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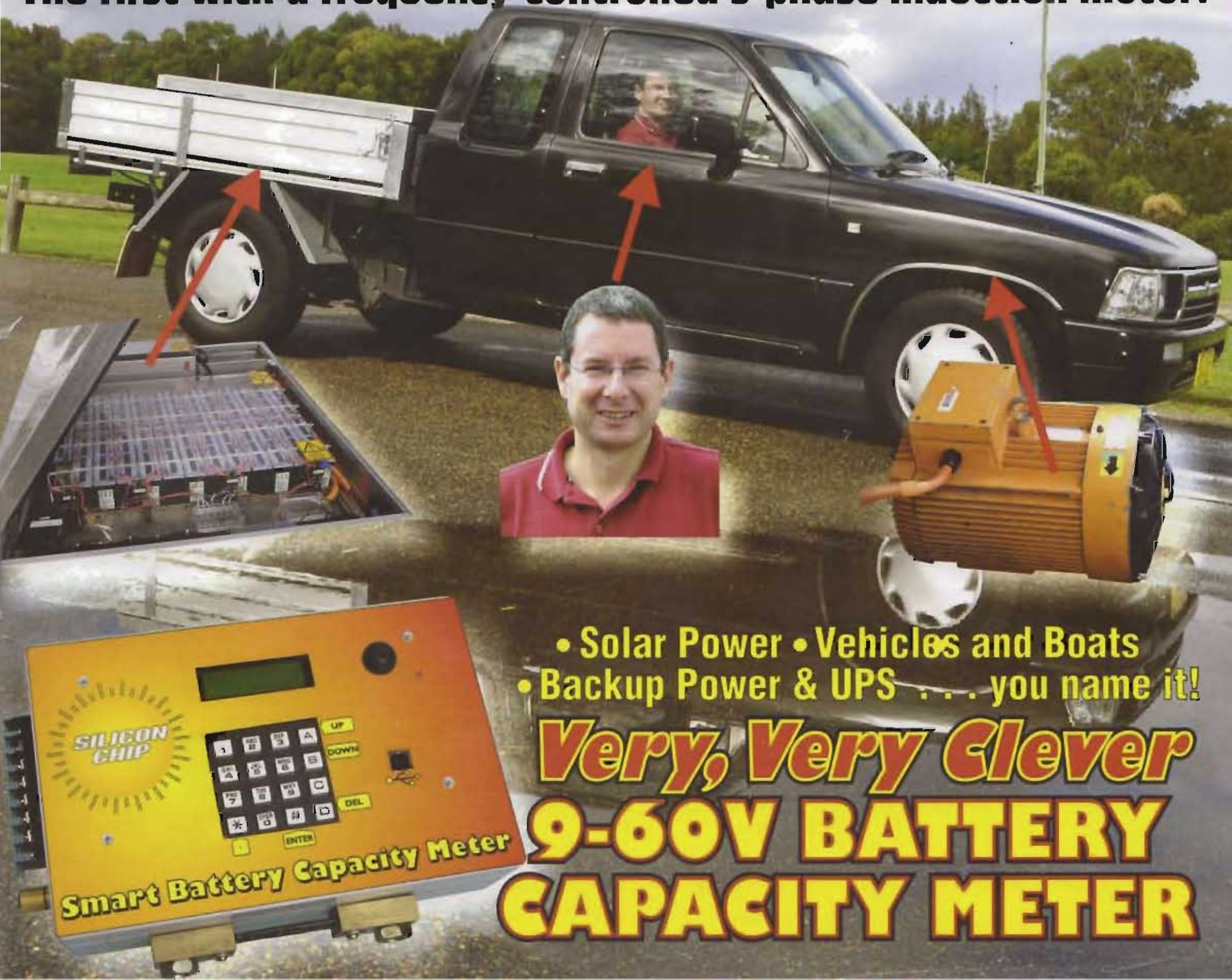

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Publisher & Editor-in-Chief
Leo Simpson, B.Bus., FAICD

Production Manager
Greg Swain, B.Sc. (Hons.)

Technical Editor
John Clarke, B.E.(Elec.)

Technical Staff
Ross Tester
Jim Rowe, B.A., B.Sc
Mauro Grassi, B.Sc. (Hons), Ph.D

Photography
Ross Tester

Reader Services
Ann Morris

Advertising Enquiries
Glyn Smith
Phone (02) 9939 3295
Mobile 0431 792 293
glyn@siliconchip.com.au

Regular Contributors
Brendan Akhurst
Rodney Champness, VK3UG
Mike Sheriff, B.Sc, VK2YFK
Stan Swan

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Editorial office:
Unit 1, 234 Harbord Rd, Brookvale, NSW 2100.
Postal address: PO Box 139, Collaroy Beach, NSW 2097.
Phone (02) 9939 3295.
Fax (02) 9939 2648.
E-mail: silicon@siliconchip.com.au

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Publisher's Letter

Let's have no more of this carbon pollution nonsense

As we approach the end of the first decade of this century, there are two great concerns: the global economic situation and global warming. Presently, with a view to improving their economic situation, most nations are not doing much about global warming, even if they have signed up to the Kyoto Accord. Ultimately, the economic situation in most nations will improve in a year or so and then it will be interesting to see if there is much action on global warming.

Maybe in a year or so, the seemingly universal panic about global warming will abate somewhat. Maybe the "science on global warming" will not seem so "settled". Sure, there will always be a proportion of hard-core fanatics who think we are headed for disaster and will always call for ever more drastic action to reduce "carbon pollution", the prime suspect for global warming. Well, I sincerely hope that these sentiments will eventually come to be regarded as fanatic belief rather than sensible concern based on real science.

For a start, let's consider this highly emotive term "carbon pollution" which is constantly being bandied about. It only takes a moment's thought to realise that there is no "carbon pollution" problem. It did exist 50 years ago, when we had steam trains and diesels with smoky exhausts and coal-burning power stations which had less than complete combustion. It used to be called soot. But it is not a problem now, in most countries. Now I know that some people use "carbon" as shorthand for carbon dioxide but it is sloppy thinking and generates worry in the unthinking masses that we are spewing all this carbon into the air. We're not.

We *are* burning tremendous amounts of fossil fuels and that is putting huge amounts of carbon dioxide into the air. Carbon dioxide is a greenhouse gas and that is a big worry, isn't it? Well, maybe. But all these doom merchants who worry about carbon dioxide never say anything at all about the other greenhouse gas which is produced when fossil fuels are burnt. What is that? It's called water vapour – the same stuff as in clouds. Is water vapour a problem? Definitely not.

Just in case you don't believe me, consider the combustion of petrol which is mainly octane, C_8H_{18}. When this is burnt, the chemical reaction is:

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$$

octane + oxygen → carbon dioxide + water

If you calculate the molecular weights of the two combustion products, carbon dioxide and water, you will find that there is more water produced than carbon dioxide. But greenies never mention it. Why? Because they have either forgotten their high-school chemistry or they are completely ignorant of it.

The point is that both water vapour and carbon dioxide are normal components of the air that we breathe. They are not pollution. They are both necessary for life to exist on the planet. If there was no carbon dioxide, plants would not grow (more high-school chemistry – it's called photosynthesis). Without plants, no animals, including us, can live. It's a simple as that. If there is more carbon dioxide in the air, plants grow more profusely. In fact, it is common practice to increase the carbon dioxide in greenhouses and aquariums to make the plants grow more vigorously.

Alright, let's say for the moment that carbon dioxide is BAD and must

continued on page 45

MAILBAG

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Time-keeping query on School Zone Speed Alert

With reference to the School Zone Speed Alert project, the worst-case crystal accuracy of 40 ppm will produce a time error of approximately five minutes over a school term. I do not know how much leniency is applied regarding the starting and finishing times for school zones but a 5-minute error may result in one incurring a fine and loss of points.

Maybe your readers would be wise to check the Speed Alert's time at the beginning of and halfway through each school term.

Col Hodgson,
Mount Elliot, NSW.

Comment: there is a reference to "trimming the crystal" on page 41 of the article. This covers your point.

More light needed on black boxes

Many years ago, I used to buy *Radio & Hobbies* magazine in an attempt to work out what happens in the "magic black box". Over the years, I learned about radio, audio and power supplies. Later came computers and programming (in Basic) and now that I am retired, modern electronics as described in your excellent magazine but I always seem to be chasing that "magic black box".

It has only just dawned on me that this is the reason that I have frowned on microprocessors in your projects. Granted, it is often easy to understand the circuits and they are easy to build. But what happens in the little black box?

Stan Swan's excellent articles help a bit. However, it didn't occur to me what was missing from these projects until the GPS Synchronised Clock article in the March issue. This gave a great description of how the program works.

How about a little more on this side of the hobby? Perhaps snippets on the program, how it was designed or how to think out the basics of the program. Even the odd routine and other demystifying techniques would make these projects more interesting.

David Lloyd,
Clare, SA.

Comment: in recent times we have attempted to give a lot more information about what happens inside micros. For example, consider the extensive description in the Car Scrolling Display project December 2008 to February 2009) and the Audio Millivoltmeter in the March 2009 issue.

Not all GPS satnavs need constant 3-satellite reception

In-car navigation comes in two versions: satellite reception only or satnav with GPS and speed data comparison. Both need about three satellites for triangulation initially to determine the vehicle's position. The in-car GPS receivers first introduced into Australia by Philips are not blacked out by satellite network shadow areas like city buildings, car parks, valleys and under thunderstorms. They continue to operate well, utilising a microprocessor computer in the unit, which processes extra data from a simple gyro and electrical pulses from the speedo.

Advanced GPS units like this process all this information to know the direction and speed of the car, comparing it with the satellite data and inbuilt maps for more accurate indication. In practice, I did find some inaccuracy once in a heavy rainstorm but generally it was unstoppable.

The Philips system worked so well there was an instance when the antenna plug was accidentally disconnected and the unit continued to work for a few days with no satellite reception. Of course, units with this technology are superior but more expensive.

Kevin Poulter,
Dingley, Vic.

DAB+ has an exciting future in Australia

I write in response to a letter to the editor with the headline "DAB On The Wane In the UK" from David Williams, Hornsby, NSW, in the May 2009 edition SILICON CHIP.

People often compare Australia's digital radio switch-on with the UK, without fully understanding that there are fundamental differences in the digital radio models in each country. In Australia, incumbent broadcasters hold the digital radio licences and multiplexes and have invested in their digital future. In the UK, a multiplex operator owns the digital radio licence and individual commercial broadcasters then pay an annual fee to transmit the digital signal. This obviously adds costs to any digital radio model in the UK.

The UK did not have the best start a little over 10 years ago but to be fair, it is only in the past three to four years that the UK market has introduced a unified ongoing marketing message from the BBC and the commercial radio sector working together, with affordable receivers and better bit rates for better audio quality.

Figures released on 7th May 2009 by Rajar in the UK show DAB digital radio ownership is up 19% year on year, with 32% of adults, more than 16 million people, now living in a DAB household. That's nearly one third of the UK's adult population and DAB radios continue selling at more than a million a year.

We have learnt much from the UK experience. Firstly, the DAB+ technology Australia is launching is far superior and more spectrum-efficient than the older DAB technology introduced

Improved direction indicator for Railpower

I would like to thank SILICON CHIP and Altronics for the Railpower controller, as published in the September and October 2008 issues. It proved easy to build, especially for someone like myself who has rudimentary electronic knowledge. It works very well as a controller.

Putting it together presented a few problems but these were found to be self-inflicted. One glaring problem arose after the unit was completed and that was that there is no way of knowing in which direction a loco will travel until it actually moves. The indicating arrow on the LCD panel is the only indication, as the LED illumination is governed by the voltage output to the tracks.

Study of the circuit and judicious use of the multimeter showed a voltage of 5V across pins 7 & 8 of IC1 which varied plus/minus dependent on the direction of travel, as selected via the pushbutton.

LED1 was disconnected from its location between Q1/3 & Q2/4. A 220Ω resistor was soldered to one leg of LED1 which was then connected between pins 7 & 8 of IC1. The direction of travel is now indicated even when the unit is first turned on and the LED stays lit at all times, indicating in which direction travel will be, even after the Stop button is pressed and the loco is stationary. All functions work as designed.

All I need now is a decent steam engine chuff-chuff and diesel engine sound unit to add to my locos.

Ted Hanson,
Maryborough Qld.

Comment: as you point out, the LCD panel does show track direction but the direction LED1 is probably misnamed and should have been "Track" because it shows the relative track voltage according to brightness with the colour change only visible when the voltage rises sufficiently.

The idea of a second more noticeable direction indicator is good and the connection of LED1 between pins 7 and 8 of IC1 is the way to go but with a 470Ω resistor instead of 220Ω.

We published a SteamSound Simulator project in the October 1991 issue. A steam train whistle and diesel horn was published in July 1994. Finally, a diesel sound simulator was published in the December 1992 issue.

in the UK, resulting in better sound quality at lower bit rates.

We have also planned for indoor coverage – the UK experience was based on plans for mobile reception and thus was hampered by poor reception and poor signal quality.

In Australia, the deployment of digital radio is supported by the entire industry – commercial, ABC and SBS and community broadcasters. This is completely different to the UK where the BBC commenced broadcasting some years before the commercial sector and there was a distinct lack of a united approach.

Our industry-wide marketing and communications campaign has begun and commercial digital radio services have switched on in Perth and other capital cities throughout May. The ABC and SBS are targeting June/July. On 6th August, all commercial networks, as well as the ABC and SBS, will take part in a national simultaneous five-state capital listener event.

The radio industry worldwide is working on digital radio receiver profiles and single-chip technology that will allow a digital radio to receive all the Eureka 147 modes, DAB+, DAB and DMB audio.

Joan Warner,
Chief Executive Officer,
Commercial Radio Australia.

Interference suppression in amplifier power supply

With reference to the item headed "Amplifier Causes Radio Interference" on page 89 of the March 2009 issue, I was involved with interference suppression as a profession for some years. I believe that placing a 10nF capacitor across each diode in the power supply block should reduce or eliminate the interference that N. H. is experiencing.

If that is not 100% successful try additional similar capacitors across some of the other power diodes in the lower

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Mailbag: continued

Running games on old computers

With reference to the Serviceman's Log story in the February 2009 issue on old computers, the ESS sound cards of old were nothing but trouble. Even when they worked the sound quality was not very good and there was always a lot of background noise. Getting them to work in DOS was always difficult but in Windows they gave little trouble (if you ignored the DOS set-up altogether).

The solution is to chuck it out and get a Sound Blaster 16 or Sound Blaster 16 pro; the most compatible sound card on Earth, even now. As far as running old software and games is concerned, if your old computer still works, you have room for it and the quality is acceptable, then keep using it by any means. It would only be landfill if you didn't. When it does break down and if it's a hardware failure it's probably not worth repairing, even if you can do it yourself.

If you want to keep playing your old games on a new machine, there are a few options. The most obvious one is to see if there is a new version that works on later hardware.

If there is a "remake" of the old game that works on new machines, they are usually greatly enhanced in the graphics and sound areas and (in my opinion) are better than the original as long as they kept the story and play the same. It is surprising the number of old games that have been remade, usually by a separate fan base, not the original creator.

Another approach is to use a virtual machine. A virtual machine (or virtual operating system) is another operating system running on a parent operating system. Normally, the virtual operating system is totally unaware it is running in a virtual environment and is thus 100% compatible. The most famous of these is VM-Ware (**http://www.vmware.com/**) but it is not free. They do have a free VMPlayer which can run a virtual machine built by some one else. Why is this useful? A third party application, VMX-builder, can be used to build a custom machine. See: **http://sanbarrow.com/vmxbuilder.HTML**

Microsoft has one too at: **http://www.Microsoft.com/windows/products/winfamily/virtualpc/overview.mspx)** but it was not free until recently when they released it as a service pack: **http://www.Microsoft.com/downloads/details.aspx?FamilyId=28C97D22-6EB8-4A09-A7F7-F6C7A1F000B5&displaylang=en**

The best totally free and open sourced virtual machine would be VirtualBox from **http://www.virtualbox.org/**

Finally, for a lot of old games you do not need a full virtual machine to run them; you can use an emulator. There were a lot of the point and click style adventure games released in the early 90s that used the same engine – these were mostly by Sierra and Lucas Arts. The engine used was dissected and recreated as an emulator to run on almost any operating system ever made, even the Nintendo DS. I was quite astounded to play one of my favourite games ('The Day Of The Tentacle') on my DS with full animation, sound effects and speech. The engine was called "Scumm" and the emulator is called "ScummVM": **http://www.scummvm.org/**

The best DOS emulator would be DOSBox: **http://www.dosbox.com/**. I have found this emulator even more compatible with DOS applications and games than DOS itself. You can play almost any DOS game on XP and even on Vista.

Philip Chugg,
Launceston, Tas.

powered sections of the amplifier.

I've always had success with suppression where the diodes have been noisy in the AM band. As you go lower in frequency, the interference gets worse. I suspect that some diodes are more prone to create noise than some other diodes – to do with the sudden transition from non-conduction to conduction.

It could be interesting to do a number of controlled experiments to determine the best method that is applicable to silence diodes. It may be worthwhile giving N. H. an opportunity to try my suggestion. If it fails, he can remove the capacitors.

Rodney Champness,
Mooroopna, Vic.

Comment: it is true that this technique worked quite well in high-voltage transmitters and transceivers but we have found it makes little difference in high-power audio amplifiers.

In fact, adding capacitors across the rectifier diodes can actually make the interference worse! Perhaps it is related to the much higher peak rectifier currents involved in audio power amplifiers and the fact that the frequencies of interest are usually much lower.

Diagrams would better describe software functions

As an avid microcontroller supporter, I am always interested to see new microcontroller applications and SILICON CHIP never fails to intrigue me with excellent projects.

However, as superb as the projects are, I feel as a professional magazine, you are missing one of the fundamentals of technical project documentation: software diagrams!

To explain my position, I am a former electrician, recently graduated electrical engineer, and now a Ph.D student in electrical engineering. As part of the university, I supervise "Microcontroller Systems" lab groups, teaching second year students how to design, write, debug and run microcontroller projects.

One of the first skills our students are taught in "Microcontroller Systems" is how to document their software using structure diagrams (in fact we use it as a combined documenting/design tool). I believe SILICON CHIP

Power considerations for the Tempmaster Mk.2

It is interesting to see how far the current requirements could be reduced for the Tempmaster Mk.2.

Starting with the passive components, the 2.7kΩ, 3.3kΩ and 500Ω trimpot resistive divider will draw 0.77mA, roughly 20% of the total current of 3.8mA. Increasing these values by a factor of 10 or even 100 will significantly drop the total current. IC1a has an input bias of 25nA so the voltage drop across these higher value resistors (2.5mV per 100kΩ) should not be a problem. In "C" mode it might be necessary to alter the positive feedback since it is now summed with a set voltage with higher impedance.

Further reduction in current can be obtained by using more recent ICs. For instance, an LM2936-5.0 has a maximum quiescent current of 15μA at 100μA load over supply voltages from 8-24V. Compare this with the LM723 standby current of 1.3mA (typical) ranging to 4mA (maximum).

The LM393 comparator draws 0.4mA which is good for a wide voltage range comparator. A single channel LM397 could reduce this to around 0.28mA but is only available in a SOT-23 package.

