tecsun engineers will produce. Indeed, this is even alluded to on Tecsun Radios Australia's own website.

Why? We cannot find any explanation.

by Ross Tester

Is it because they believe they have extracted every last ounce of performance of this type of design with the PL-990? Looking at the specs and spending some time “hands on” you could easily be led to believe this is the case.

There are other indicators that Tecsun have produced something pretty significant when it receives **very** favourable technical comparison reviews when put up against some of the world's best brands. But when you compare them dollar for dollar, the Tecsun doesn't just win, it wins hands down!

But we're getting ahead of ourselves – and the only way that you would really be able to

Tecsun-PL990 Specifications

Frequency range and tuning step:

Long wave (LW):	100-519kHz 9kHz steps (1kHz fine tuning)
Medium wave (MW):	520-1710kHz 10kHz steps (1kHz fine tuning) or 522-1620kHz 9kHz steps (1kHz fine tuning)
Short wave (SW):	1711-29999kHz 5kHz steps (1kHz fine tuning)
FM:	Selectable – 64-108MHz, 76-108MHz, 87-108MHz, 87.5-108MHz, FM tuning step 100kHz/10kHz

Intermediate frequency: AM first IF, 55.845MHz,
second IF 10.7MHz, third IF (DSP) 45kHz
FM 128kHz

Sensitivity/Selectivity:	LW	3mV/m	40dB
	MW	1mV/m	40dB
	SW	<20µV	45dB
	FM	<3µV	60dB

Audio format: Supports 16bit / 44.1kHz WAV, FLAC, APE,
WMA, and MP3 formats
MicroSD (TF) Card up to 128G (not included)
Can also pair to mobile phone (Bluetooth)

Speaker: 4Ω, 3W

Power: Internal: 3.7V (18650 rechargeable lithium battery)
External: DC power supply: USB 5V current >1A

judge for yourself would be to do your own A:B comparison. For many, that won't be easy, so let's see if we can help you out somewhat.

The PL-990

It's described as a "high performance shortwave radio". Talk about damning with faint praise – it is so much more than that.

For a start, it covers much more than shortwave, though that covers from 1711-29999kHz in 5kHz steps and fine tuning steps of 1kHz. Even with shortwave radio broadcasts not the force or quantity they once were (witness Radio Australia!) if it's on the shortwave bands, the PL-990 will give you the best chance of finding it.

Looking at the AM band, it covers 522 to 1620kHz in 1kHz fine tuning steps when set to the standard Australian 9kHz channel spacing. If you change it to 10kHz spacing (which is just a couple of button presses) that upper limit increases to 1720kHz.

If you're more into FM broadcasts, you've got a much greater range than the "normal" 88-108MHz. You can switch the lower limit to 64MHz, 76MHz, 87MHz or 87.5MHz, with a selectable tuning step of 100kHz or 10kHz.

Admittedly, there's not a great deal of interest below our 88-108MHz band – it's mainly allocated to fixed and mobile radio, especially business and industry. But a lot of listeners get a kick out of . . . listening! And we believe some footy enthusiasts like to eavesdrop on the referee's two way radio comms in this band.

And for the masochists out there (oooh – wait for the screams!) it also covers the long wave (LW) band of 100-519kHz, in 9kHz steps or 1kHz fine tuning steps. Especially

here in Australia, there's not a great deal to listen to down there – but you could have fun trying. OK, there are a few aircraft nav beacons "down there" and even an amateur radio allocation for CW enthusiasts.

As you can see, it really does cover a huge slice of the electromagnetic spectrum. But wait, there's more!

If you find there really is nothing worth listening to, you can always listen to your favourite music saved to a micro SD (TF) card – up to 128GB – in 16-bit/44.1kHz WAV, FLAC, APE, WMA or MP3 formats.

You can also plug the PL-990's digital audio input socket into your computer via a USB-C lead (not included) and play music stored on your PC.

Audio quality

And that brings us to another of the PL-990's strong points: its audio quality.

Read any review or comparison and that's one thing that's always commented on: it just sounds great – much better than you might expect an off-air signal (or even recorded music) to sound.

It's hard to be objective about this – but subjectively, we were impressed. It doesn't sound anything like your typical portable radio – the Tecsun engineers have really excelled themselves here!

The audio amplifier is coupled to a wide-range speaker. It's not stereo (why would you bother listening to mono radio?) but the combination works very well.

If you DO want stereo sound, say from your micro SD card or perhaps FM stereo broadcasts, you have the choice of stereo headphones or line out for an external amplifier.

Size

All this is packed into 198 x 120 x 38mm – much smaller than most competitors. There's nothing remarkable about the case – it's functional and puts all the controls at your fingertips. Information is imparted by means of a relatively large (65 x 25mm) LCD readout. Weight, by the way, is about 620g. It's powered by a single 18650 Tecsun-branded li-ion cell. Like all li-ions, it's rated at 3.7V and this one is rated at 2000mAh. We're delighted to see it's not one of those ten thousand mAh cells you find on ebay and the like! (You know the ones – they don't exist...)