A better device, also SOT-23, is the LMV7271. This has a current of 10μA however is restricted to a maximum of 5V on any pin. Thus the relay driver would need to be modified. The LMV7271 can source and sink current so an NPN transistor on the 0V side of the relay could be driven. This would change the logic of the comparator with it now active high. Thus the "H" and "C" modes would be swapped.

The last component to consider is the sensor. For a 2.8V sensor reading there is 2.2V across the 5.6kΩ resistor connected to it, giving 0.4mA. An alternative is the LM19, a 3-terminal device with a current drain of only 10μA that can operate off a 5V supply. However, the LM19 output decreases with temperature, with the datasheet showing it varying from 1.8639V at 0°C to 1.515V at 30°C. Thus voltages of 1.84064 to 1.64293 correspond to the range of the Tempmaster.

This could be accommodated by interchanging the "H" and "C" modes and altering the resistive divider and trimpot to give a slightly wider range (0.2V compared to 0.17V) with a somewhat lower minimum voltage (1.64V compared to 2.75V). The trimpot wiper would be best connected to the other end of the trimpot to maintain the rotational "sense" for increasing the temperature setting.

Thus, changing the resistors, voltage regulator and sensor as above should result in a reduction of around 2.3mA, giving a total current of 1.5mA. If the SOT-23 LMV7271 device was used, then adding up the standby currents gives a total under 50μA. The weak link in all of this is now the 12V power supply.

Dr Alan Wilson,
Glen Iris, Vic.

Comment: we agree that the current drain can reduced by raising the value of the resistors in the voltage divider. However, your suggested alternative ICs are much more difficult to obtain.

should be documenting the software as not just a text explanation but as a graphical diagram. I know personally that this will greatly aid my understanding in what is exactly happening in the microcontroller, as I'm sure it will with others.

I would even suggest that it would improve your readers' programming ability by providing a graphical foundation for proper program structure and flow (reading someone else's code certainly doesn't help the new students at university!).

I realise space within your articles is limited but I believe a well-constructed structure diagram or state diagram could cut down the space required to describe software function (at least for smaller projects). These diagrams are not difficult to read. Perhaps you could even run a section on construct-

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Mailbag: continued

Browns Gas needs lots of power

With reference to the letter in the April 2009 issue, about using "Brown's Gas" to improve car fuel economy, anyone who remembers high-school chemistry or makes the effort to look up Wikipedia will find that however you do it, it takes more energy to create a litre of hydrogen (or the mythical "Brown's Gas" or oxy-hydrogen) than is recovered by burning it. So however it is done, unless you have a source of free or very low cost energy, you lose.

At 100% efficiency, it takes about 1.4Ah (amp.hour) of electricity to produce a litre of gas. To produce two litres per minute would take about 300A from a car battery/alternator!

Also, if you try to generate hydrogen or oxy-hydrogen by electrolysis using a 12V battery as the source, you will wait forever unless you first add salt or acid or something to turn it into a good electrolyte. If you don't believe me, try it!

I suspect that those people who claim to generate and use these gases in their cars are actually just slowly pulling the water out of the container as a vapour due to the engine vacuum, otherwise their water container would never get empty.

Unfortunately, with the internet, there is no easy way to validate the claims of the charlatans and ratbags who propagate this sort of rubbish to sell their kits or plans.

Rod Cripps,
Parkdale, Vic.

ing structure and state diagrams, one issue prior to using them.

For more information on state diagrams, Wikipedia gives a good description and a number of examples and information on the actual structure diagram software we use can be found at: **http://www.aaee.com.au/conferences/papers/2005/Paper/Paper60.pdf**

Jonathan Currie,
Auckland, NZ.

Comment: we agree that diagrams can be good for showing program structure but as you say, space is a big constraint. And while it may not be obvious, we already have major investment in producing all the other diagrams in the magazine – there is a limit to how much time and space we can devote to each article.

No easy substitutes available for many incandescent lamps

Nowhere have I seen any reference to the lamps used in the multitude of fridges, ovens and microwaves being phased out. Only incandescent lamps can withstand the heat inside an oven and fluorescent tubes do not work at the low temperatures inside refrigerators.

In very cold conditions, compact fluorescents (CFLs) are very dim unless they can warm up. Only specialised CFLs can dim in chandeliers and "mood" light fittings and do not have the "candle" and other decorative shapes used either.

Outside security lamps use halogen spot lamps and what about the multitude of incandescent halogen down lights across homes and shops?

Most commercial outside lighting is by halogen lights which are incandescent with a gas added in their envelope. Are they also banned?

Has Peter Garrett ever given thought to all this or are all his advisors clerical and non-technical staff? It would seem so. By all means replace the standard light globe but a blanket ban on all incandescent lighting has not been properly assessed.

Bram Hester,
San Remo, NSW.

Relays still have their place

I agree with the comments about a renaissance of relays, in the letter by Ken Moxham (page 7, March 2009). In the early 1970s I worked for a company that had the contract to build the stage manager's desks for the four theatres of the Opera House.

Switch banks in each desk controlled all of the lighting for that theatre. If solid-state relays had been used there would have been the risk that the radar pulses from passing ships (less than 100 metres away) could trigger some of the relays and upset the lighting.

So all relays were mechanical throughout the four theatres. The system has worked well ever since.

Dave Jeanes,
Tweed Heads, NSW.

Antenna earthing is desirable

We recently had an extra room added to the house which required a TV point. This and the purchase of a HD LCD TV prompted me to replace the motley collection of cable and splitters of my distribution system which over the years had grown from the original single point to five.

I rewired in RG6, with F connectors and cast alloy splitters. The improvement in reception was amazing. One of the old splitters had failed on one output and the 5-year old Akai TV in that room had used a rabbit's ears antenna. When I connected this to the new system we had 50Hz hum on all radios in the house. When I unplugged the fly-lead from the wall socket, I felt a tingle when I touched the shroud.

I measured the voltage to earth with my Fluke DMM. It was 110VAC and as it could supply no current, the source was obviously high impedance. I have not had time the look at the TV yet to find the cause but it made me think about the lack of any earthing on the antenna system.

In the days before live chassis, switchmode supplies and 2-pin mains plugs, the shield on the antenna cable was earthed by its connection to the earthed chassis. Now the whole system floats above earth so that if a fault connects it to a dangerous voltage,

New lease on life for old bike

I know nothing about electronics but my wife is very good at building PC boards. Today I tested the CDI module for small petrol motors (Silicon Chip, May 2008) on my Rickman-Zundapp 125 vintage MX bike. It started on the first kick and I took a ride. I am very pleased.

I have included a picture of the bike. As you can see the connection is temporary. All I need now is the correct size box to finish it up nicely. Thanks for helping to extend the life of these old engines.

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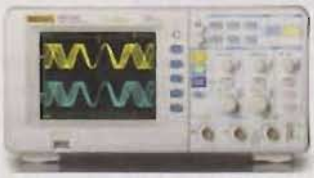

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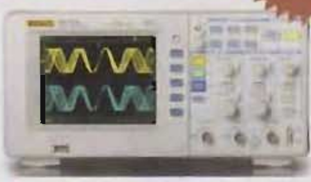

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Mailbag: continued

Vintage battery restoration

I though I might share a way to preserve the original look and feel of a 276-P battery to run my favourite 1960s HMV transistor radio.

Recently, I was fortunate to find an old battery and I rebuilt it using high-quality alkaline D cells. Some might say, why not use rechargeables but these batteries have such a long shelf life that I typically get three to four years before replacement is due.

The only points to note are to not glue the top flap down; it is held in place by the radio battery plug. I use thin polystyrene packing to eliminate the possibility of shorting between the female plug and the batteries.

Andrew Prest,
Sunshine, Vic.

there is no path to cause a protective device, fuse, circuit breaker, etc, to operate. I am planning to connect the metal housing of one of the splitters to my house protective earth, so as to provide this path.

Phil Andrews,
Adelaide, SA.

Disappointment with USB printer switch

I am a bit disappointed with the USB Printer Switch published in the April 2009 issue. Mechanical data switching technology has been available forever – we used to have one 20 years ago for two computers running one parallel port printer. It annoyed us then, so we upgraded to one that detected a signal and changed automatically.

I thought that with today's availability of cheap programmable chips it would be easy (and probably cheaper) to make an automatic one than to hook up a big switch. Most people just change the USB cable over and even if they did decide to manually switch, they probably, wouldn't go to the expense of using a PC board and just wire point-to-point.

That project really does belong in the 1960s and in popular mechanics, not in an electronics magazine. I am sure most (all?) readers already know how to wire up a switch!

Gary Lindsay,
Otaki Beach, NZ.

Comment: it is true that we could have come up with a more complicated electronic version but we wanted to keep the cost down.

Electric car owners should be forced to have home solar power

Mitsubishi has announced that they were going to produce their iMiEV electric car in Australia, see http://tinyurl.com/cx4mob

If we are going to have battery-powered cars, rechargeable from home power supplies, we should also put into place compulsory home solar

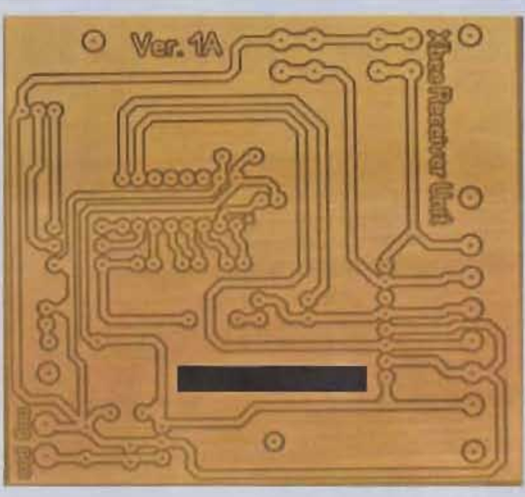
Reply from the designer of the UV oven

Having read the letters of complaint about my conversion of a microwave oven to a UV light box (SILICON CHIP, October 2008) in recent months, I should like to offer the following statement for your readers' information.

I fully acknowledge and accept that my use of green/yellow wire in this device was a bad call on my part. However, colour of wire not withstanding, the device is electrically safe. All connections are insulated, the wire is 10A and mains-rated and there is even plastic under all the starters and mains terminal blocks, as outlined in the article. Your readers, who are complaining, are writing as if I had used bare exposed copper wire with no insulation at all!

Jeff Thomas writes in the December 2008 Mailbag of all sorts of horrors associated with this project, not just the wiring – he seems to hate the very concept itself and every aspect of it! He almost goes so far as to say that the project will not work as an exposure method at all.

To him and others with similar views, I ask you to have a look at the accompanying high-res photo which shows the results of using this oven. It most certainly does work and it works very well indeed.



Peter Laughton also writes in the February 2009 Mailbag of concerns with the green/yellow wiring, and while again, I acknowledge his letter with respect to the wire colour, I stand by my comments that the device is perfectly safe – even with the "wrong" colour code. Yes, I should not have used green/yellow wire but all connections that have anything to do with the live parts are well insulated and labelled and so I still don't see this as being the massive problem that some of your readers suggest that it is.

Finally, John Hunter covers just about everything else I wanted to say in April 2009 Mailbag. In particular, I refer to his paragraphs on being realistic, using commonsense and that I am the only one who will ever work on the unit. I would like to thank him for defending my idea and bringing some logical thinking to the colour-code issue.

So, in summary: YES you are all quite correct – I should not have used green/yellow wire and NO, I won't wire like this again for any project. But if I may offer one rhetorical question in closing to all those who still have a problem and are jumping up and down at this very moment as they read this: "Do you know what the word pedantic means?".

Graeme Rixon,
Mosgiel, NZ.

Comment: we thought it was great project concept. Just remember: it is easier to criticise an idea than to come up with an original concept. We would hate to have contributors discouraged from submitting articles because they might be criticised.

systems for purchasers of these cars. At least the power from these would offset some of the power consumed by recharging these cars and help cut emissions from coal-fired power stations.

John Vance,
via email.

Comment: this was just a bit of "spin" by the Federal Government but to be fair, the Federal Transport Minister, Anthony Albanese, did not state that the car would actually be made in Australia. While Mitsubishi may be putting the iMiEV into low-level production later this year, it is not ever going to be made in Australia. It is slated for initial release in Japan in 2010. Mitsubishi ceased all manufacture in Australia in 2008. In fact, we have doubts whether the iMiEV will ever go on sale in Australia.

When and if electric cars do go on sale in Australia, a requirement for the prospective purchasers of the cars to also install a home solar system would put the kiss of death on them. In any case, many purchasers of these tiny electric vehicles are likely to be inner-city dwellers who live in high-rise apartment blocks and there's no prospect of them installing a home solar system. SC

At last, a fair-dinkum electric vehicle conversion using an induction motor . . .

Mal's EV

By LEO SIMPSON

Malcolm Faed has produced the first electric vehicle conversion using an industrial 3-phase induction motor controlled by a variable frequency, variable voltage converter. As far as we know, it is the first such road-registered DIY conversion in Australia and it is probably one of the first in the world.

Back in the December 2008 issue we reported on the Australian Electrical Vehicle Association's field day held in October. We commented that all the vehicle conversions on display appeared to be based on DC motors with wound fields and ratings up to about 70kW.

But we have always felt that the ideal conversion should be based on a 3-phase induction motor, as in hybrid electric vehicles and in larger commercial electric vehicles as well as modern diesel locomotives.

So when we heard that Malcolm Faed was engaged in a conversion which would use an industrial grade 3-phase induction motor and matching drive (the inverter), we watched his internet blog with keen interest. Just recently he has completed it and is now happily driving a registered electric vehicle on Sydney's roads. He dropped into our offices to show it off.

Just to prove the point, here's the rego sticker, placed just a couple of months ago. It shows a gross vehicle mass (GVM) of a little over two tonnes.

It is based on a Toyota Hilux Xtracab utility, a rugged commercial vehicle with an aluminium tray body with plenty of space for the battery bank. To look at the finished vehicle, the conversion looks surprisingly straightforward although Malcolm would have undoubtedly spent hundreds of hours thinking about each step in the process before actually doing it.

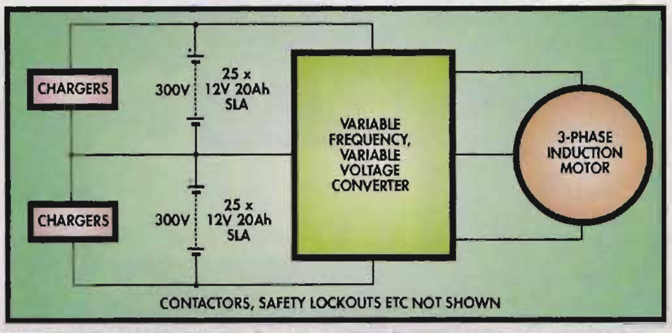
The conversion can be summarised as having a whopping orange induction motor mounted in the now very spacious engine bay and the battery bank and inverter system mounted on the rear tray under a large canopy.

With the bonnet down and the canopy closed, the only clue that this might be an electric vehicle is the plastic cover for a standard 230VAC mains 3-pin male socket on the side of the tray body, used for battery charging.

Perhaps another clue, if you see the black Hilux pulled up next to you in traffic, is that you won't hear the motor running – because it isn't! That is not to say that the motor is silent because once it is above walking speed, the motor can certainly be heard – and nor is it particularly quiet.

But before we get too far ahead, let's discuss more of the basics of the conversion. The battery bank consists of 50 12V 20Ah sealed lead acid cells giving a total battery supply


Unlike today's petrol engines shoe-horned into the bay, this under-hood shot shows a lot of space, even with a grunty 3-phase industrial motor. It has an electric fan fitted because the internal cooling just isn't enough at low engine speeds. Inset top right is the ratings plate for the ASEA motor. It's showing its age but can still be read.



On the face of it, this electric vehicle conversion is pretty simple. The execution proved to be a tad more difficult!

rail of 600V. This is fed to a Danfoss VLT5042 frequency converter intended to drive 3-phase induction motors up to 48kW (peak).

Now the cunning aspect of Malcolm's conversion is that it feeds the 600V DC directly to the VLT5042 converter. Why is this cunning? Because when used normally, the VLT5042 is fed with 3-phase 415VAC which is then internally rectified by a 6-diode bridge to obtain 586V DC and it is this DC which is then converted to variable frequency, variable voltage AC.

What Malcolm has done is to bypass the internal 3-phase bridge rectifier and feed the frequency converter with DC from the batteries instead.

The 600V battery supply is split into ±300V rails and so there are three supply leads into the VLT5042 converter: +300V, 0V & -300V.

For charging from 230VAC, the battery bank is split into 12 banks of four (48V) and one bank of two (24V) and these banks are charged by 13 intelligent switchmode chargers. Each night the battery bank is charged using off-peak electricity, so the cost of energy for this vehicle is particularly low.

Total capacity of the battery bank is 12 kilowatt-hours and this gives a driving range of about 40km – fairly modest but adequate for Malcolm's short daily commute.

Most readers will be aware that the speed of an induction motor is more or less locked to the frequency of the AC driving voltage. Hence, a 4-pole induction motor connected to a 50Hz mains supply will normally run at about 1440 RPM; slightly less than the so-called synchronous speed of 1500 RPM.

Incidentally, the synchronous speed of an induction motor can be calculated using the formula:

$$n = \frac{120f}{P}$$

where n = RPM, f = frequency and P = number of poles of the motor.

Similarly, a 2-pole induction motor will run at about 2880 RPM, again slightly less than the synchronous speed of 3000 RPM. The difference between the motor speed and synchronous speed is known as "slip" and this is dependent on the load on the motor (or the torque produced).

Hence, in order to drive the motor over a wide range of RPM, the frequency converter must have a similarly wide output. In the case of the Danfoss VLT5042 used here, the drive frequency is configured to vary from 0.5Hz to 132Hz and the voltage must also be varied, from quite low at low frequencies up to a maximum of 415V (3-phase AC) at 50Hz and then fixed for higher frequencies.

The VLT5042 is able to work in open or closed-loop mode and has a speed pickup input. On Malcolm's conversion the speed pickup is a toothed wheel on the output shaft of the motor and a Hall Effect sensor. At this stage though,

Mal Faed drying off the electronics while we took photos of his EV conversion on a (very!) wet day. This is looking across the battery bank with the Danfoss VLT5042 controller under his right elbow.

QUICK FACTS

Vehicle:	1992 Toyota Hilux Extra Cab. 2WD (RN90R)
Range:	35km to 70% discharge – hilly terrain (Collaroy to Terrey Hills return) Deeper discharges will significantly affect the life of the batteries.
Charge time:	1 – 5 hours depending on distance travelled.
Cost to run:	1.39¢/km (off-peak 1 electricity tariff); 4.9¢/km (peak electricity tariff) Battery cost ~10¢ per km. (Total 11.39 to 14.9¢/km) Compared to petrol, 13¢ per km – 11l/100km @$1.18/l Add 5 to 15¢/km for servicing Total 18 to 28¢/km
Efficiency:	Hilly terrain – battery to wheels: 238Wh/km Flat terrain – battery to wheels: 200Wh/km
Performance:	Peak power – 35kW at wheels (48kW electrical) Peak torque – 1615Nm at wheels. Peak motor torque 315Nm Originally: Power 75kW @ 4800 RPM; Torque 185Nm @ 2800 RPM
Converted weight:	1544kg (Original weight 1250kg; GVM [Gross Vehicle Mass] 2050kg)
Motor nominal:	15kW / 99Nm, ASEA, aluminium frame, 3-phase induction motor.
Motor peak:	~48kW / ~350Nm
Braking:	Regenerative and original vacuum assisted hydraulic.
Controller:	Danfoss VLT5042 3-phase Inverter (aka Variable Speed Drive / VSD). Provides regenerative braking.
Batteries:	50 x 20Ah (@ 2hr rate) Greensaver SLA
Battery energy:	12kWh
Chargers:	13 x 2.5A switch-mode smart chargers
Top speed:	75km/h on flat
Modifications:	• Manual steering • Electric heater • 5:125:1 differential

the VLT5042 is being used in open-loop mode, with the motor speed pickup being connected for speedo operation only. Even though it's road registered and drivable, it's still a work-in-progress!