Price

As you might expect, a premium product like the PL-990 doesn't come cheap. It retails for \$550, and that includes the radio itself, a faux leather carry pouch, 18650 battery, 230V "USB" charger and lead (of course, you can use the lead to charge it from your PC, car USB supply, etc etc), a long-wire "wind up" antenna and a pair of stereo ear buds.

Naturally, instructions are also included but it's just as easy to download a copy from the Tecsun Radios Australia website (www.tecsunradios.com.au) – that way you can search for what you want.

For those who want to protect their investment, a deluxe version is available which includes the hard clamshell case shown opposite – this fits the radio inside its carry pouch.

Performance

The PL-990 has been receiving high praise for its SSB performance. When resolving SSB signals, especially those way down in the mud, it's very important that the radio is



Two versions of the PL-990 are available from Tecsun Radios Australia: the radio itself, a rechargeable 18650 lithium battery with charger/supply and USB charging cable, a wind-up external antenna and a stereo earbud set. This retails for \$550. For those who want to protect their investment, the deluxe version includes all the above plus includes the hard clamshell case shown here for \$635.



able to not only receive, but allow you to understand what is being received!

On the PL-990, the noise floor is very low and the SSB is very stable. Along with the choice of direct entry (push-button) or rotary tuning, the radio has a fine tuning control to assist you in resolving SSB (upper or lower sidebands).

DSP (digital signal processing) of course is responsible for a lot of the performance. It does things the old analog circuitry didn't have a chance of handling.

FM performance is also very good, especially with that fine audio quality we mentioned earlier. AM, similarly, is right up there. Sensitivity on the FM setting is quoted as $<3\mu\text{V}$, while MW (AM broadcast) is 1mV/m . Unfortunately, even with its widest tuning range set, the PL-990 cannot get as far as the 6m or 2m amateur bands.

LW is problematic: finding a signal worth listening to (especially in this part of the world) is not real easy – we're not real sure why long wave is included in many radios these days! Longwave sensitivity is 3mV/m .

As we mentioned earlier, shortwave (SW) signals are also much more sparse than they were a couple of decades ago. There are amateur operators, of course (the PL-990 can tune into all amateur bands between 160m and 10m), and despite the comments above, there are still many countries (did someone mention China) pumping out signals on the shortwave bands.

You should find *some* signals around the 16m, 31m and 49m bands, although broadcasts can occasionally be heard in the 22m, 19m and 41m bands.

Shortwave band sensitivity is 45dB.

Selectivity is quoted as $>40\text{dB}$ on the medium wave and long wave bands, $>45\text{dB}$ on shortwave and $>60\text{dB}$ on FM.

We haven't mentioned the PL-990's IFs. It is a triple conversion receiver, with IFs at 55.845MHz, 10.7MHz and the third IF (DSP) at 45kHz. The FM IF is 128kHz.

Undocumented features

The PL-990 instruction manual is very comprehensive in the steps required to achieve a myriad of functions.

But the radio has several features which are not documented in the instruction manual. Some of these, such

as the ability to turn dynamic noise reduction on and off, ability to change the muting threshold, ability to change the FM de-emphasis and even the ability to adjust the line output level to suit your amplifier, are detailed on www.tecsunradios.com.au. We've seen other references to the same things on the net and we're sure as more and more users discover more and more features, they'll be promulgated in the usual ways.

Conclusion

We started out by saying this is a very worthy successor to the popular PL-880 receiver.

Apart from the noticeable improvements, such as better stability on SSB, better synchronous detection, (arguably!) better audio quality (though this was/is one of the PL-880's strong points), the PL-990 just seems to do everything a little better (yes, that's subjective but that's the way we see it).

Add to that little things like switchable antennas (the external antenna socket, so essential for "proper" listening, now works on long wave, medium wave and short wave).

Of course, it has the features you'd expect in a good receiver – a clock with twin timers and alarms (never miss that transmission you wanted to listen to! We're pretty impressed by this radio. If you own an earlier model it might be time to update to this, the latest . . . and possibly the last!

A bonus!

For Australian and New Zealand customers, whichever version you order, Tecsun Radios Australia will also include a stylish Tecsun polo shirt to show your jealous friends you're part of the "in" crowd – those who own a Tecsun! (limited sizes available)



Contact:

Tecsun Radios Australia

Address: 24/9 Powells Road, Brookvale, NSW 2100

Web: www.tecsunradios.com.au

Advanced GPS Computer



part two – construction and use

Our new GPS Computer has many more features than the last two, and combines all their best features. Now that we have finished describing how it works, let's move onto the construction and usage instructions. We'll also delve into how the software works, for those who are interested.

by Tim Blythman

We have a lot to cover in this article; after describing the assembly of the custom board, putting it all together and fitting it into its case, we also need to explain how to use its many features.

Since the software is quite complicated and we had to solve some interesting problems to make it work, we also have a separate panel explaining some of the code's trickier details, including the CFUNCTIONs that do most of the hard work. You can read that one if you are interested, or skip it if you aren't. So without further ado, let's move on to putting the Advanced GPS Computer together.