The VLT5042 uses a bank of high-voltage insulated gate bipolar transistors (IGBTs) in a 6-way bridge to give a 3-phase drive to the 4-pole motor which is delta-connected. The motor is a second-hand ABB unit with a nameplate rating of 15kW at 415VAC. That might seem low but remember that such a motor can deliver at least three times its rated power for short periods.

The motor sits in the engine bay of the Toyota Hilux in virtually splendid isolation. The only modification is that it has been fitted with a standard 12V radiator fan which is controlled by a thermostatic switch on the motor body. The fan replaces the internal fan, which was ineffective at low speeds and too noisy at the higher speeds the motor is now required to run at.

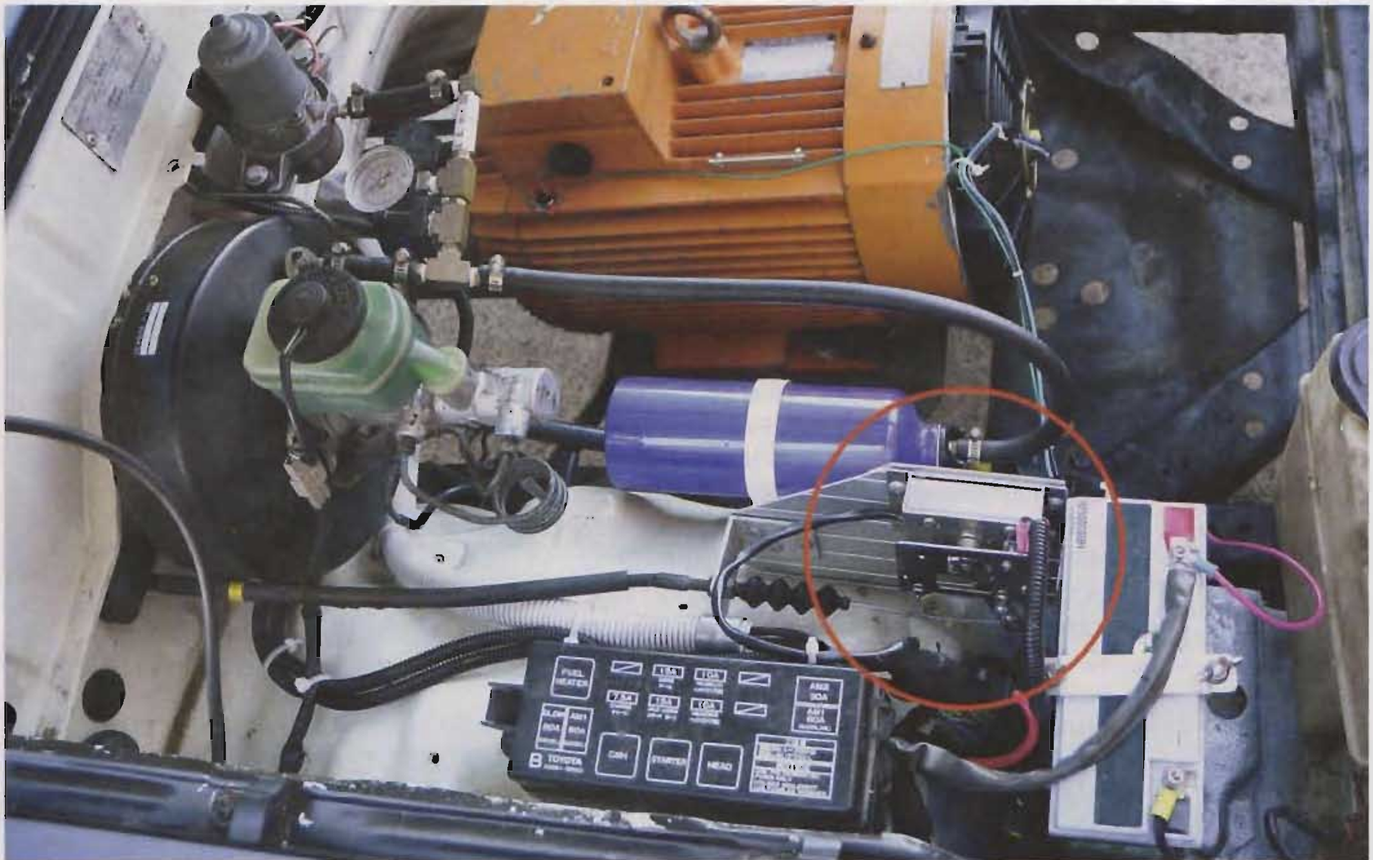
Even so, the 12V fan does not cut in frequently and would only be expected to be running when the Hilux is climbing a steep hill.

The motor drives the differential of the Hilux directly; there is no intermediate gearbox. However, Malcolm has increased the diff ratio to 5.125:1 to obtain a better hill climbing capability – necessary for his Sydney northern beaches' location. Top speed is about 75km/h.

Engine braking & regeneration

One aspect of this conversion which is not immediately obvious is that the combination of the Danfoss VLT5042 and the 3-phase motor can provide substantial engine braking, dependent on the throttle setting. The engine braking is an

The large knob in the foreground is the Forward/Neutral/ Reverse switch, with the Danfoss keypad and display. It is not possible to inadvertently throw the car into reverse while under way. This is prevented by a key interlock which must be used to change motor direction.



This shot shows the 12V battery (right corner) which provides power to all the ancillaries. Above it is the blue vacuum reservoir, included so that the vacuum pump, adjacent to the power brake booster, does not cycle frequently. The vacuum pump is fitted with a gauge – just to show it is working. Centre right of the photo (circled) is the throttle potentiometer. The pot is 10kΩ (linear) and provides 60° of rotation.

inherent function of induction motor slip, whereby when the motor is being "over-run" by the drive shaft (as when coasting down a hill), the motor is effectively generating reverse torque.

But since the motor is being driven by the rear wheels, it also provides worthwhile regeneration, delivering significant current to the batteries on long downhill runs.

The battery charging evidently takes place via the substrate reverse diodes in the IGBTs. A meter inside the vehicle monitors the battery drain and the regeneration.

Regeneration is a particular advantage of using a 3-phase motor and one which cannot easily be provided in conversions using series DC motors. Ultimately, an AC conversion such as this should be very quiet because the motor is not subject to the high frequency pulse drive normally employed in DC conversions.

The 3-phase sinewave is synthesised by higher frequency switchmode pulsing so high frequency whistling is evident from outside the vehicle.

Ancillaries

All electric vehicle conversions need to provide a 12V battery supply to run the ancillaries such as the vehicle's instrumentation, windscreen wipers and washers and lighting.

Not something you see every day!

This is provided by a 12V SLA battery, identical to those sitting in the rear tray. It is charged by a pair of switchmode regulators, one of which is connected to the +300V rail while the other is connected to the -300V rail. Both their floating outputs are connected in parallel to charge the battery.

As well as lighting, it also provides power to a 12V vacuum pump which runs the power brake booster. It also drives a 12V blower for the ceramic core heater. The heater is run from the 600V supply and provides demisting for the windscreen.

There is no air-conditioning for the driver and passengers though... That might be in a subsequent EV conversion perhaps.

Driving it

Driving the converted Hilux is a bit of an art because the throttle and braking response needs to be learned. If you're too hard on the throttle, the motor slip goes to a high value and it loses power.

Having said that, the vehicle evidently has adequate power to keep up with other traffic and is no slouch when climbing hills. However the battery drain goes up alarmingly at these times, rapidly reducing the available capacity. On the level, the car trickles along.

Where it is disconcerting is that the motor is not as smooth as you would expect and has significant vibration conducted through the cabin – almost a cogging effect.

This is probably a consequence of the motor being solidly mounted to the chassis without any rubber mounts to provide isolation. Perhaps that might be a later modification.

When climbing hills the motor also becomes quite strident – surprisingly so. We measured a peak of 78dBA inside the cabin. Of course, large 3-phase industrial motors are never silent; it is just that you are seldom aware that they produce any noise since it is normally drowned out by the machinery they are driving.

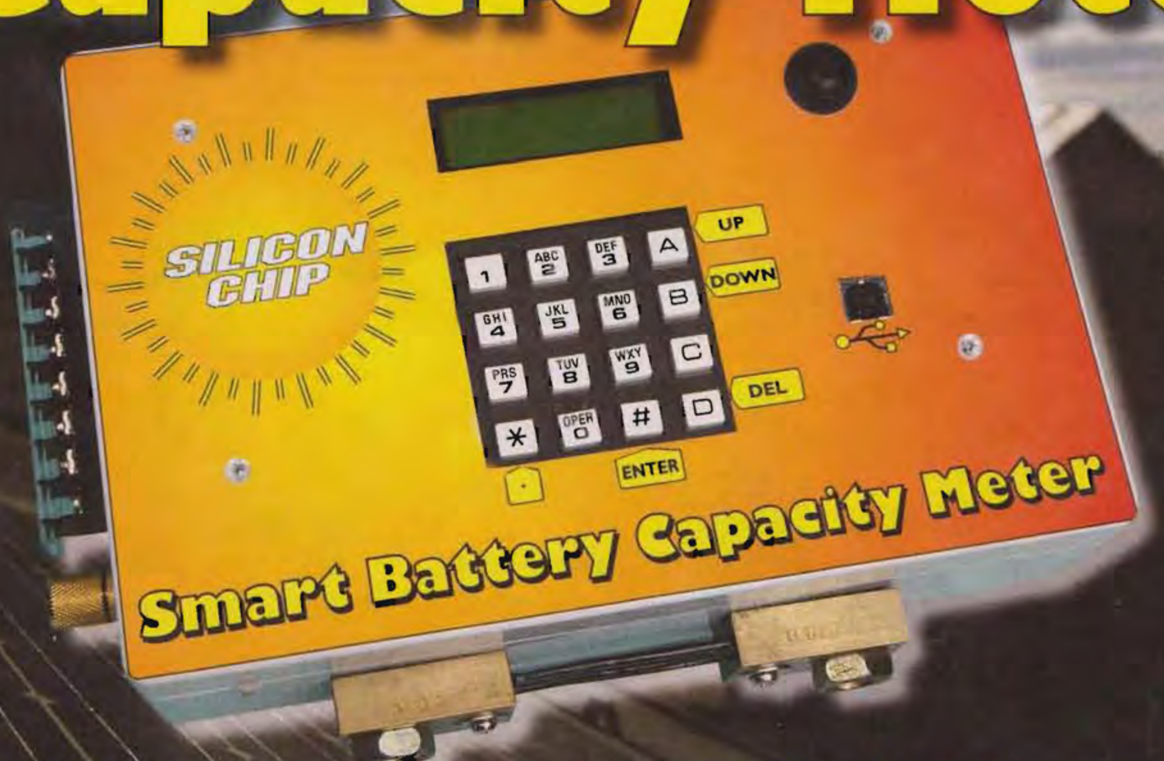
Overall, we are very impressed with this EV conversion. Not only is it the first using an induction motor but Malcolm's choice of vehicle is very appropriate. It is a strong commercial vehicle and should provide good protection in the event of a crash. Even if it rolled over, you could fairly confident that the battery pack would be securely held in place. Having back seats, it also provides for four occupants, something that most prior conversions using conventional cars cannot provide. SC

Much more detail can be found on Malcolm's EV Blog: http://a4x4kiwi.blogspot.com/

This view shows 10 of the 13 individual battery chargers.

This shot show the Danfoss VLT5024 frequency converter with the top cover removed. In the foreground you can see the two 13.8V 25A switchmode power supplies which are used to charge the 12V ancillary battery. They occupy the space originally taken up by the 415V 3-phase rectifier filters.

High Current, High Voltage, Smart Battery Capacity Meter



Ideal for solar power battery monitoring but also perfect for a wide variety of rechargeable battery applications, this smart battery meter monitors the charge and discharge of lead-acid, Nicad and NiMH batteries with an operating voltage range of 9-60V and currents up to 80A. It has settable overload and under-voltage protection and it can be connected to a PC for logging of battery condition.

Rechargeable batteries are expensive, regardless of what type they are or where they are used. To obtain absolute maximum life from them, it is very important to charge and discharge them properly – and that requires very careful monitoring.

Because you can't be there continuously watching meters, it is essential that you have the equipment that can. And that's where this very smart battery capacity meter comes in.

Just take a look at the features panel below and you'll have to agree: it is very smart!

It uses a heavy-duty shunt to monitor charge and discharge currents. All the readings are shown on a backlit 2-line LCD panel and the various modes – and there are many to choose from – are simply selected by pressing a button on an alphanumeric keyboard.

A USB connection allows you to log the battery voltage, battery capacity, charge current and many other readings. We show you how data can be imported into a spreadsheet and graphed on your PC.

An audible alarm warns you when the remaining battery capacity drops below a preset percentage. You can then disconnect the load to protect the battery, either manually or automatically via an optional heavy-duty relay. The latter will then reconnect the load after the battery voltage rises to a preset safe level.

It can be used with all types of lead acid batteries, including SLA (Sealed Lead Acid), deep discharge, etc, or with virtually any type of nickel-metal-hydride (NiMH) and nickel-cadmium (Nicad) batteries, as long as they are 9V or more.

Circuit Operation

The circuit of the Battery Capacity Meter is shown in Fig.1 and is based around a PIC18F2550 microcontroller (IC1) which incorporates a USB interface. The micro drives the 2-line LCD panel and polls the alphanumeric keypad to respond to buttons being pressed.

By Mauro Grassi

The circuit runs from a 5V rail, derived from an LM2574HV-5 high-voltage step-down regulator, REG1. REG1 is a buck switch-mode regulator that produces 5V from an input voltage range of around 7-60V. The HV suffix in the part number refers to the 60V version of the regulator.

The regulator works with a minimum of external components: a 220μH inductor (L1), a Schottky diode (D8) and a large electrolytic bypass capacitor on the output of the regulator at pin 1 (the 5V rail).

REG1 also incorporates a nice feature, the $\overline{ON}$/OFF input at pin 3. When this pin is low, the regulator is enabled; when high, it is disabled. This pin is pulled up by a 10kΩ resistor meaning that the regulator is off by default, providing no power to the rest of the circuit.

There are two ways that the regulator can be turned on or kept on by

Main Features

- High Voltage (9-60V) and High Current (~80A) range
- Display Up to 12 different readings: Battery Voltage (V), Battery Capacity in Amp.hours (AH), watt-hours (WH) or percentage (%), Load Current (A), Charge Current (A), Net Current (A), Circuit Current (mA), Time Remaining (D:H:M), Charge/Discharge Cycles, Load (W), Relay Current (mA)
- Backlit LCD Display with variable brightness and timeout period (to stop backlighting)
- USB 2.0 for Data Logging
- Data Logging with RLE Compression can log up to four readings at any one time, transfer to PC and import into spreadsheet, create graphs
- Uses Peukert's Law for discharging Lead Acid batteries, with customisable constant and charging efficiency setting
- Suitable for all Lead Acid (including deep cycle) and NiMH & Nicad batteries
- Automatically detects top of charge (Lead Acid) or bottom & top of charge (Nicad/NiMH):
  - Lead Acid: determines top of charge by detecting trickle current and cell voltage
  - Nicad & NiMH: detects discharge end-point by detecting falling voltage and low cell voltage
- Audible Capacity Alarm
- Fail-safe shut down on under-voltage
- Overload protection with soft fuse (requires external relay)
- Under-voltage protection (with optional relay)
- Keeps track of number of charge/discharge cycles
- Persistent settings and hierarchical menu system
- One-time software calibration using only a DMM
- Customisable averaging for all readings
- Standby mode when small load or charge current to save power
- Housed in a rugged plastic case

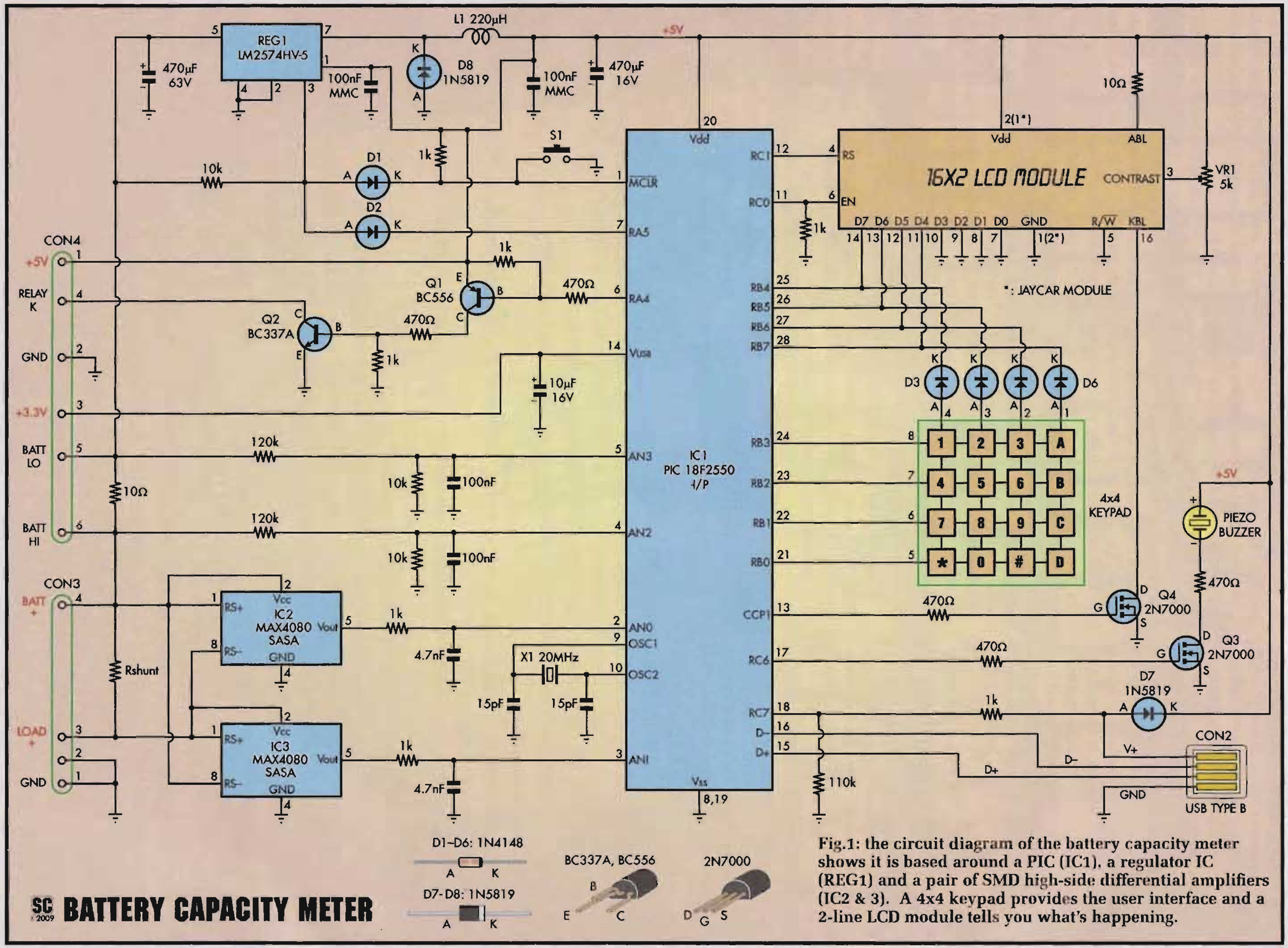


Fig.1: the circuit diagram of the battery capacity meter shows it is based around a PIC (IC1), a regulator IC (REG1) and a pair of SMD high-side differential amplifiers (IC2 & 3). A 4x4 keypad provides the user interface and a 2-line LCD module tells you what's happening.

the circuit. Diodes D1 and D2 form a wired AND gate connected to pins 1 & 7 of IC1 and the pushbutton switch S1. So the regulator can be turned on by pressing switch S1 on the front panel or turned on by the microcontroller using the digital output at pin 7 (RA5).

So to turn on the circuit, you press S1 and the microcontroller starts running its software, after a power-on reset (POR). One of the first things the microcontroller does is bring pin 7 low, to keep REG1 on.

Note that S1 is also used for bringing the meter out of standby or to reset the software fuse after an overload condition.

The 16-key alphanumeric keypad has its rows and columns scanned by the micro. Diodes D3 to D6 prevent the associated column lines from being shorted if two keys from the same row are pressed simultaneously. This is important because the four lines are also used to write data to the LCD panel (in 4-bit mode) and we don't want this data scrambled inadvertently.

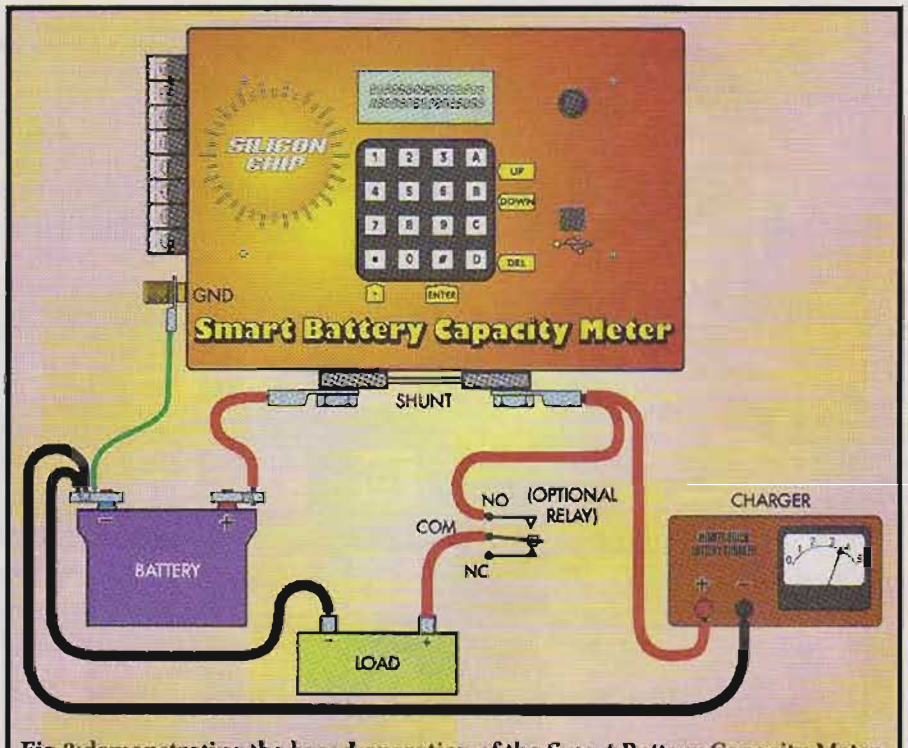


Fig.2:demonstrating the broad operation of the Smart Battery Capacity Meter. It is essentially a very low resistance (1mΩ!) between the battery charger and the battery, with the ability to cut off power if certain parameters are not met.

Transistors Q1 & Q2 are connected as inverting buffers to drive an external relay and they are controlled by pin 6 of the microcontroller. Q2 is a B337A NPN transistor rated at 80V and 800mA. Note that if you are driving the relay from more than 12V you will need a dropping resistor. The optional relay can switch off the load if an over-current or under-voltage condition occurs. We will say more on this later.

A 2N7000 FET, Q3, is used to drive a piezo buzzer to give audible feedback on key presses and other system events.

The backlight of the LCD is controlled by a pulse width modulation (PWM) output of the micro via a second 2N7000 FET, Q4, to vary the brightness. It is dimmed up and down as required by the firmware.

USB interface

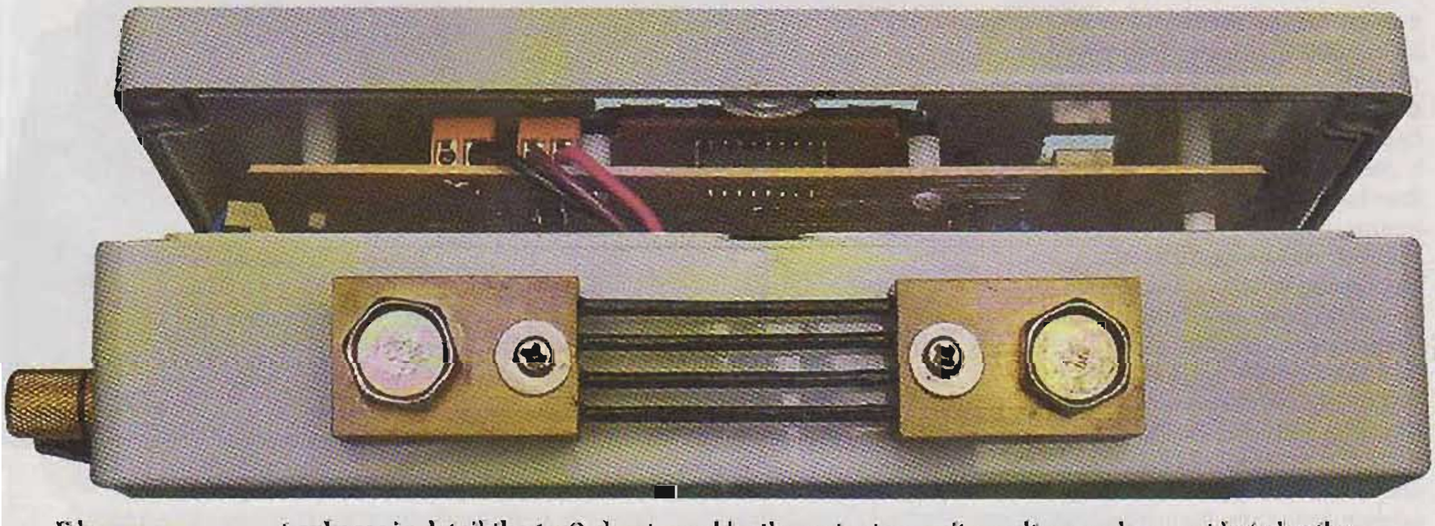
The USB data lines are connected straight through to the type B connector.

When connected to a USB port on a computer, the USB power connection passes through a voltage divider consisting of the 1kΩ and 110kΩ resistors into pin 18 of IC1. This is used to sense when a USB cable is attached or disconnected.

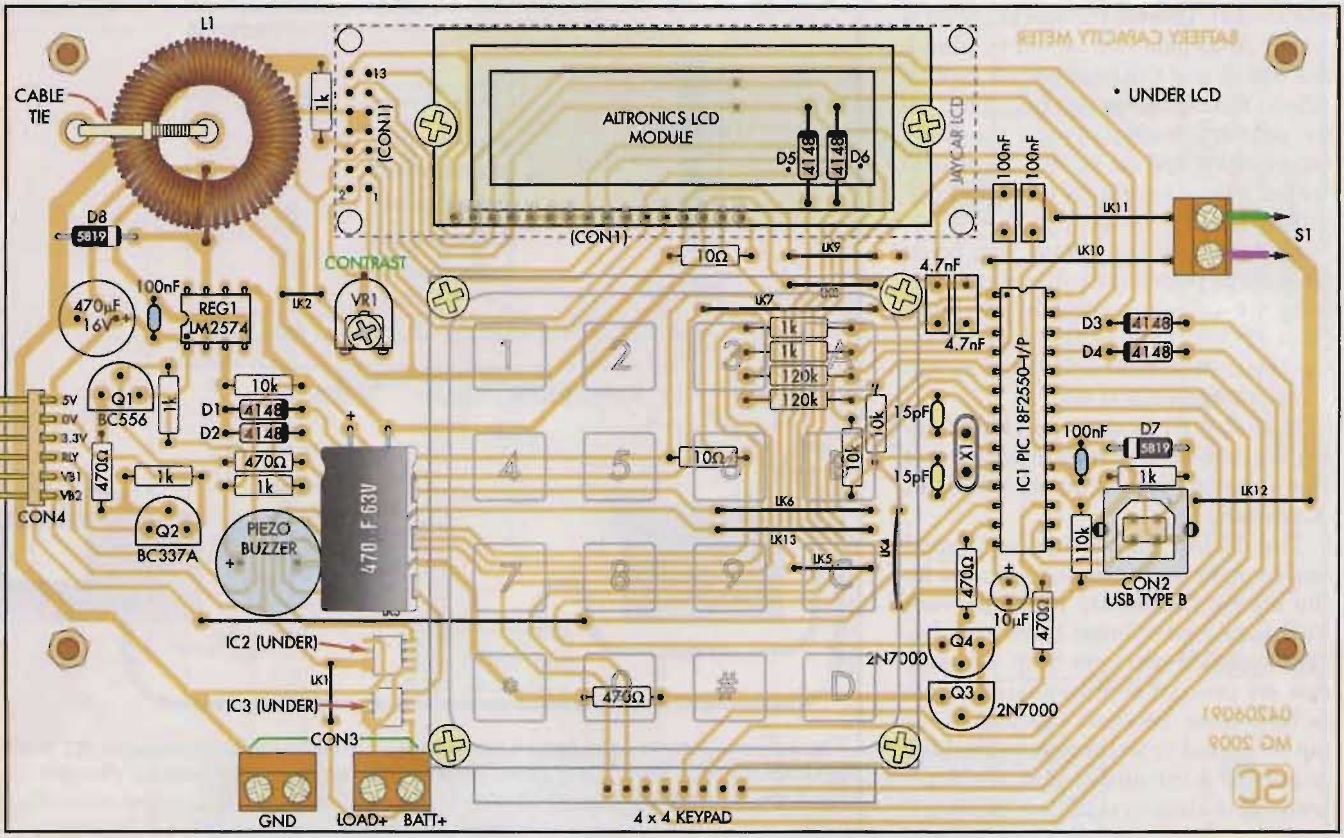
The Schottky diode (D7) also allows the circuit to be powered directly from the USB port.

Shunt resistor

The charge and discharge currents to the battery (or battery bank) are monitored by a one milliohm (1mΩ)



Edge-on, you can not only see in detail the 1mΩ shunt, used by the meter to monitor voltage and current but also the method of mounting the PC board to the underside of the case lid.



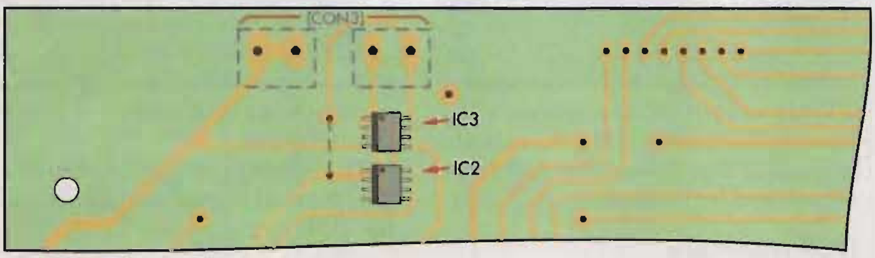


Fig.3: the component overlay for the meter– everything except S1 is on board, including the two SMD ICs on the reverse side (shown at left).

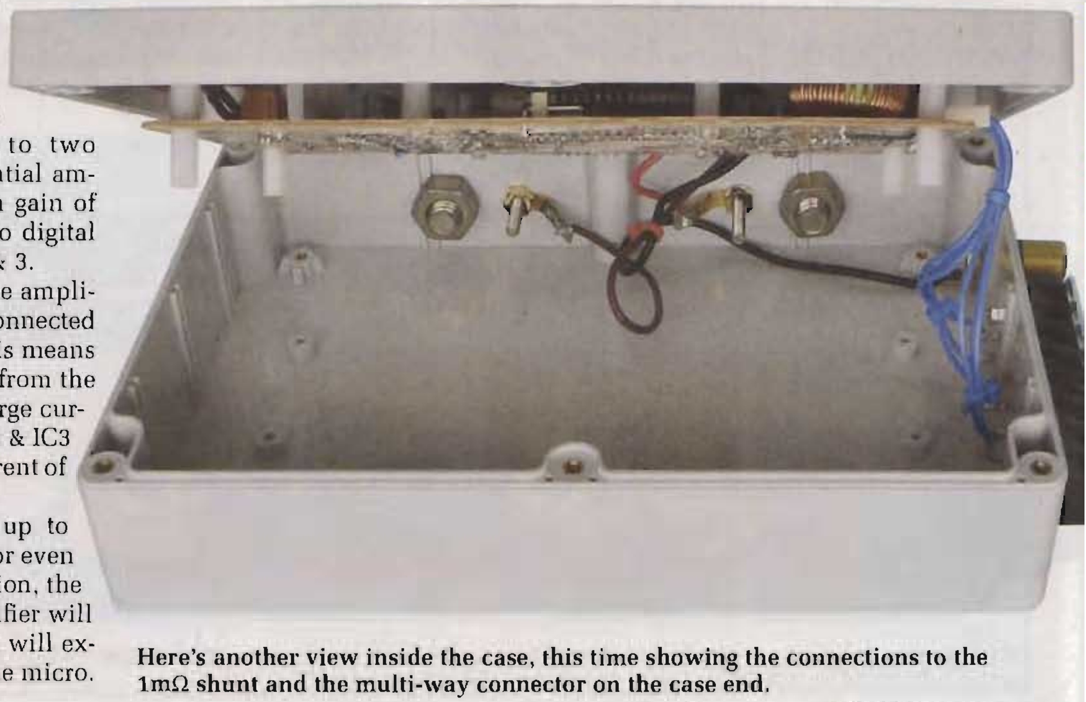
For this reason we have included a low-pass filter consisting of a 1kΩ resistor and 4.7nF capacitor in the output of each amplifier. The 1kΩ resistors will protect the internal pro-

100A shunt resistor in series with the positive lead to the battery (see the diagram of Fig.2).

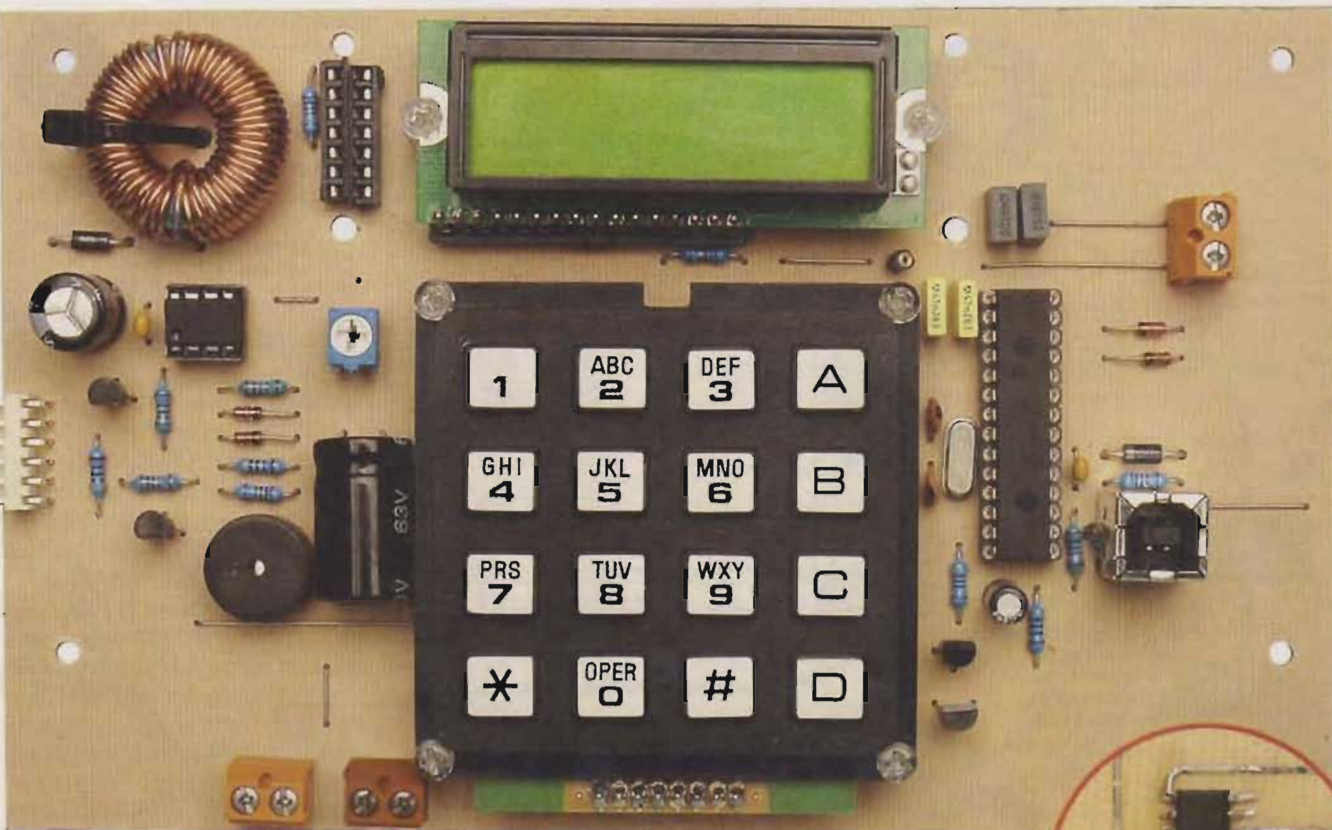
The voltage developed across the shunt is fed to two MAX4080 high-side differential amplifiers which both a have a gain of 60. These feed two analog to digital inputs on the micro, pins 2 & 3.

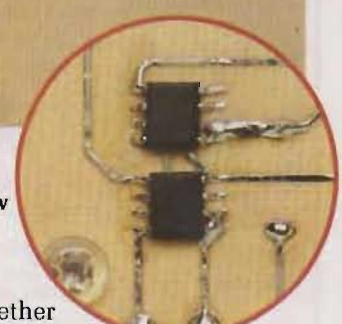
Note that the two high-side amplifiers have their inputs cross-connected across the shunt resistor. This means that IC2 senses load current from the battery while IC3 senses charge current. The outputs of both IC2 & IC3 range from 0V to 5V, for a current of 83A through the 1mΩ shunt.

For higher currents, say up to the 100A rating of the shunt or even higher in an overload condition, the output of the high-side amplifier will go proportionally higher and will exceed the 5V input limit for the micro.



Here's another view inside the case, this time showing the connections to the 1mΩ shunt and the multi-way connector on the case end.