Construction

You will need to build the Micromite V3 Backpack

module with a 3.5in LCD touchscreen. Its construction was detailed in the August 2019 issue (siliconchip.com.au/Article/11764)

If you haven't already done so, you will need to fit the DS3231 RTC IC and its accompanying passive components to the V3 Backpack (see photos overleaf). This is a surface-mounting part, so the usual cohort of SMD gear will be required. There are also a few SMDs on the GPS Computer PCB.

A fine-tipped temperature-adjustable soldering iron is highly recommended, along with fine solder wire, flux paste, tweezers, a magnifier and solder-removal wicking braid. The flux releases smoke when soldering, so good ventilation and/or fume extraction is needed.

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X 0432A

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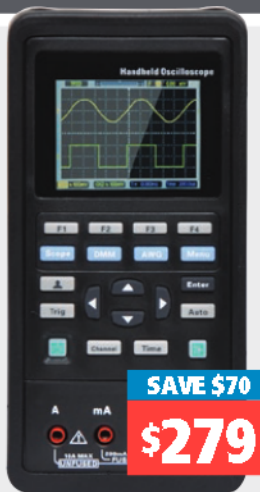
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Iroda® Solder Pro 70W Soldering Tool Kit

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Includes storage case.



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C 5064



Opus One® 140W Soundbar Wireless Subwoofer

Our new premium finish soundbar offers rich, clear sound from it's 6 high performance speaker drivers, plus a 8" subwoofer which can be placed anywhere in your lounge room thanks to wireless connectivity. Offers bluetooth audio streaming from your favourite devices, plus S/PDIF digital audio input for connection to your TV (cable included).

\$299 SAVE \$90

Soundbar: 97 x 8 x 7.5cm
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C 5038

Similar spec to \$600 systems with sound quality that's just as good!



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A 4201

Bluetooth® 2x50W Amplifier

Stream audio directly from your device to your speakers in the study or entertaining area. 3.5mm and RCA inputs. Class D design. Internal headphone amplifier. Includes power supply, banana speaker plugs & 3.5mm to RCA cable.

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Multi-platform ready! Suits PC, Playstation, Xbox and Switch with included TRRS adaptor. Offers excellent comfort for long gaming sessions with RGB lighting effects (when USB is plugged in). 2m cable.



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C 9042



SAVE \$20
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A 1112

Experience wireless sound while you game.

Also works with laptops!

This tiny USB type C adaptor provides wireless audio streaming for two pairs of headphones for two player gaming on Switch, PS4 or watching media on PC & Mac. *Accessories for illustration purposes.



LED base light shows when your mic is on

D 0981

NEW!
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USB Gooseneck Mic

Great for gaming, YouTube and livestreaming. Quality omnidirectional mic insert. Mic gain and mute control knob with LED lighting.



SAVE \$30
\$129



A 1116

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C 0392

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A 2548



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SAVE 25%

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With muting button

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Top quality audio for group communications or one-on-one meetings. USB C connection. Rugged diecast case with rubber feet for excellent isolation. Includes 2m USB cable.

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



\$139

S 9455A

HOT PRICE!



\$23.95

P 8149

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- Internal battery - set it up anywhere!
- Day/night with IR
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Camera measures just 10mm across



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



\$169
S 9850

Wi-Fi HD Camera Clock

- Real alarm clock function • Two-way audio (mic & speaker) • Motion detect recording • USB or battery powered (S 4736 x 2 \$18.50ea)

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



S 9845A

\$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

S 9843B

Also includes ball joint bracket.

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.



S 9020

\$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.



HOT PRICE!

\$79.95

S 9017A

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» Springvale: 891 Princes Hwy 03 9549 2188
» Airport West: 5 Dromana Ave 03 9549 2121
New South Wales
» Auburn: 15 Short St 02 8748 5388
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» Virginia: 1870 Sandgate Rd 07 3441 2810
South Australia
» Prospect: 316 Main Nth Rd 08 8164 3466

SERVICEMAN'S LOG



Dave Thompson

I've repaired planes before, but never tanks

Some jobs require a great deal of patience and involve plenty of introspection. Did I do the right thing? When is the right time to call it quits? This is one such story, illustrating the pitfalls of my life as a serviceman.

In the years that I have been The Serviceman, I have tried to keep this column from being too computer-repair centric, mainly because computers are quite boring to many of the service people who read this magazine.

However (there's always a however!), a repair I've had on the boil for almost a year now illustrates just how fickle the business can be, and how much we rely on others to do their jobs properly to have a successful outcome. I'd call this one a cautionary tale.

It all started a long, long time ago in a galaxy far, far away (not really!) when a regular customer brought me a machine I was already very familiar with; a Dell Alienware M18X gaming laptop. The Alienware range of Dell laptop computers is well-known for their blistering performance. Therefore, they are a very sought-after machine within the gaming fraternity (and sometimes 'power users' too).