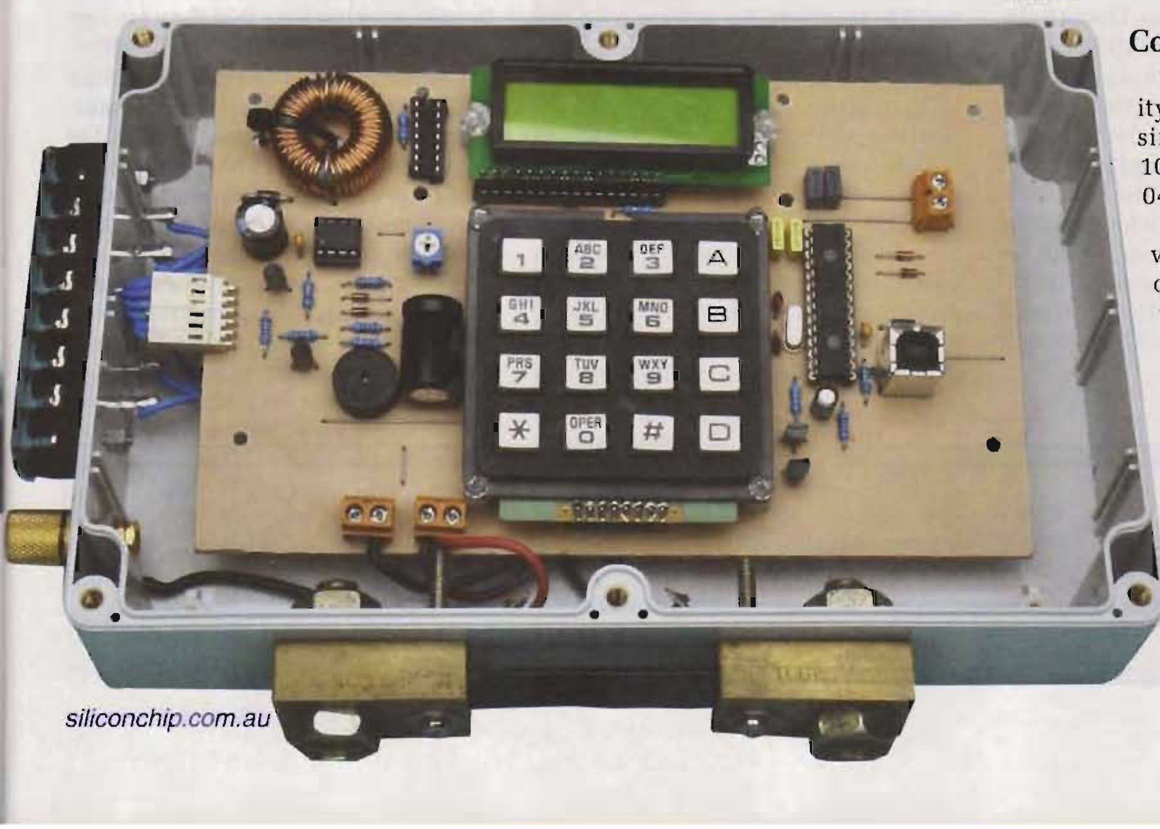


This photograph of the completed PC board is the same size as Fig.3 opposite, while the two SMDs on the underside are inset at right. Obviously there are several resistors and links underneath the keypad which must be soldered in before the keypad is fitted. The photo below shows the completed meter PC board sitting inside the plastic case – it roughly occupies this position but is held in place by four Nylon screws through the lid into Nylon spacers.

tection diodes of the micro.

A 20MHz quartz crystal (X1) is used to derive the system clock for the microcontroller as well as the USB clock using an internal PLL stage. The two ceramic 15pF capacitors provide the correct loading for the crystal.

Finally, a 10Ω resistor is used to sense the current drawn by the circuit itself. Two voltage dividers, 120kΩ and 10kΩ together with 100nF filter capacitors are connected to pins 4 & 5 of IC1 and read the battery voltage and the current drawn by the circuit.



Construction

The Battery Capacity Meter is built on a single-sided, 177mm x 109mm PC board coded 04206091.

Begin by installing the wire links. There are 13 of these and they are of varying lengths. In each case, you use tinned copper wire bent to the correct length using pliers. You can straighten the wire by pulling it using a vyse and pliers.

Once the links are in, continue with the resistors. These are of different values and you should check

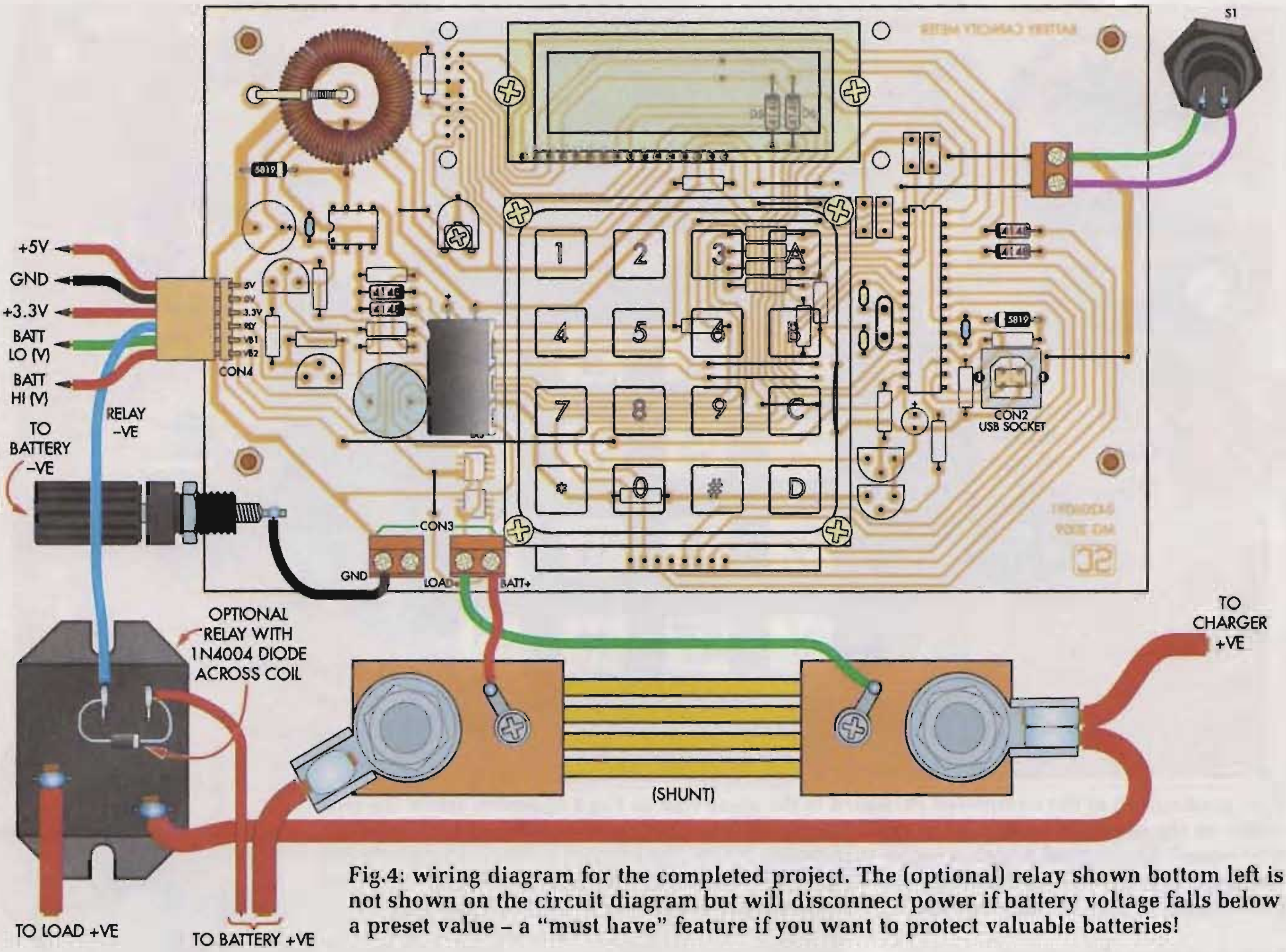


Fig.4: wiring diagram for the completed project. The (optional) relay shown bottom left is not shown on the circuit diagram but will disconnect power if battery voltage falls below a preset value – a "must have" feature if you want to protect valuable batteries!

them with a DMM before soldering or refer to the resistor colour code table – or both!

The next thing to do is to solder in the eight diodes. These are of two different types – there are six 1N4148 signal diodes and two 1N5819 Schottky types. The part numbers are marked on the body. Make sure that they are installed with the correct orientation by referring to the component overlay of Fig.3 (a stripe indicates the cathode).

You have two options when it comes to the LCD module. You can use the Altronics Z-7013 or the Jaycar QP-5515. We recommend using the Altronics LCD because it has a backlight which can be turned off.

None of the Jaycar backlit modules allow you to turn off the backlight so the Jaycar unit we have specified does not have a backlight.

Suitable LCD module connectors need to be made, by cutting a 40-pin IC socket to size. A single 16-pin connector is required for the Altronics LCD module, while the Jaycar LCD module needs two 7-pin connectors, which mount parallel to (and touching) each other.

While you're about it, you should also cut an 8-pin connector for the keypad to go into. Solder in both the appropriate LCD and keypad sockets.

Now that the sockets are soldered in, you can solder the corresponding pin strips to the keypad and the LCD module. These will plug in later. Refer to the photos for guidance.

The 8-pin socket for REG1 and the 28-pin socket for IC1 can be soldered in next, making sure that they are correctly oriented.

The next thing to do is to solder in the three 2-way terminal blocks. They should face outwards from the PC board to allow cable connection. The 6-way right-angled header (used for calibration) can also be installed now.

Solder in the two transistors and the two FETs. With their pins oriented in the triangular pattern, these can only go in one way.

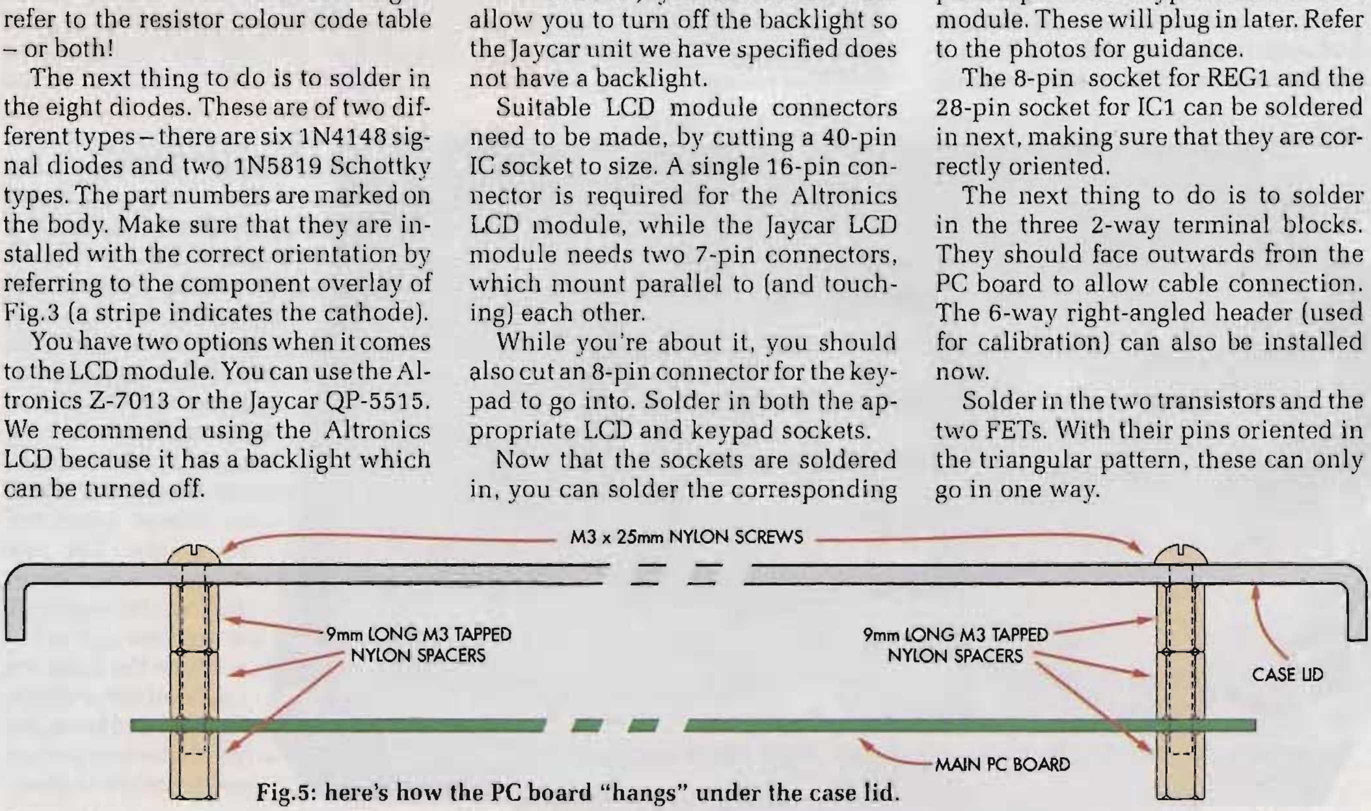


Fig.5: here's how the PC board "hangs" under the case lid.

Then solder in the capacitors, making sure the polarised electrolytics are correctly oriented.

The large 63V electrolytic mounts with its body parallel to the PC board surface, with its leads bent down 90° to allow lid clearance – see photo.

You can solder the crystal next, as well as the inductor. The inductor mounts horizontally and is secured to the PC board using a cable tie. Don't rely on the solder joins to hold it in place.

The variable resistor, which is used to set the contrast of the LCD screen, can go in next.

Continue by soldering in the type B USB socket and the piezo buzzer. Both must be oriented correctly.

The keypad plugs in to the 8 pin socket and is secured to the PC board using eight M3 Nylon 5mm screws and four 9mm M3 Nylon spacers. Because it is rather difficult to buy 5mm Nylon screws, you'll probably need to do what we did: cut them down from 12mm types. The four mounting holes on the keypad may need to be enlarged to fit the screws, using either a drill or a tapered reamer.

Once that is done, you can install the LCD module. The Altronics module is secured using four Nylon 12mm M3 screws and two 9mm M3 Nylon spacers. The Jaycar module uses four mounting screws and spacers instead.

You should now insert REG1 into its socket but leave IC1 (the microcontroller) out for the moment.

Surface mount devices

Now flip the PC board to the copper side. The two differential amplifiers (IC2 and IC3) are soldered directly to the copper side of the PC board. They are surface-mount devices so you will need a fine tipped soldering iron and some solder wick (for removing any solder bridges).

In each case, you should orient the IC over its pads – refer to the component overlay and photos to determine the correct orientation – then one-at-a-time, secure each IC with a clothes peg and solder pins 1 and 2 first to anchor the IC. Remove the peg, then proceed to solder pin 5 followed by the rest of the pins – refer to photo. Repeat for the other IC.

With the exception of installing IC1, that completes the construction of the PC board.

Parts List – Battery Capacity Meter

1 PC board, code 04206091, 177 x 109mm
1 Sealed polycarbonate case, 222 x 146 x 55mm (Jaycar HB-6220)
1 LCD 16 x 2 module (Altronics Z-7013 (preferred), Jaycar QP-5515)
1 220μH inductor (Jaycar LF-1276, Altronics L-6625)
1 20MHz crystal (Jaycar RQ-5299)
1 mini PCB piezo buzzer, 7.6mm pin spacing (Jaycar AB-3459, Altronics S-6104)
1 1mΩ 100A Current Shunt (Jaycar QP-5414)
1 40-pin IC socket (to be cut for IC1 and LCD mounting)
1 28-pin IC socket (0.3mm)
1 8-pin IC socket
3 2-way mini PCB terminal blocks – 5mm spacing (Jaycar HM-3173, Altronics P-2032A)
1 0.1" 6-way right-angled header pin (Jaycar HM-3426, Altronics P-5516)
1 0.1" 6-way header plug (Jaycar HM-3406, Altronics P-5476)
1 16-key alphanumeric keypad (Jaycar SP-0772, Altronics S-5383)
1 dome pushbutton switch or equiv. (Jaycar SP-0656, Altronics S-1084) (S1)
1 6 way terminal barrier, panel mount (Jaycar HM-3168, Altronics P-2206)
1 USB Type B vertical socket (Farnell 1076666)
4 Nylon screws M3 25mm
12 Nylon screws M3 12mm
14 tapped Nylon spacers 3mm x 9mm (Jaycar HP-0926, Altronics H-1333)
2 M3 12mm screws with washers and nuts (for terminal barrier mounting)
5 cable ties (1 for L1, remainder for cable dressing)
1 gold-plated metal body banana socket [black ring] – for GND terminal (Jaycar PT-0431)
1 1m length tinned copper wire (for the links)
1 10cm length 24x 0.2mm insulated hookup wire (for PC board connection)
1 1m length of hookup wire or 200mm rainbow cable (for connecting CON4)
Heavy-duty cable to suit charger current with suitable eyelets for shunt

Semiconductors
1 PIC18F2550-I/SP microcontroller programmed with 0420609A.hex (IC1) (Farnell: 9321250)
1 LM2574HVN-5.0 5V voltage regulator (REG1) (Farnell 9489916)
2 MAX4080-SASA+ high side current sense amplifiers (IC2, IC3) (Farnell 1379747)
1 BC556 PNP transistor (Q1)
1 BC337A NPN transistor (Q2)
2 2N7000 FETs (Q3, Q4)
6 1N4148 diodes (D1-D6)
2 1N5819 Schottky diodes -(D7, D8)

Capacitors
1 470μF 16V electrolytic
1 470μF 63V electrolytic
1 10μF 16V electrolytic
2 100nF monolithic
2 100nF MKT
2 4.7nF MKT
2 15pF ceramic

Resistors (0.25W, 1%)
2 120kΩ 1 110kΩ 3 10kΩ 6 1kΩ 5 470Ω 2 10Ω
1 5kΩ trimpot (VR1)

Optional Parts for external relay
1 horn relay 150A 12VDC SPDT (Jaycar SY-4073)
1 1N4004 diode
1 gold-plated metal body banana socket [red stripe] – for load terminal (Jaycar PT-0430)