As with any high-performance laptop, all this muscle doesn't come cheap. My client bought his Alienware laptop in the USA when he was

travelling there some years ago. Even though it was 'on special' at the time, he still paid around \$US6,000 for it, a staggering sum of money for a laptop at the time.

It's luggable, all right

\$US6,000 buys a lot of hardware, and this Dell is no exception. The computer boasted the likes of twin accelerated (and upgradeable) graphics cards, dual RAIDed hard drives and a high-definition 17-inch screen, a relative rarity at the time.

To call this machine a 'laptop' is perhaps a bit disingenuous; it's built like a tank. I certainly wouldn't want to carry it around with me and plop it on my lap, given it weighs around 8kg. It is more of a 'desktop replacement' computer, intended to sit in one place most of the time, not be lugged around as one would a more 'typical' laptop.

To give this some context, I took a standard Acer laptop with me on a trip to Europe a few years back, and by the third week of our travels, I was so sick of carrying it around I was seriously

Items Covered This Month

- Servicing is often a tankless job
- Pool pump filtration system failure
- Replacing shorted schottky diodes
- Fault-finding an audio level meter kit by ET!

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

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Email: dave@pcanytime.co.nz

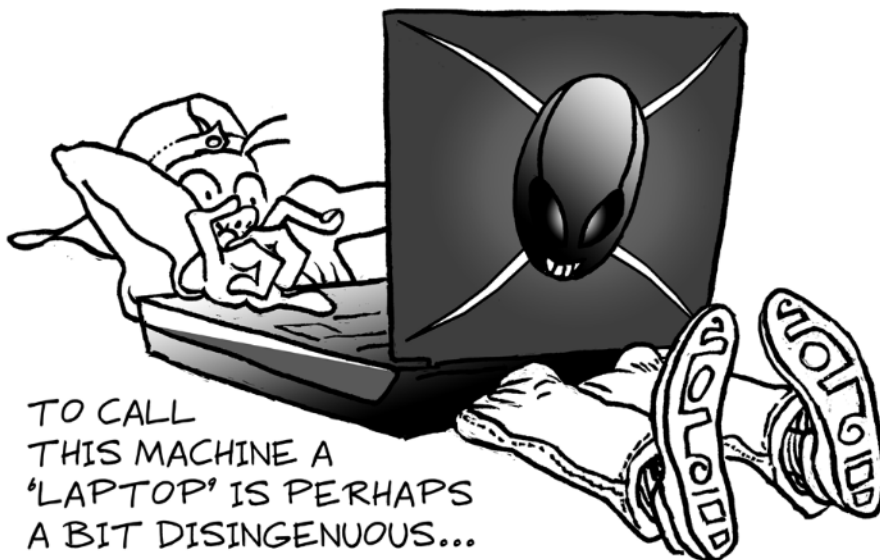
ready to drop it in a rubbish bin at Frankfurt airport.

I can see the advantages of tablets! Even with a nice laptop bag, it was such a hassle to take everywhere with us. That's even ignoring how much of a pain it was to take it through the customs checks in European airports, where customs officers seem to assume that every laptop is a disguised bomb.

I almost ditched our laptop due to its weight and size, and in fact, I ended up leaving it in Croatia, where we spent most of our time over there, rather than lugging it back with us.

That was an everyday laptop with a then-standard 15-inch screen; this Alienware thing I had in the workshop weighed at least three times as much, and the 'bag' that came with it looked (and felt) more like a shoulder-borne suitcase than a laptop bag. So, it's a very large and well-appointed gaming laptop intended (I assume) to be sat on a desk and not moved unless absolutely necessary.

I've worked on this machine before, mainly to rectify the odd software/operating system glitch or similar small-fry stuff. Nothing too serious.



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Helping to put you in Control

ECO PID Temperature Control Unit RS485

ECO PID from Emko Elektronik is a compact sized PID Temperature Controller with auto tuning PID 230 VAC powered. Input accepts thermocouples J, K, R, S, T and Pt100 sensors. Pulse and 2 Relay outputs. Modbus RTU RS485 communications.

SKU: EEC-022

Price: \$104.45 ea



Mini Temperature and Humidity Sensor

Panel mount Temperature (-20 to 80degc) and Humidity (0 to 100% non condensing) sensor, linear 0 to 10V output. Cable length 3 meters.

SKU: EES-001V

Price: \$164.95 ea

ESM-3723 Temperature and RH Controller 230 VAC

Panel mount temperature & relative humidity controller with sensor probe on 3 metres of cable. It can be configured as a PID controller or ON-OFF controller. 230 VAC powered. Includes ProNem Mini PMI-P sensor.

SKU: EEC-101

Price: \$619.95 ea



PTC Digital ON/OFF Temp Controller

DIN rail mount thermostat with included PTC sensor on 1.5m m lead. Configurable for a huge range of heating and cooling applications. 230 VAC powered.

SKU: EEC-010

Price: \$98.95 ea

Ursalink 4G SMS Controller

The UC1414 has 2 digit inputs and 2 relay outputs. SMS messages can be sent to up to 6 phone numbers on change of state of an input and the operation of the relays can be controlled by sending SMS messages from your mobile phone.

SKU: ULC-005

Price: \$228.76 ea **20% off!**



4 Digit Large 100mm Display

Accepts 4~20mA, 0~10Vdc, is visible 50m away with configurable engineering units. 10cm High digits. Alarm relay and 230VAC Powered with full IP65 protection

SKU: FMI-100

Price: \$1099.95 ea



Touchscreen Room Controller

SRI-70-BAC Touchscreen Room Controller are attractive flush mounted BACnet MS/TP controllers with a large colour intuitive 3.5" touchscreen for viewing the system status and modifying the settings.

SKU: SXS-240

Price: \$306.90 ea



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The Rowe AMI JAL-200 Jukebox

This JAL-200 was made in Australia by National Instruments around 1963. It is 1.45m tall, 680mm wide, 850mm deep and weighs 150kg. Its audio power output is 25W per channel, and it can play either side of any one of 100 7-inch, 45RPM records, for a total of 200 songs.

By Jim Greig



The first jukebox was made around 1890, and multiple selection devices originated around 1918. So there were over 40 years of development behind this unit. It is interesting to compare it to its competitor another 40 years later – a matchbox-sized MP3 player with thousands of songs, connecting to a powered speaker via Bluetooth.

Like most pre-computer jukeboxes, the JAL 200 is a mechanical marvel. Designed to work almost full-time in dirty, hotbars with minimal problems, it is sturdy and designed to be easily maintained.

It was functional when purchased, but had to be cleaned and all capacitors were replaced. Changes were also made to improve its long-term reliability:

- The metal rectifier (copper oxide or selenium) for the 30V DC control circuits was replaced with silicon diodes.
- Capacitors used as back-EMF suppressors were replaced with silicon diodes (as in later units).
- I added two fuses that were shown in the circuits but not installed.

It has functional units which convert a pushbutton selection to rotary movement, store the selections and play the records. Many of these are visible in Fig.1.

The pushbutton unit is robust (think of the stuff spilt into it!) and divided into two, 10 numbers (1-9 plus 0) and 20 letters (A to V except for I and O), as needed for a 200 record selection. This jukebox supports remote wall boxes, small selection units that can be mounted near selected tables at the bar/restaurant/etc.

Each button is connected to a short copper track segment on the search unit (Fig.2). The number side is shown; letters are on the reverse. When two buttons are pressed, the search motor (top left) rotates the plastic arm until the outer brush touches the energised number segment. A relay picks up to drop power to the search motor, and energise the number sprag relay. The arm stops at the selected number.

It is stopped quickly and in the correct place by the sprag relay, which has a long arm that pulls against a notched wheel and stops the rotation when a

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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)
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)
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	Microbridge (May17), USB Flexitimer (June18) Digital Interface Module (Nov18), GPS Finesaver (Jun19) Digital Lighting Controller LED Slave (Dec20)
PIC16F1455-I/SN	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	Auto Headlight Controller (Oct13), Motor Speed Controller (Feb14) 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)
PIC32MM0256GPM028-I/SS	Super Digital Sound Effects (Aug18)
PIC32MX170F256D-501P/T	44-pin Micromite Mk2 (Aug14), 4DoF Simulation Seat (Sep19)
PIC32MX170F256D-501/S/P	Micromite LCD Backpack V1-V3 (Feb16 / May17 / Aug19) Touchscreen Voltage / Current Ref. (Oct16), Deluxe eFuse (Aug17) Micromite DDS for IF Alignment (Sep17), Tariff Clock (Jul18) GPS-Synched Frequency Reference (Nov18), Air Quality Monitor (Feb20) RCL Box (Jun20), Digital Lighting Controller Micromite Master (Nov20) Advanced GPS Computer (Jun21)
PIC32MX170F256D-I/SO	Battery Multi Logger (Feb21)
PIC32MX270F256D-501/S/P	ASCII Video Terminal (Jul14), USB M&K Adaptor (Feb19)
PIC32MX795F512H-801/PT	Maximite (Mar11), miniMaximite (Nov11), Colour Maximite (Sep12), Touchscreen Audio Recorder (Jun14)

\$20 MICROS

dsPIC33FJ64MC802-E/S/P	1.5kW Induction Motor Speed Controller (Aug13)
dsPIC33FJ128GP306-I/PT	CLASSIC DAC (Feb13)
dsPIC33FJ128GP802-I/S/P	Ultra-LD Preamp (Nov11), LED Musicalcolour (Oct12)
PIC32MX470F512H-I/PT	Stereo Echo/Reverb (Feb14), Digital Effects Unit (Oct14)
PIC32MX470F512H-120/PT	Micromite Explore 64 (Aug16), Micromite Plus (Nov16)
PIC32MX470F512L-120/PT	Micromite Explore 100 (Sep16)

\$30 MICROS

PIC32MX695F512L-801/PF	Colour MaxiMite (Sep12)
PIC32MZ2048EFH064-I/PT	DSP Crossover/Equaliser (May19), Low-Distortion DDS (Feb20) DIY Reflow Oven Controller (Apr20)