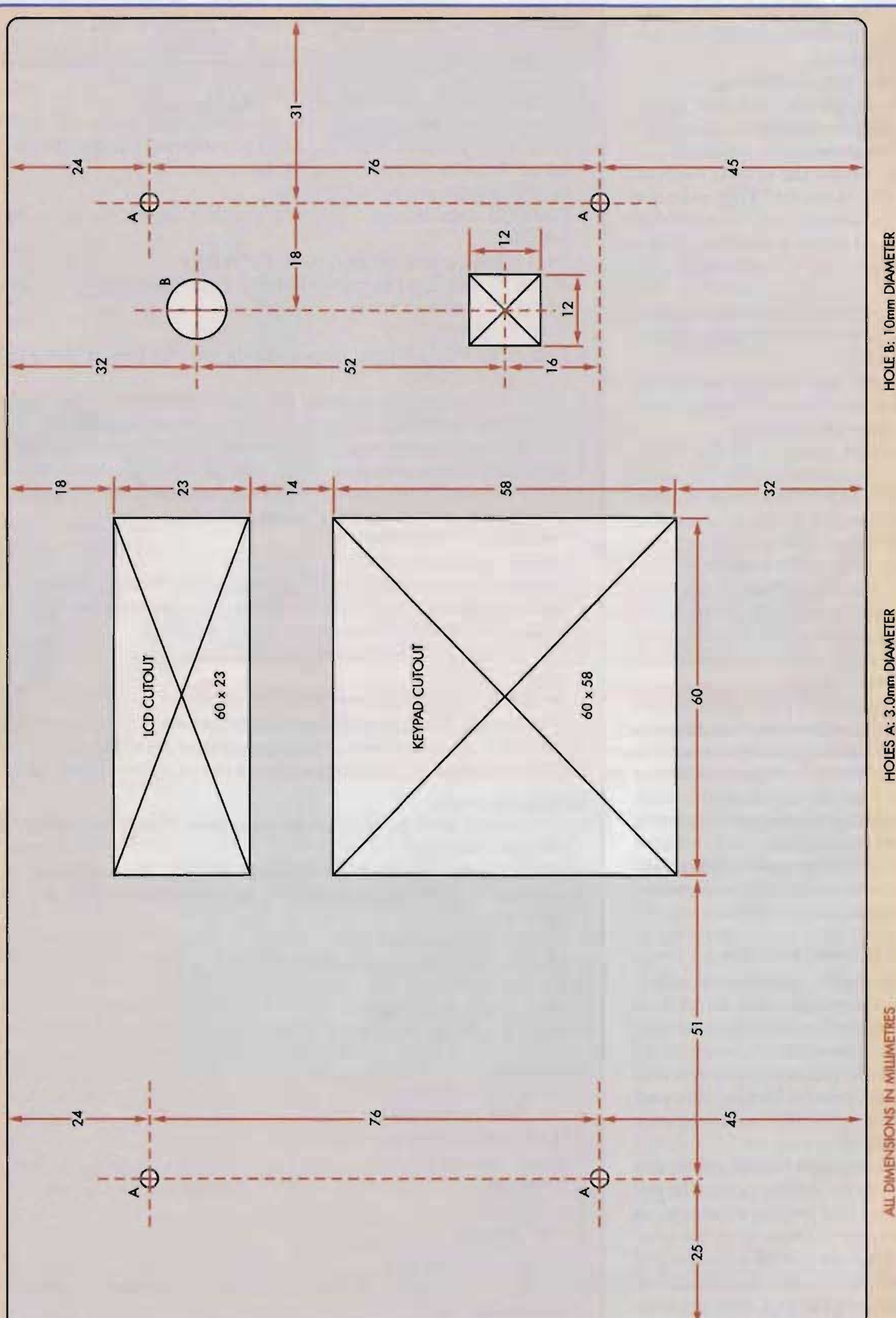


Fig.6: drilling/cutting detail for the case lid, to which attaches the PC board. The cutout dimensions for the LCD readout suit the recommended Altronics module. If you use the alternate Jaycar module, the cutout will need to be amended to suit. Use the PC board overlay as a guide, as it has the Jaycar module position indicated and is also accurately located by the four mounting screws. Incidentally, the front panel artwork can be downloaded from www.siliconchip.com.au, along with the PC board pattern.

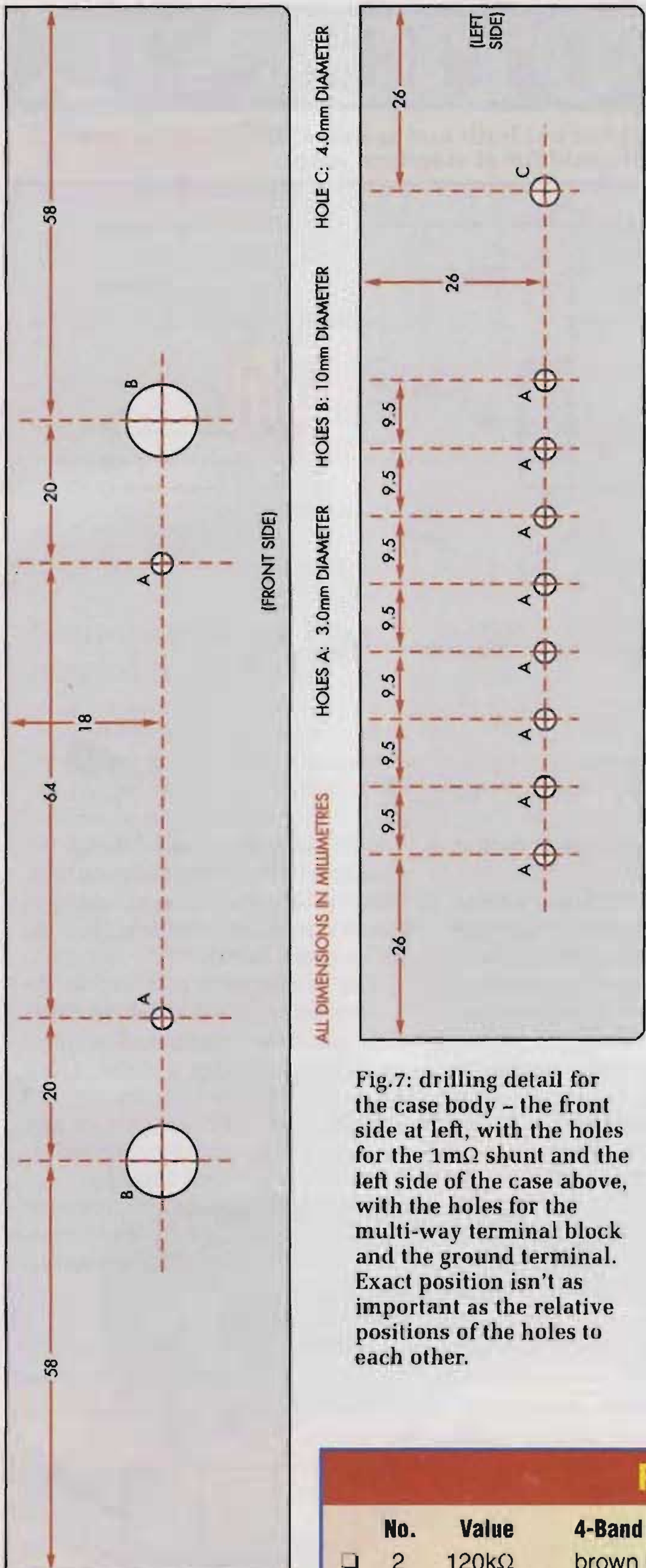


Fig.7: drilling detail for the case body – the front side at left, with the holes for the 1mΩ shunt and the left side of the case above, with the holes for the multi-way terminal block and the ground terminal. Exact position isn't as important as the relative positions of the holes to each other.

Before installing the PC board in the case, you should connect a 9-60V battery to CON3 (to the "BATT+" and "GND" terminals with correct polarity). Hold S1 down and check the +5V rail (pin 1 of REG1) is close to 5V. If it is, you can disconnect power and install IC1 in its socket. If it is not, there is something wrong and you should disconnect power immediately and recheck your soldering and component placement.

Installing in the case

You can see how the PC board is installed in its case by referring to the photographs. It is actually mounted in the lid, with three connectors that mate with terminals (or the current shunt) installed on the sides of the case.

In the top right hand corner of the PC board there is a 2-way terminal block that connects to S1 mounted on the lid of the case.

The pair of 2-way terminal blocks on the bottom left corner of the PC board accept power and connect to the current shunt (note that one of the GND connections is not used), as shown in Fig.4. Finally, the 6-way right angled header forming CON4 is for calibration and connects to the panel mount 6-way terminal barrier on the left side of the case, as shown in the photograph. The connecting cable can be made from a 20cm length of rainbow cable or similar lengths of individual hookup wire.

The external GND connection, a gold-plated, metal-body banana socket with black polarity ring, is on the left side of the case. Exact position is unimportant.

Follow the drilling guide in Fig.6 to make the required holes on the left and bottom sides of the case.

The current shunt mounts on the bottom side of the case and the holes shown are appropriate for the specified 1mΩ current shunt (Jaycar QP-5414). If you use another current shunt, you may need to modify the hole positions.

The two terminals of the current shunt then connect to the right-hand 2-way terminal block in the bottom left corner of the PC board (CON3). Make sure you connect them the right way around as shown in Fig.4. If you don't, you will get strange readings for the load and charge currents.

Important Note: you should use a 10cm length of 24 x 0.2mm multi-strand hookup wire to connect the BATT+ terminal to the shunt. The software takes into account the resistance of this 10cm length.

Once the PC board is installed in the case you can screw on the lid.

That completes construction of the Smart Battery Capacity Meter.

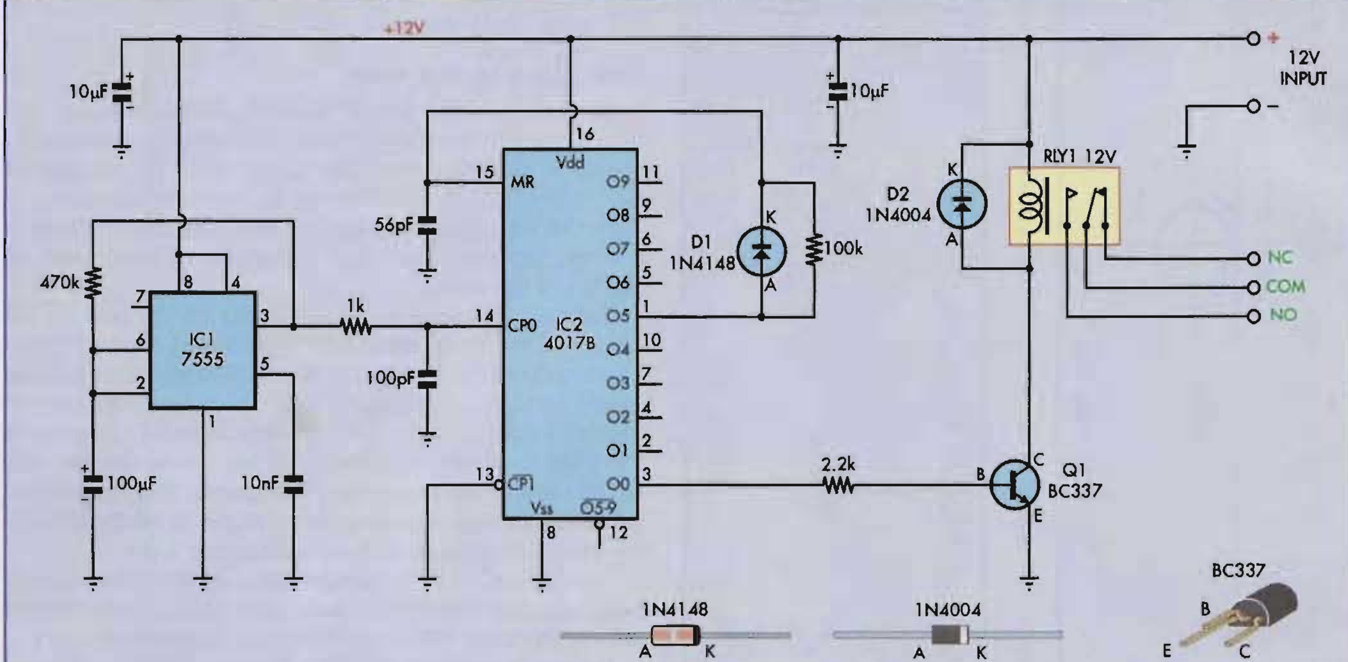
Next month we'll run through the rather extensive setup and calibration procedure. But don't let that scare you – it only has to be done once! SC

Resistor Colour Codes

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	120kΩ	brown red orange brown	brown red black red brown
❑	1	110kΩ	brown brown orange brown	brown brown black red brown
❑	3	10kΩ	brown black orange brown	brown black black red brown
❑	7	1kΩ	brown black red brown	brown black black brown brown
❑	5	470Ω	yellow violet brown brown	yellow violet black black brown
❑	2	10Ω	brown black black brown	brown black black gold brown

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



One-in-five timer

This timer circuit provides an output cycle which is on for one minute and off for five-minutes.

The 7555 timer (IC1) produces a positive pulse about once every 60s to clock a 4017 divider (IC2). The '0' output of IC2 is high for 60 seconds and drives Q1 and the relay during this period. On the next clock signal from IC1, the '1' output goes high and the '0' output goes low and the relay is off.

The '2', '3' and '4' outputs successively go high after each clock pulse from IC1. On the sixth pulse, the '5' output goes high, resetting the 4017 counter and the '0' output goes high again.

IC1 is connected as an astable oscillator with the 100µF capacitor charged and discharged via a 470kΩ resistor. The threshold and trigger inputs at pin 6 and 2 monitor the capacitor voltage.

When the capacitor charges to 2/3rds the supply, the pin 3 output goes low to discharge the capacitor. When the capacitor discharges to 1/3rd the supply, the pin 3 output goes high to charge the capacitor. So the pin 3 output goes high (12V) and low (0V) repeatedly as it charges and discharges the capacitor.

The pin 3 output of IC1 clocks the 4017 divider via a 1kΩ resistor and 100pF capacitor to slow down the rise time of the 7555 timer output. This prevents multiple clocking of the 4017 counter at the positive edge of the clock signal.

The '5' output from IC2 connects to the reset input via a 1N4148 diode (D1) and 10kΩ resistor. The 56pF capacitor provides a reset delay while this capacitor charges up via a high output from the '5' output. The resulting high signal on the reset input of IC2 causes the '5' output to go low again. The reset signal remains high until the capacitor discharges via the 10kΩ resistor. This ensures a sufficient reset pulse for IC2.

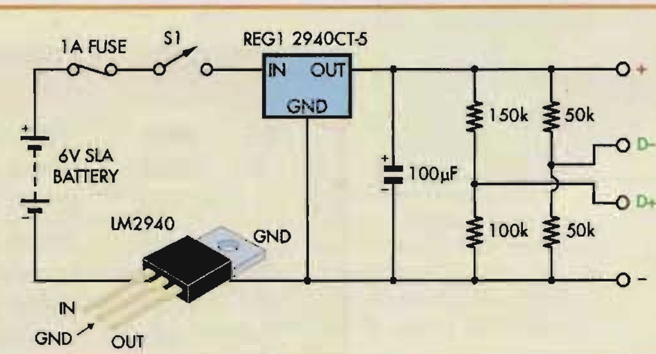
John Clarke,
SILICON CHIP.

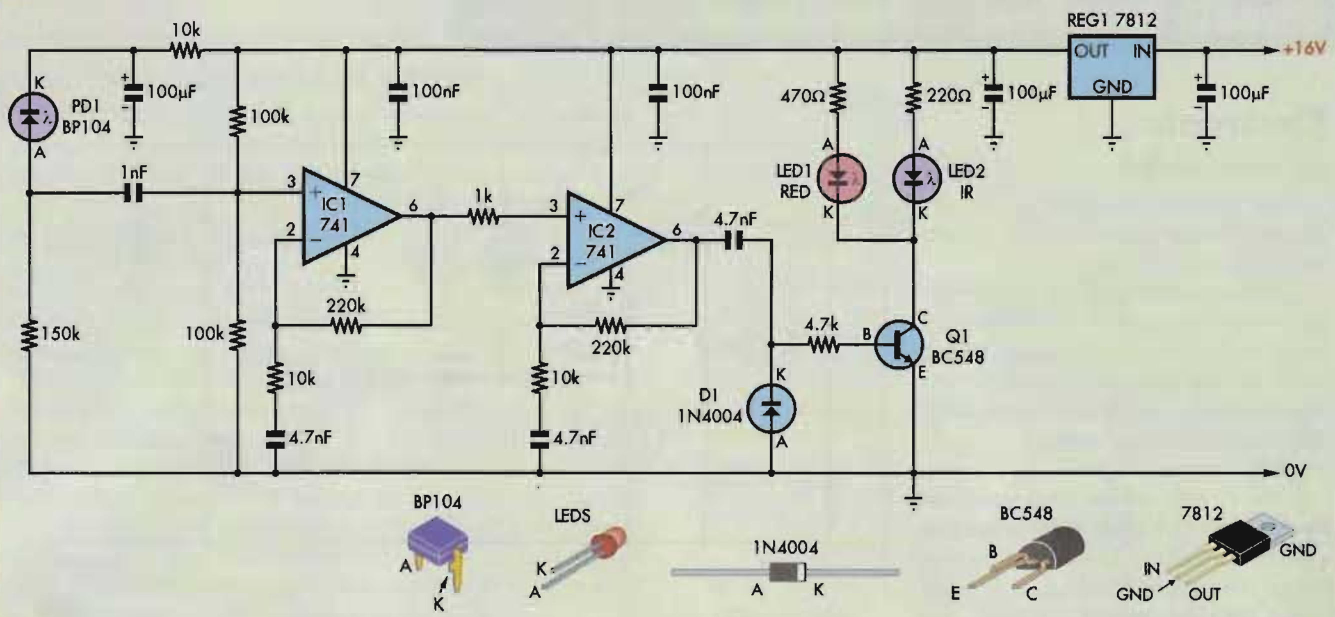
External USB supply for iPOD touch

This USB supply is capable of feeding an iPOD or other device which require the D+ and D- signals in order to accept a charge. It comprises a low dropout regulator (REG1) to provide the 5V supply and two resistive dividers to provide the D+ and D- lines.

It needs to be wired to a suitable USB socket.

Jeff Teasdale, Christchurch, NZ. ($30)





Remote control extender for Foxtel

This remote control extender was designed to work with the Foxtel IQ remote controller. Most other remote control extenders, including those published by SILICON CHIP, will not work with the Foxtel remote.

The circuit uses two 741 op amps, each with a gain of 23, giving a total gain of over 500. The 40kHz signal from the Foxtel remote is detected by the BP104 photodiode (Jaycar ZD-1947) and is applied to the non-inverting input of IC1 via a 1nF capacitor. The capacitor values in the circuit were chosen to limit the frequency response below 34kHz.

The output of the second op amp, IC2, has its negative excursion clamped by diode D1 and the positive peaks drive transistor Q1 which in turn drives IR LED2 and red LED1. The latter gives a visible indication that the circuit is receiving and transmitting a signal.

The IR LED is located near the IR receiver on the Foxtel IQ set-top unit and connected to this circuit via about 15 metres of light-duty figure-8 cable. The circuit is powered with a 12V plugpack which delivers about 16V DC.

The receiver is quite sensitive and will receive reliably at distances of over four metres. However, if the distance between the remote and the receiver is too close, the receiver overloads and becomes unreliable. If necessary, the receiver sensitivity can be reduced by decreasing the 220kΩ feedback resistors.

Jack Holliday,
Nathan, Qld. ($40)

Contribute And Choose Your Prize

As you can see, we pay good money for each of the "Circuit Notebook" items published in SILICON CHIP. But now there are four more reasons to send in your circuit idea.

Each month, the best contribution published will entitle the author to choose the prize: an LCR40 LCR meter, a DCA55 Semiconductor Component Analyser, an ESR60 Equivalent Series Resistance Analyser or an SCR100 Thyristor & Triac Analyser, with the compliments of Peak Electronic Design Ltd www.peakelec.co.uk

So now you have even more reasons to send that brilliant circuit in. Send it to SILICON CHIP and you could be a winner.

You can either email your idea to silchip@siliconchip.com.au or post it to PO Box 139, Collaroy, NSW 2097.

Richard van Wegen is this month's winner of a Peak Atlas Test Instrument

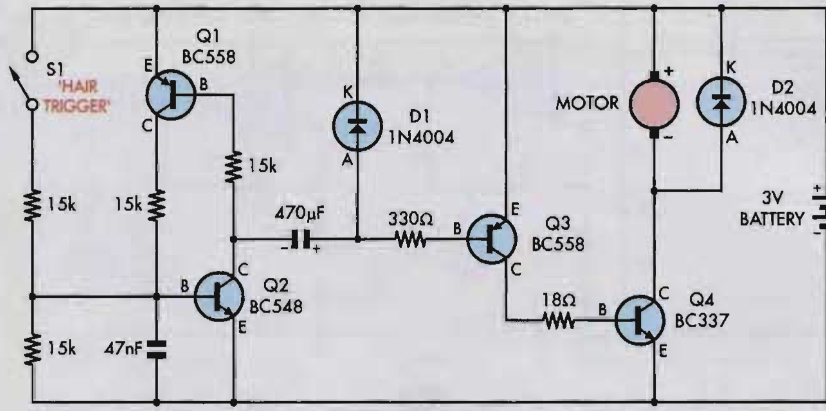
Electronic mousetrap

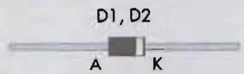
This circuit is added to an ordinary mouse trap to make it very sensitive.

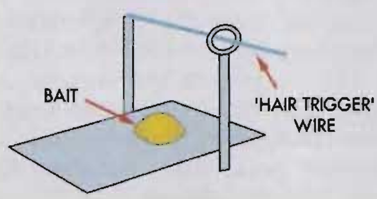
Ordinary spring-loaded mousetraps can often have the bait taken by mice without being sprung. Trying to make the trigger more sensitive often results in the trap being very difficult to set and making it quite risky to human fingers!

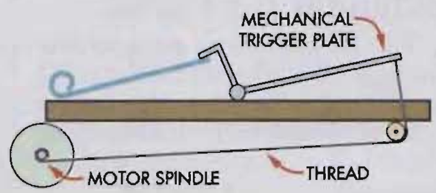
This circuit solves that problem by making the trap very sensitive and never failing to catch a mouse when it touches the bait. It is easy to set into the bargain. In brief, the trigger rod is replaced by a trigger plate which is actuated by a thread pulled by a small motor.

A hair-trigger wire above the bait is positioned so that the mouse cannot help touching it when it takes a nibble. The hair trigger is shown on the circuit as switch S1 and when it is closed, it pulls up the base of Q2 which then turns on Q1. In fact, they both then latch into full conduction and Q2 also pulls the negative side of the 470μF capacitor down which then charges via the base of transistor Q3, turning it on. This turns on Q4 which drives the motor.





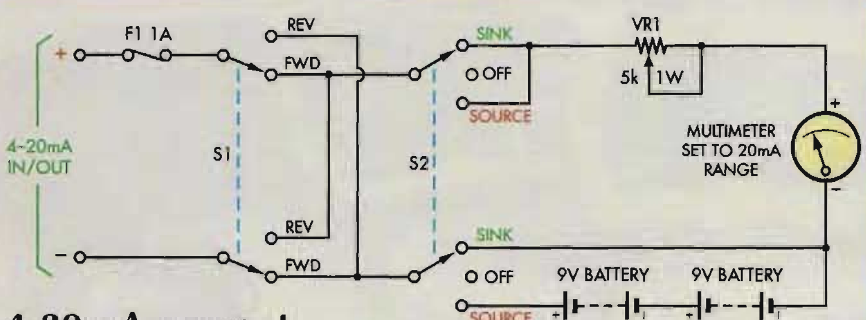




After five seconds or so, the 470μF capacitor is fully charged and base current for Q3 ceases to flow. Hence, Q3 & Q4 turn off and the motor stops. In the meantime, the mouse should be caught fast.

Diode D1 discharges the 470μF capacitor when the power is turned off. The circuit is powered from two AA cells.

Richard van Wegen,
Hawthorndene, SA.



4-20mA current loop tester

This very simple current loop tester consists of a couple of 9V batteries (connected in series), a potentiometer, a forward/reverse switch (S1) and a double-pole centre off switch (S2).

It is not meant for calibration purposes but can force a current through a loop to test an instrument and also monitor the loop current. It can also simulate a high loop resistance, depending on the setting of VR1.

The multimeter should be set to a suitable DC current range to monitor the current.

Peter Laughton,
Tabulam, NSW. ($35)

Tester for rotary encoders

Incremental rotary encoders are a common industrial device with a slotted disk and optical sensors. Most devices have internal PNP transistors and deliver about 2500 pulses per revolution from two channels. The two channel outputs are out of phase to enable rotation direction sensing. There is also a third Z channel which produces one short duration zero point pulse per turn.

This circuit allows testing of the encoders by making the pulse channels verifiable by the human eye. The 4017 ICs are used as dividers. Their carry outputs (pin 12) are cascaded and three LEDs provide indication that 5-10, 50-100 and 500-100 pulses have been counted.

Floating current source has wide supply voltage range

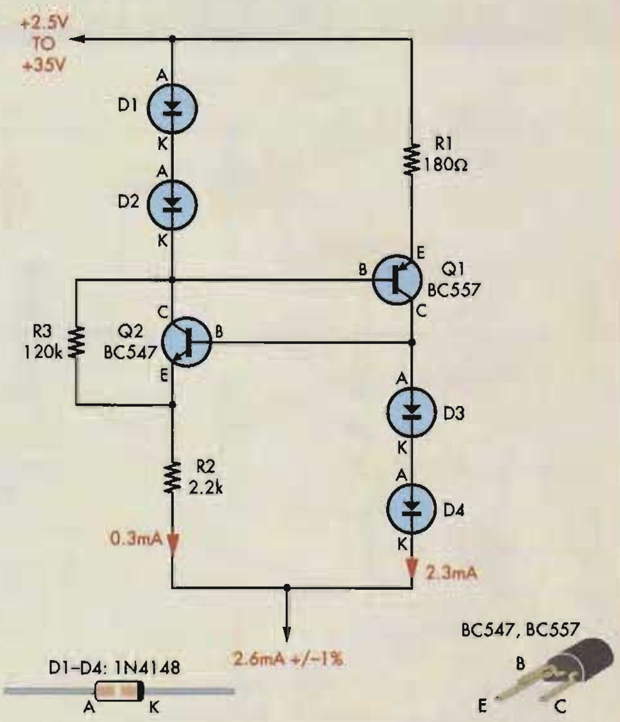
This floating current source regulates the current through itself to a close tolerance over a wide range of supply voltages. The minimum supply voltage is around 2.5V and the maximum supply voltage is limited only by the breakdown voltages of the components.

Transistor Q1, in conjunction with resistor R1 and diodes D1 & D2, forms a current source. The current through Q1 is limited to approximately $V_{BE}/R1$. Improved immunity to supply voltage variations is achieved by the use of a second current source, formed by transistor Q2 resistor R2 and diodes D3 & D4. This regulates the bias current of D1 and D2. In turn, the regulated current from the collector of Q1 biases D3 and D4.

Resistor R3 provides initial bias for Q1 to help the circuit start, since both transistors would otherwise be off at power-up. The exact value of R3 is not critical except that at the maximum supply voltage it must not conduct more than the current programmed by R2.

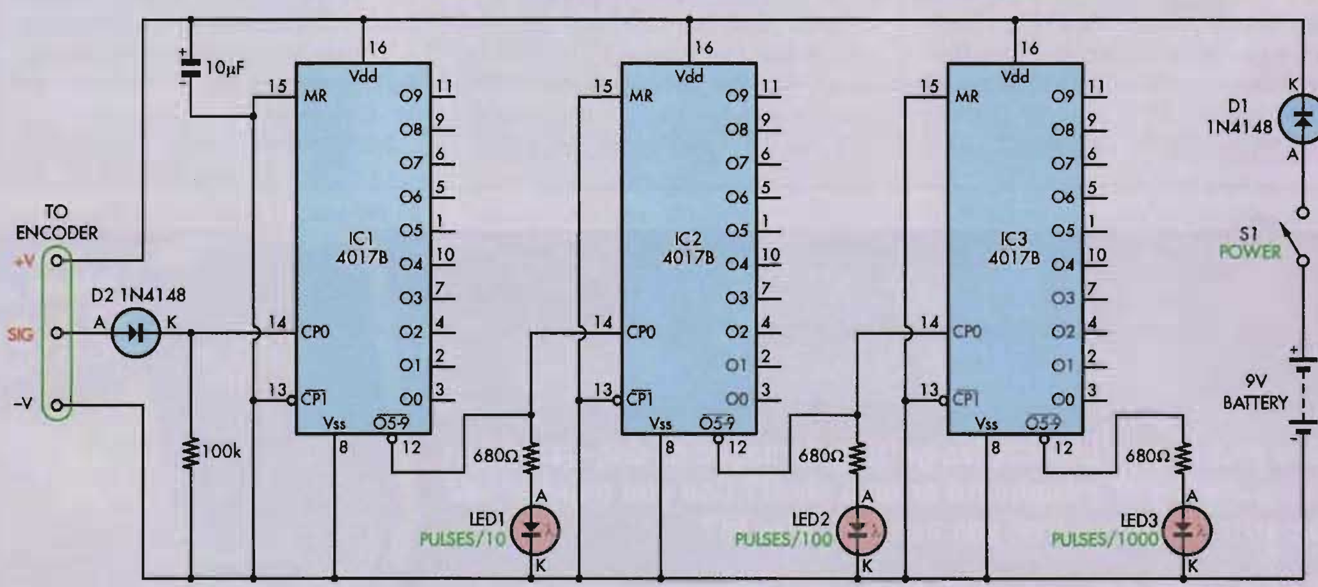
Because the bias currents in the circuit are regulated, it is possible to calculate the programmed current as a function of R1 and R2 to a reasonable degree of accuracy using the known characteristics of the diodes and transistors used. As a rule of thumh, however, the programmed current is $V_{BE}/R1 + V_{BE}/R2$.

The choice of bias currents for the diodes does not appreciably affect the degree of regulation. This allows the designer to select values for R1 and R2 that split the current between the left and right sides of the circuit in a proportion that enables the most economical choice of components.



With the component values shown, the programmed current is 3.6mA, regulated to within 1% for supply voltage variations between 2.5V and 35V. This is split, with R1, Q1, D3 and D4 passing 3.3mA while D1, D2, Q2, R3 and R2 pass the remaining 0.3mA.

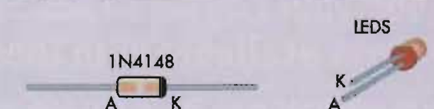
Andrew Partridge,
Toowoomba East, Qld. ($40)

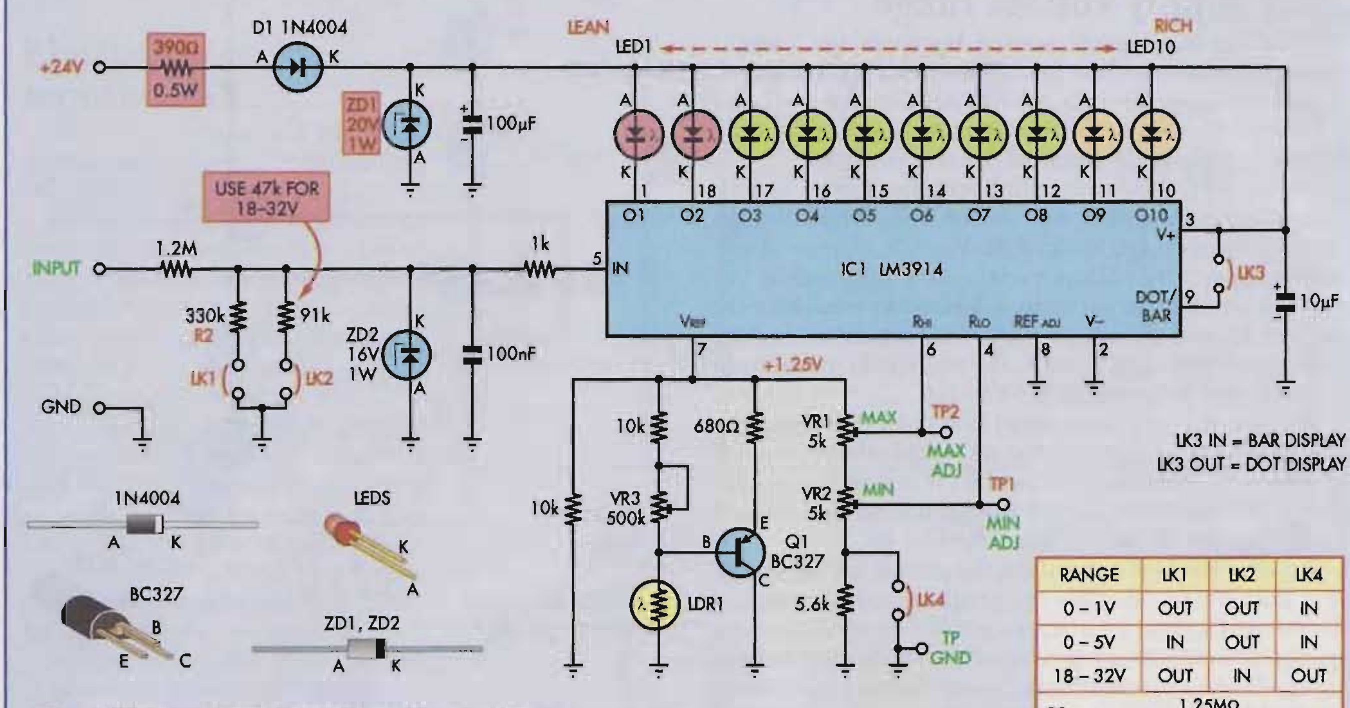


This will prove that the encoder is producing the correct pulses.

LED1 (5-10 pulse) is especially useful for counting the Z pulse which can be hard to view on a scope because of its short duration.

Jeff Teasdale,
Christchurch, NZ. ($40)





RANGE	LK1	LK2	LK4
0 – 1V	OUT	OUT	IN
0 – 5V	IN	OUT	IN
18 – 32V	OUT	IN	OUT

$R2 \approx \frac{1.25M\Omega}{\text{Input voltage range (max)} - 1.25V}$

SC ©2009 **AUTOMOTIVE VOLTAGE MONITOR** (MODIFIED FOR 24V SYSTEMS)

Modified vehicle voltage monitor

The popular Vehicle Voltage Monitor project featured in the May 2006 issue can display voltages over three ranges, specifically 0-1V, 0-5V and 9-16V. It can be used to monitor an oxygen sensor (0-1V), other vehicles sensors such as airflow and MAP sensors (0-5V) or monitor the vehicle's battery voltage (9-16V). However, it was not designed to work in vehicles with 24V batteries.

The LM3914 has a maximum rating of 25V and since most lead-acid batteries can rise to 29V or more when charging, some changes are required to limit the supply voltage.

To do this, the 22Ω ohm resistor supplying the original 16V zener diode for the supply to the LED anodes and V+ for IC1 is changed to 390Ω 0.5W and zener diode ZD1 is changed to a 20V 1W type. This limits the voltage to IC1 to 20V.

The input divider is changed so that when link LK2 is in place, the division shows a nominal full range on the LED display when there is 33V at the input. For this change, the 91kΩ resistor is changed to 47kΩ.

These changes now mean that the voltage ranges are 0-1V, 0-5V and 18-32V, as set out in the table.

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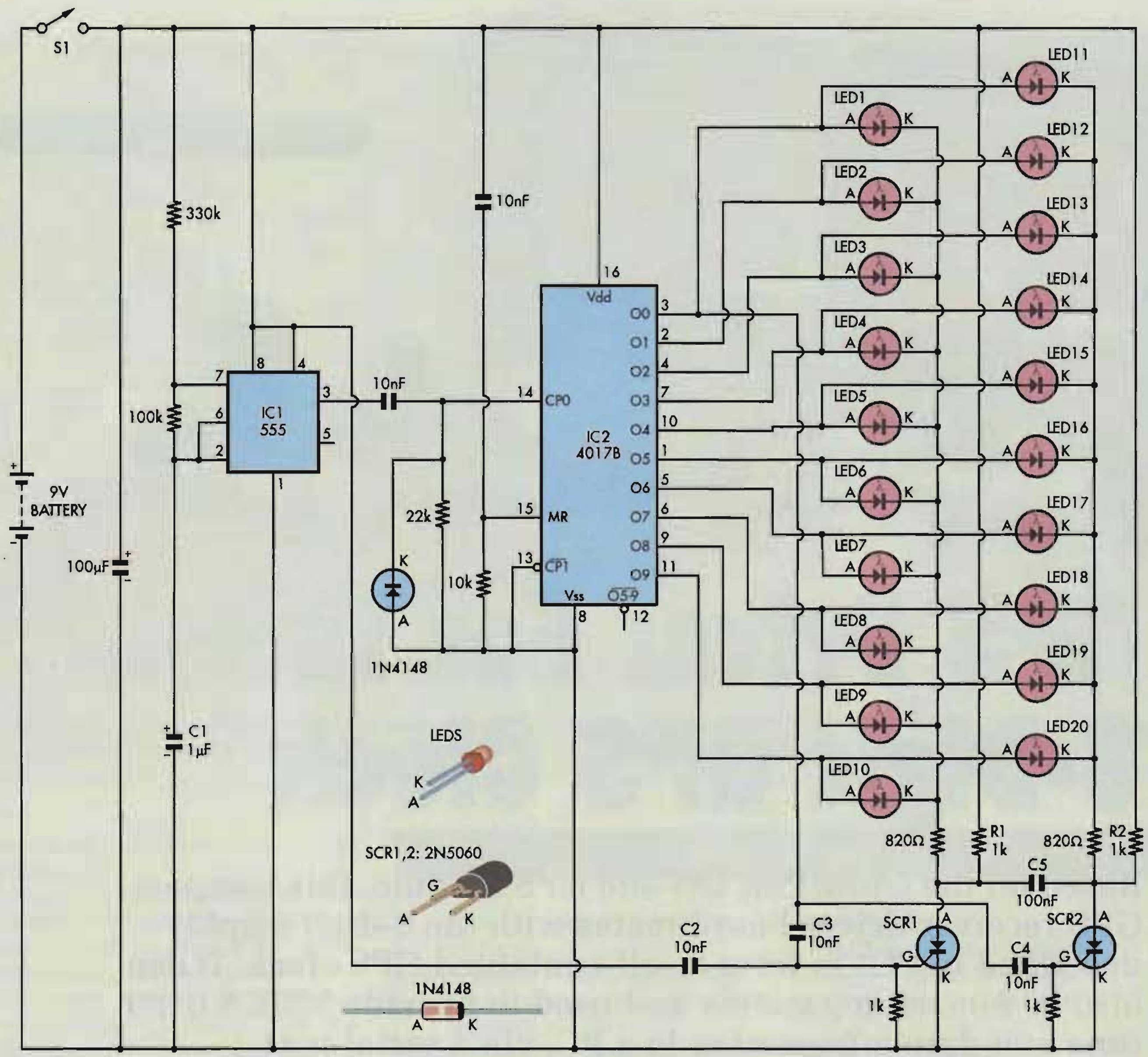


20-LED chaser uses SCR flipflop

Just when you thought there could not possibly be another variation of a 4017 LED chaser, here is another but with the addition of a quirky flipflop using two SCRs. Each SCR controls a string of 10 LEDs.