KITS, SPECIALISED COMPONENTS ETC

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MODEL RAILWAY LEVEL CROSSING

- Pair of programmed PIC12F617-I/PS	\$15.00
- ISD1820P-based audio recording and playback module	\$5.00

ADVANCED GPS COMPUTER

- Micromite LCD Backpack V3 kit (SC5082)	\$75.00
- VK2828U7G5LF GPS module (SC5135)	\$25.00
- MCP4251-502E/P IC (SC5052)	\$3.00

ARCADE PONG (CAT SC5834)

Pair of Signetics-branded NE555Ns, for critical A9/B9 paddle ICs	\$12.50
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MINI ISOLATED SERIAL LINK COMPLETE KIT (CAT SC5750)

All parts required to build the project including the PCB	\$10.00
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MINIHEART HEARTBEAT SIMULATOR (CAT SC5732)

All SMD parts, including IC2 - does not include PCB	\$5.00
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AM/FM/SW RADIO

- 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 ² C module) (SC4198)	\$7.50

LED CHRISTMAS ORNAMENTS (CAT SC5579)

Complete kit including micro but no coin cell (specify PCB shape & colour)	\$14.00
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RGB STACKABLE LED CHRISTMAS STAR (CAT SC5525)

Complete kit including PCB, micro, diffused RGB LEDs and other parts	\$38.50
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FLEXIBLE DIGITAL LIGHTING CONTROLLER PARTS

4 x Si8751AB ICs, 8 x SiHB15N60E-GE3 Mosfets, switchmode converter module, 6N137 opto, high-voltage resistors and capacitors plus SMD LEDs.	\$100.00
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D1 MINI LCD WIFI BACKPACK KIT

Complete kit including 3.5-inch touchscreen, PCB and ESP8266-based module	\$70.00
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COLOUR MAXIMITE 2

Short form kit includes everything except the case, CPU module, power supply, optional parts and cables (Cat SC5478)	\$80.00
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Short Form kit (with CPU module): includes the programmed Waveshare CPU module and everything included in the short form kit above (Cat SC5508)	\$140.00
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MICROMITE LCD BACKPACK V3 KIT (CAT SC5082)

Includes PCB, programmed micros, 3.5in touchscreen LCD, UB3 lid, mounting hardware, Mosfets for PWM backlight control and all other mandatory on-board parts	\$75.00
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Separate/Optional Components:

- 3.5-inch TFT LCD touchscreen (Cat SC5062)	\$30.00
- 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)	\$3.00
- 23LC1024 1MB RAM (SOIC-8) (Cat SC5104)	\$5.00
- AT25SF041 512KB flash (SOIC-8) (Cat SC5105)	\$1.50
- 10uF 16V X7R through-hole capacitor (Cat SC5106)	\$2.00

VARIOUS MODULES & PARTS

- Si4732 radio IC (Si473x FM/AM/SW Radio, Jul21)	\$7.50
- EA2-5NU relay (PIC Programming Helper, Jun21)	\$3.00
- VK2828U7G5LF GPS module (Advanced GPS Computer, Jun21)	\$25.00
- MCP4251-502E/P (PIC Programming Helper, Jun21)	\$3.00
- Pair of NE555N timer ICs (Recreating Arcade Pong, Jun21)	\$12.50
- 2.8-inch touchscreen LCD module (Lab Supply, May21)	\$22.50
- Spin FV-1 (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 (Electronic Wind Chimes, Feb21)	\$6.00
- IPP8DP03P4L04 (Dual Battery Lifesaver / Vintage Radio Supply, Dec20)	\$5.00
- 16x2 LCD module (Digital RF Power Meter, Aug20)	\$7.50
- WS2812 6x8 RGB LED matrix module (Ol' Timer II, Jul20)	\$15.00
- MAX038 function generator IC (H-Field Transanalyser, May20)	\$25.00
- MC1496P double-balanced mixer (H-Field Transanalyser, May20)	\$2.50
- AD8495 thermocouple interface (DIY Reflow Oven Controller, Apr20)	\$10.00
- 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 & MCP7383IT (UHF Repeater, May19)	\$11.50
- MCP1700 3.3V LDO regulator (suitable for USB M&K Adaptor, Feb19)	\$1.50

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TEMPERATURE SWITCH MK2	JUN18	05105181	\$7.50
LiFePO ₄ UPS CONTROL SHIELD	JUN18	11106181	\$5.00
RASPBERRY PI TOUCHSCREEN ADAPTOR	JUL18	24108181	\$5.00
RECURRING EVENT REMINDER	JUL18	19107181	\$5.00
BRAINWAVE MONITOR (EEG)	AUG18	25107181	\$10.00
SUPER DIGITAL SOUND EFFECTS	AUG18	01107181	\$2.50
DOOR ALARM	AUG18	03107181	\$5.00
STEAM WHISTLE / DIESEL HORN	SEP18	09106181	\$5.00
DCC PROGRAMMER (INC. HEADERS)	OCT18	SC4716	\$7.50
1. WITHOUT HEADERS	OCT18	09107181	\$5.00
OPTO-ISOLATED RELAY (INC. EXT. BOARDS)	OCT18	10107181/2	\$7.50
GPS-SYNCHED FREQUENCY REFERENCE	NOV18	04107181	\$7.50
LED CHRISTMAS TREE	NOV18	16107181	\$5.00
DIGITAL INTERFACE MODULE	NOV18	16107182	\$2.50
TINNITUS/INSOMNIA KILLER (JAYCAR VERSION)	NOV18	01110181	\$5.00
1. 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
1. CASE PIECES (CLEAR)	JAN19	SC4849	\$0.00
REMOTE CONTROL DIMMER MAIN PCB	FEB19	10111191	\$10.00
1. MOUNTING PLATE	FEB19	10111192	\$10.00
1. 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
1. INPUT SELECTOR PCB	MAR19	01111112	\$15.00
1. PUSHBUTTON PCB	MAR19	01111113	\$5.00
DIODE CURVE PLOTTER	MAR19	04112181	\$7.50
1. UB3 LID (MATTE BLACK)	MAR19	SC4927	\$5.00
FLIP-DOT (SET OF ALL FOUR PCBs)	APR19	SC4950	\$17.50
1. COIL PCB	APR19	19111181	\$5.00
1. PIXEL PCB (16 PIXELS)	APR19	19111182	\$5.00
1. FRAME PCB (8 FRAMES)	APR19	19111183	\$5.00
1. 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
1. ADC PCB	MAY19	01106191	\$7.50
1. DAC PCB	MAY19	01106192	\$7.50
1. CPU PCB	MAY19	01106193	\$5.00
1. PSU PCB	MAY19	01106194	\$7.50
1. CONTROL PCB	MAY19	01106195	\$5.00
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STEERING WHEEL CONTROL IR ADAPTOR	JUN19	05105191	\$5.00
GPS SPEED/CLOCK/VOLUME CONTROL	JUN19	01104191	\$7.50
1. CASE PIECES (MATTE BLACK)	JUN19	SC4987	\$10.00
RF SIGNAL GENERATOR	JUN19	04106191	\$15.00
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BATTERY ISOLATOR CONTROL PCB	JUL19	05106191	\$7.50
1. MOSFET PCB (2oz)	JUL19	05106192	\$10.00
MICROMITE LCD BACKPACK V3	AUG19	07106191	\$7.50
CAR RADIO DIMMER ADAPTOR	AUG19	05107191	\$5.00
PSEUDO-RANDOM NUMBER GENERATOR	AUG19	16106191	\$5.00
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1. HIGH-CURRENT H-BRIDGE MOTOR DRIVER	SEP19	11109192	\$2.50
MICROMITE EXPLORE-28 (4-LAYERS)	SEP19	07108191	\$5.00
SIX INPUT AUDIO SELECTOR MAIN PCB	SEP19	01110191	\$7.50
1. PUSHBUTTON PCB	SEP19	01110192	\$5.00
ULTRABRITE LED DRIVER	SEP19	16109191	\$2.50
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PRECISION AUDIO SIGNAL AMPLIFIER	OCT19	04107191	\$5.00
SUPER-9 FM RADIO PCB SET	NOV19	06109181-5	\$25.00
1. 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
1. HEATSINK SPACER (BLACK)	NOV19	SC5168	\$5.00

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DIGITAL PANEL METER / USB DISPLAY	NOV19	18111182	\$2.50
1. ACRYLIC BEZEL (BLACK)	NOV19	SC5167	\$2.50
UNIVERSAL BATTERY CHARGE CONTROLLER	DEC19	14107191	\$10.00
BOOKSHELF SPEAKER PASSIVE CROSSOVER	JAN20	01101201	\$10.00
1. SUBWOOFER ACTIVE CROSSOVER	JAN20	01101202	\$7.50
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PRODUCT SHOWCASE

ElectroneX to return in September

After a one year break, Australia's only dedicated trade event for the electronics industry will be held in Sydney in September.

ElectroneX – The Electronics Design and Assembly Expo will be staged during 15-16 September at Rosehill Gardens Event Centre.

In addition to featuring a wide range of electronic components, test and measurement products and other

ancillary products and services, companies can also discuss their specific requirements with contract manufacturers that can design and produce turnkey solutions for particular applications.

This is a must-see event for decision makers, managers, engineers and industry enthusiasts or those designing or manufacturing products that utilise electronics.

The SMCBA Electronics Design & Manufacture Conference, held concurrently with the Expo, will feature a series of sessions on the latest hot topics and workshops over the two

days. The full program can be viewed at www.smcba.asn.au

Registration for the Expo is now open and all visitors are asked to pre-register to avoid queuing at the entrance. Visitors can register for free online at www.electroneX.com.au



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Open Source USB Power Delivery software from Microchip

USB Type-C with Power Delivery (PD) and open source software are two technologies leading the next wave of wired connectivity.

Microchip's new Power Delivery Software Framework (PSF) allows you to modify and own the IP in your USB-PD systems. By merging your code with Microchip's fully functional PD stack, you have the flexibility to create different product offerings while choosing from a wide variety of Microchip SmartHubs, micros and standalone PD solutions for USB systems.

Microchip's PSF provides an open-source code base for power delivery and a comprehensive programming environment, removing the need for manufacturer dependence

and making it easy for users to program micros and immediately modify PD code as their system evolves. Using this, customers can reduce time to market and overall bill of materials.

Developers can also choose from an expanded family of Microchip controller options to host PD functionality, including the new UPD301B and

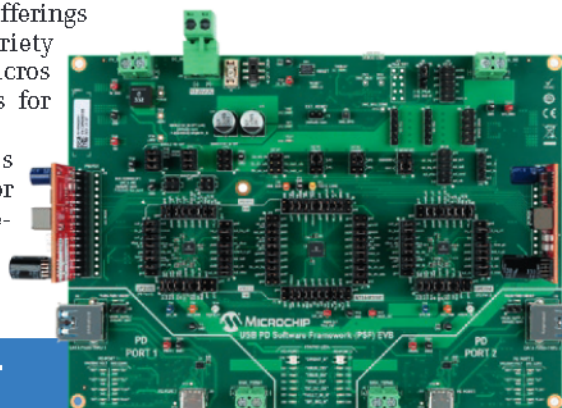
UPD301C standalone PD controllers.

The PD architecture's open approach enables customers to easily add a USB-C/PD port to a wide range of embedded applications, while also allowing customers to reallocate unused pins or CPU memory to other system functions

A range of Microchip SAM and PIC MCUs and dsPIC Digital Signal Controllers (DSCs) are supported.

The PSF solution gives designers the option to run PD on existing Microchip microcontroller infrastructure by adding the UPD350 PD transceiver, or by integrating PD into more complex product offerings with proprietary system code.

The PSF is supported by Microchip's MPLAB X IDE development environment. The PSF evaluation board can be purchased from: www.microchip.com/DevelopmentTools/ProductDetails/PartNO/EV65D44A



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Silicon Labs' EFM32PG22 microcontrollers now available at Mouser

Mouser Electronics is now stocking the new EFM32PG22 (PG22) microcontrollers from Silicon Labs.

The new Series 2 Gecko microcontrollers are ideal for energy-efficient and space-constrained applications in consumer electronics, personal hygiene devices, Internet of Things (IoT), and industrial automation devices.

The microcontroller incorporates a low-power ARM Cortex-M33 core running at up to 76.8MHz, plus up to 512KB of flash and 32KB of RAM. The devices consume just 26µA/MHz in Active Mode at 38.4MHz and as little as 0.95µA in DeepSleep mode with 8KB of RAM retention.

The PG22 development kit includes four different environmental sensors

and stereo PDM microphones, providing an ideal platform for the development of energy-friendly electronic devices. To learn more, visit www.mouser.com/new/silicon-labs/silicon-labs-efm32pg22-mcus/

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Advertising Index

AEE ElectroneX.....	25
Altronics.....	87-90
Ampec Technologies	9
Dave Thompson	111
Digi-Key Electronics	3
element14.....	7
Emona Instruments	IBC
Hare & Forbes	OBC
Jaycar	IFC,53-60
Keith Rippon Kit Assembly	111
LD Electronics	111
LEDsales	111
Microchip Technology	5
Mouser Electronics.....	11
Ocean Controls	94
PMD Way.....	111
SILICON CHIP Shop.....	104-105
Switchmode Power Supplies	8
The Loudspeaker Kit.com	95
Tronixlabs	111
Vintage Radio Repairs	111
Wagner Electronics	10

Notes & Errata

Advanced GPS Computer, June 2021: in the parts list on p29, the catalog code given for the laser-cut lid was SC5083, but that is the original 'inset' lid to suit the 3.5in touchscreen. As mentioned in the article, a different lid is needed to give enough clearance inside the box. The correct catalog code is SC5856.

Mini Arcade Pong, June 2021: if you can't get the 7450 or 74LS50, you can use the 74LS51, which is more readily available. To use the 74LS51, pins 11 and 12 need to be tied high (they must be left open if using the 7450). You can do this by bridging them together and then running a short wire link to pin 14.

Refined Full-Wave Motor Speed Controller, April 2021: we have created an alternative version of the PIC firmware, 1010221B.HEX. This works identically to the original (A) version, except that it won't start the motor if the speed pot is not at zero when power is applied. You need to rotate the speed pot to zero and then back up to start the motor. This safety feature could be useful in some situations.

USB Flexitimer, June 2018: in the circuit diagram (Fig.1) on page 26, LED2 and LED3 are swapped. LED2 (ON) connects to pin 5 of IC1 via a 3.3k Ω resistor, while LED3 (OFF) connects to pin 2 via another 3.3k Ω resistor.

The August 2021 issue is due on sale in newsagents by Monday, July 26th. Expect postal delivery of subscription copies in Australia between July 23rd and August 10th.

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