Most of the circuit is a standard 4017 chaser. IC1 is a 555 timer connected in astable mode and its output frequency is set by capacitor C1 and the 330kΩ and 100kΩ resistors. IC1 clocks the 4017 (IC2) at its pin 14 input. Each of the 10 4017 outputs is connected to the anodes of two LEDs as shown but their cathodes are connected to one of the two SCRs.

When power is applied to the circuit, the gate of SCR1 is pulled high via 10nF capacitor C3 and it switches on so that LED1 can light (also turned on by pin 3 of IC2). The 4017 then runs through 10 clock pulses, successively lighting LEDs2-10. On the 11th clock pulse, pin 3 of IC2 goes high and pulls the gate of SCR2 high via 10nF capacitor C4. SCR2 now pulls the anode of SCR1 low via 100nF capacitor C5. This turns SCR1 off and now LEDs11-20 can successively turn on.

Note that when SCR2's gate was pulled high to turn it on, capacitor C3 also pulled the gate of SCR1 high but since it was already on, it could not change its state.

At the 21st clock pulse, pin 3 of IC2 will again go high and the gates of both SCRs will be pulled high via capacitors C4 & C4. This time, SCR1 turns on and pulls the anode of SCR2 low via capacitor C5, turning it off. LEDs1-10 then run through their sequence. This cycle continues, with SCR1 and SCR2 alternately robbing each other of anode current so that they are turned off, the same as in a flipflop. Resistors R1 & R2 are included to provide sufficient holding current for the SCRs.

The value of C1 can be reduced to speed up the cycling action as required. If you make the first 10 LEDs red and the second set green, and arrange them in one circle of alternating colours, you can have a colour-changing ring, if the clock speed is sufficiently fast.

If all the LEDs are same colour and arranged as two concentric rings, the rings will appear to pulse, if flashed sufficiently fast.

A. J . Lowe,
Bardon, Qld. ($55)

Pt.2 By JIM ROWE

GPS Driver For The 6-Digit GPS Clock

Based on the GlobalSat EM-408 GPS module, this compact GPS receiver/driver board mates with the 6-digit display described in Pt.1 to form a self-contained GPS clock. It can also be housed separately and used to provide NMEA 0183 time and date information to a PC, via a serial port.

THE 6-DIGIT GPS Clock Display described in last month's issue of SILICON CHIP was originally conceived as an attachment for the author's GPS-Based Frequency Reference (March-May 2007). The idea was that since the NMEA 0183 stream of GPS time, date and navigational data was available from the GPS receiver in the Frequency Reference, we'd provide a "smart" display unit to receive this data stream, extract the time information and display it in either its native UTC form or converted to local time.

However, before the design was published, we realised that it would also be of interest to many more people than those who had built the GPS-Based Frequency Reference. That's because it could be turned into a fully self-contained GPS Clock simply by building a GPS receiver and display driver module into the same enclosure. And by taking advantage of one of the low-cost GPS receiver modules currently available, this could be done surprisingly cheaply – with the complete clock costing less than $200. Not bad for a clock offering you very close to "atomic time" (and updated every second), wouldn't you say?

So that's the story behind the little GPS Clock Driver board described here. Its main application is to convert last month's 6-Digit Display into a self-contained GPS clock. Alternatively, it can be used to feed the GPS/NMEA 0183 data stream into a PC via a standard serial port. You can then use a freeware software program such as "GPS Clock" to process and display the data – see panel.

How it works

As mentioned above, the heart of the new driver board is the GlobalSat EM-408 "GPS Engine" module. This module was also used in Geoff Graham's GPS-Synchronised Analog Clock, described in the March 2009 issue.

The EM-408 is quite small, measuring just 36.4 x 35.4 x 8.3mm. Despite this, it includes a built-in microwave "patch" antenna and is very sensitive (-159dBm). This allows it to operate reliably indoors using just the patch antenna, without requiring an external antenna or cabling. The current drain is also surprisingly modest, at

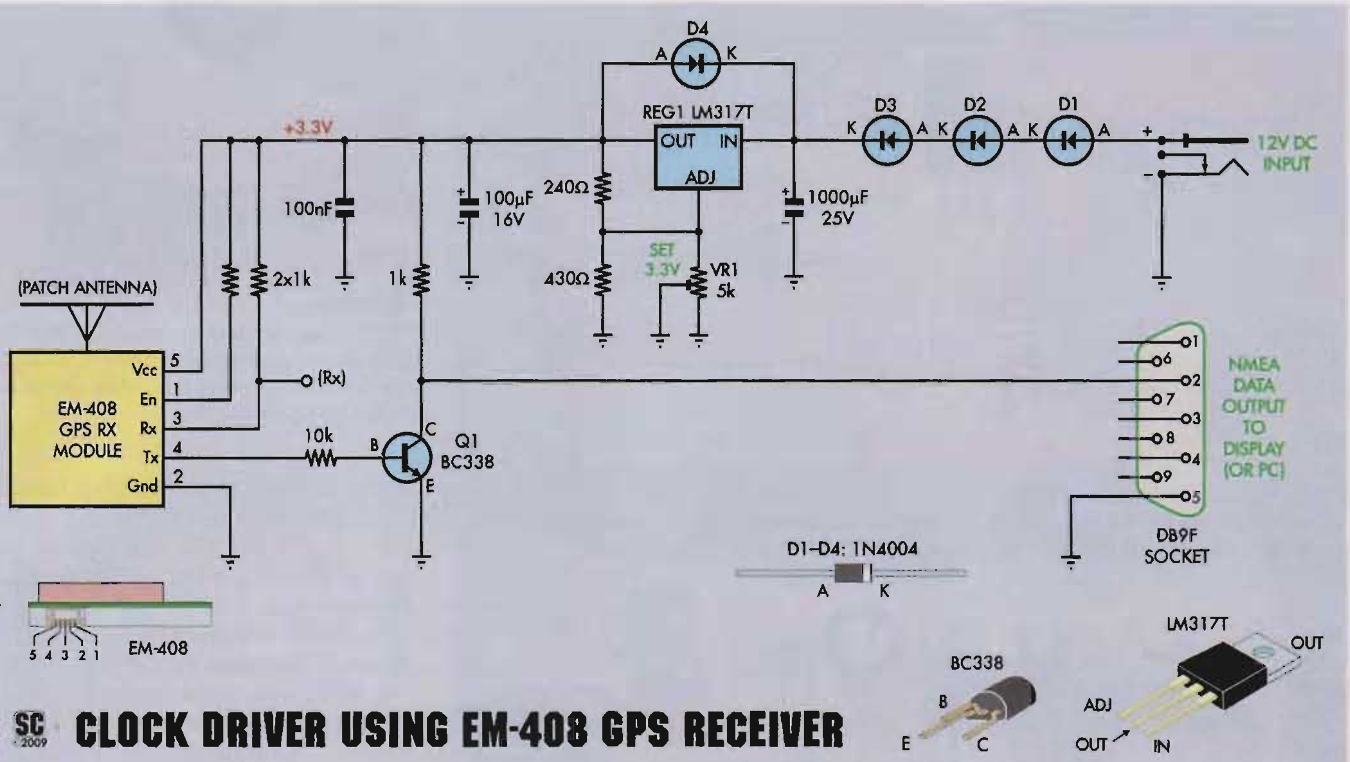


Fig.1: the circuit uses an EM-408 GPS receiver module and an adjustable LM317T regulator to provide a 3.3V supply. The output from the GPS module appears at pin 4 and is inverted by transistor Q1 to drive the display board.

just 44mA continuous from a 3.3V supply rail.

As a result, all we have to do to use it as a clock driver is to provide it with a source of 3.3V DC power plus a simple buffer stage to interface its NMEA 0183 data stream output to the serial data input of the clock display (or a PC). Fig.1 shows the circuit details.

In operation, the driver board operates from the same +12V DC supply used for the display board via its own 3.3V regulator circuit (REG1). REG1 is an LM317T adjustable regulator and is configured in standard fashion, with trimpot VR1 used to set the output voltage to 3.3V, as required by the EM-408. Diodes D1-D3 provide both supply polarity protection and an additional 1.8V voltage drop from the 12V source to reduce the power dissipation of REG1.

Diode D4 protects REG1 from reverse current damage.

As shown in Fig.1, the EM-408's Vcc input (pin 5) is connected to the +3.3V line, while the En input (pin 1) is pulled high via a 1kΩ resistor to the same line, to enable it. Also pulled up via a 1kΩ resistor is the Rx input (pin 3), which is provided on the EM-408 to allow it to be fed with NMEA setting-up commands in some applications.

We don't need to do this in the present project, because it comes set up to do what we want by default – ie, it supplies the NMEA data stream at 4800bps and also supplies the $GPRMC sentence we need to extract the time.

Parts List

- 1 PC board, code 07106091, 122 x 57mm
- 1 GlobalSat Technology EM-408 GPS Engine module with cable (Altronics K-1131)
- 1 short length of double-sided adhesive foam tape
- 1 PC-mount 2.5mm DC connector (optional – see text)
- 1 PC-mount DB9F connector (optional – see text)
- 1 M3 x 6mm long M3 pan-head screw
- 4 M3 x 30mm screws, countersink head
- 9 M3 nuts
- 1 5kΩ horizontal trimpot (VR1)

Semiconductors
- 1 LM317T adjustable regulator (REG1)
- 1 BC338 NPN transistor (Q1)
- 4 1N4004 diodes (D1-D4)

Capacitors
- 1 1000µF 16V RB electrolytic
- 1 100µF 16V RB electrolytic
- 1 100nF monolithic ceramic

Resistors (0.25W 1%)

1 10kΩ	1 430Ω
3 1kΩ	1 240Ω

Where To Get The EM-408

The EM-408 GPS Engine module is available in Australia from Altronics for $99.00 (Cat. K-1131).

Another source for the EM-408 is SparkFun Electronics of Boulder, Colorado, USA. Their website is at www.sparkfun.com and payment can be made using most popular credit cards. At the time of writing, they were offering the EM-408 GPS module for US$64.95 plus US$3.40 for handling and shipping to Sydney (check prices to other cities).

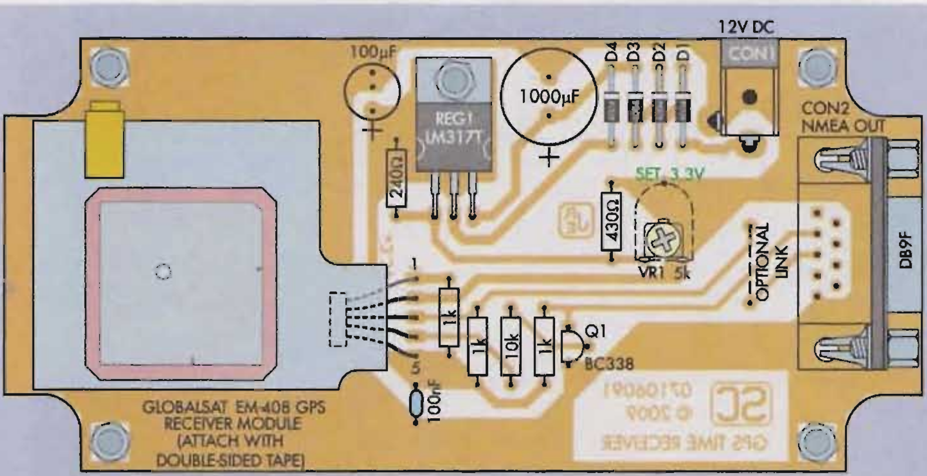
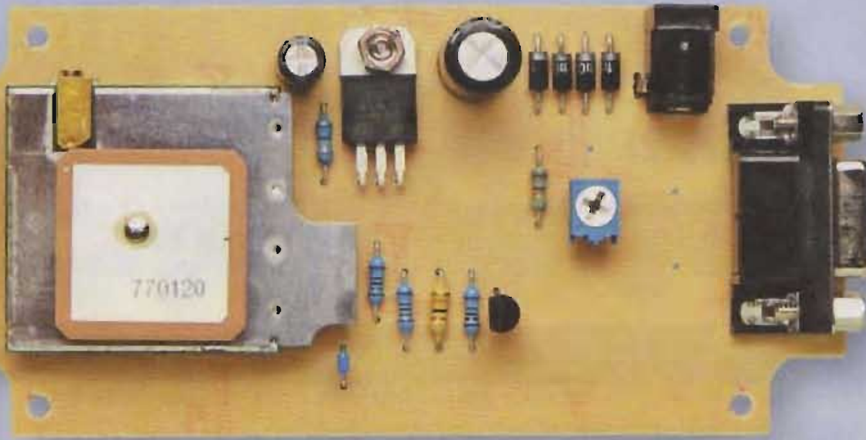


Fig.2: install the parts on the PC board as shown here. Note that CON1 (the DC socket) and CON2 (the DBF9 connector) are both left out if you intend installing this board in the same case as the display board (see Fig.3).



This view shows the completed assembly. The GlobalSat EM-408 GPS module is attached using double-sided adhesive foam tape.

The NMEA data stream emerges from the EM-408 at its Tx output (pin 4) and is then fed to a simple inverting buffer stage based on transistor Q1. The inverted signal appearing at Q1's collector is then fed to the serial input of the display board (or to the serial port of a PC), either directly or via a DB9F socket and serial cable.

Board assembly

The assembly is straightforward with all parts, including the EM-408 GPS module, installed on a small PC board coded 07106091 and measuring 122 x 57mm. This board has cut-outs in each corner so that it can be housed in a standard UB3-size (130 x 68 x 44mm) utility box, if you want to build it as a separate unit.

Fig.2 shows the assembly details. Note that there's provision to mount both a 2.5mm DC input socket (CON1) and a DB9F socket (CON2) on the board. However, these are fitted only if you intend building an external unit. Leave these parts out if the module is to be mounted in the clock case (it's

This close-up view shows how the EM-408 is connected to the PC board via the 5-way interface cable supplied with the module – see text.

wired directly to the display board). The optional link shown just to the right of trimpot VR1 can also be left out, as it's not needed for this particular project.

Begin the assembly by installing the resistors, followed by trimpot VR1 and the 100nF monolithic capacitor. Table 1 shows the resistor colour codes but it's also a good idea to check each one using a multimeter before installing it. Note the 10kΩ resistor that's second to the left from transistor Q1 – be sure to install it in its correct location.

The two electrolytic capacitors can now go in, taking care to fit them with the correct orientation. Follow these with the four diodes (D1-D4), then install transistor Q1 and regulator REG1. As shown, the latter is installed with its leads bent down at right angles about 6mm from its body, so that they go through their matching holes in the board.

Secure REG1's metal tab to the board using an M3 x 6mm screw and nut before soldering its leads. Don't solder its leads first. If you do, the solder joints could be stressed as its tab is bolted down and this could lift (or crack) the board tracks.

Check that the diodes, transistor Q1 and the regulator are all installed with the correct orientation.

Fitting the EM-408

The EM-408 GPS engine module

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	3	1kΩ	brown black red brown	brown black black brown brown
❑	1	430Ω	yellow orange brown brown	yellow orange black black brown
❑	1	240Ω	red yellow brown brown	red yellow black black brown

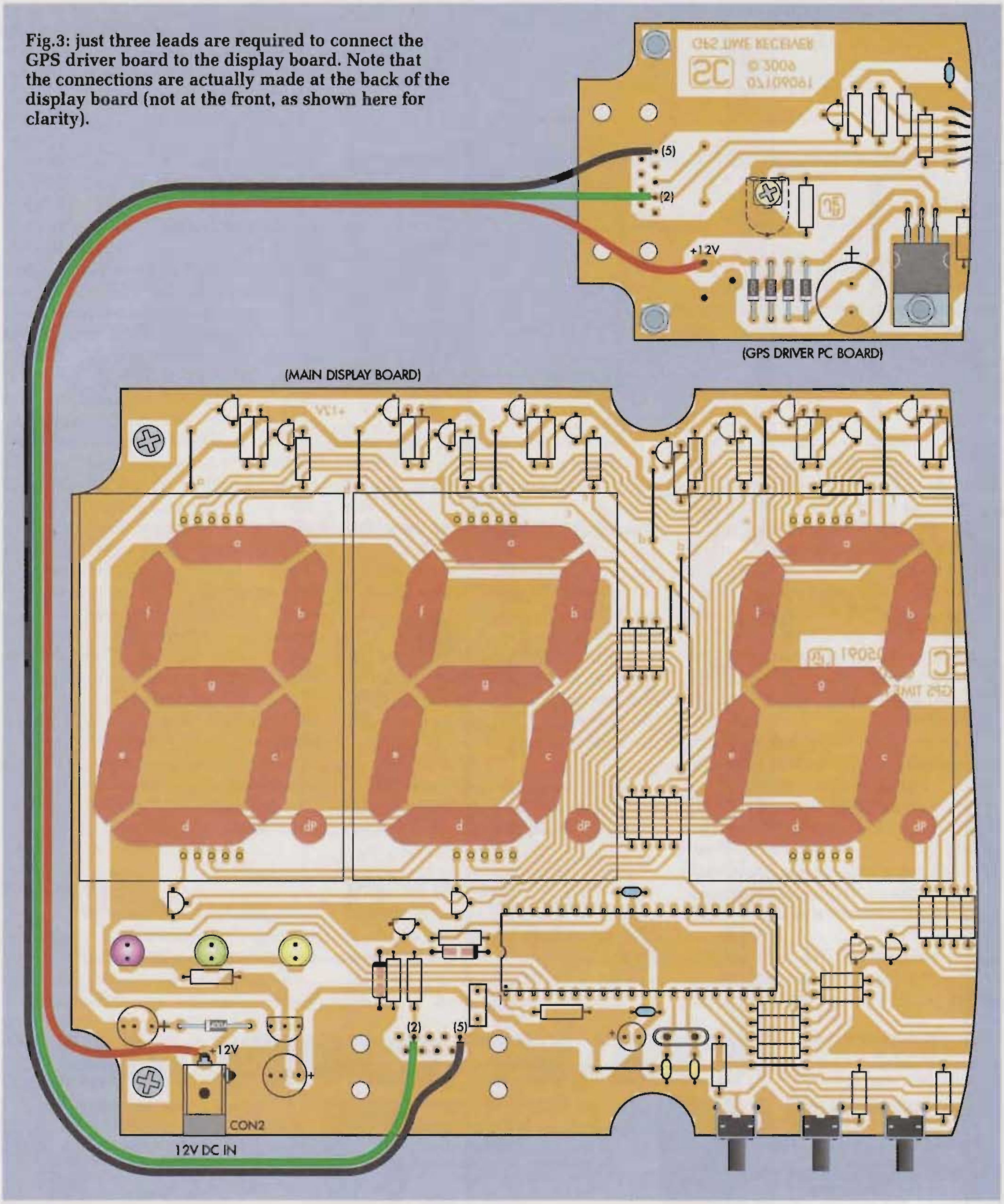


Fig.3: just three leads are required to connect the GPS driver board to the display board. Note that the connections are actually made at the back of the display board (not at the front, as shown here for clarity).

is next on the list. This is attached to the top of the PC board using a strip of double-sided adhesive foam tape and must be orientated as shown in Fig.2. However, before fitting it in place, you have to make the interconnections between it and the PC board.

As supplied, the EM-408 comes with a matching 5-way interface cable. This is about 25mm long and is fitted at each end with a mini 5-way SIL plug, one of which is plugged into a matching socket on the GPS module itself.

For this application, you have to cut the cable in half and then use one half to make the connections between the module and the PC board. Remove about 4mm of insulation from the five

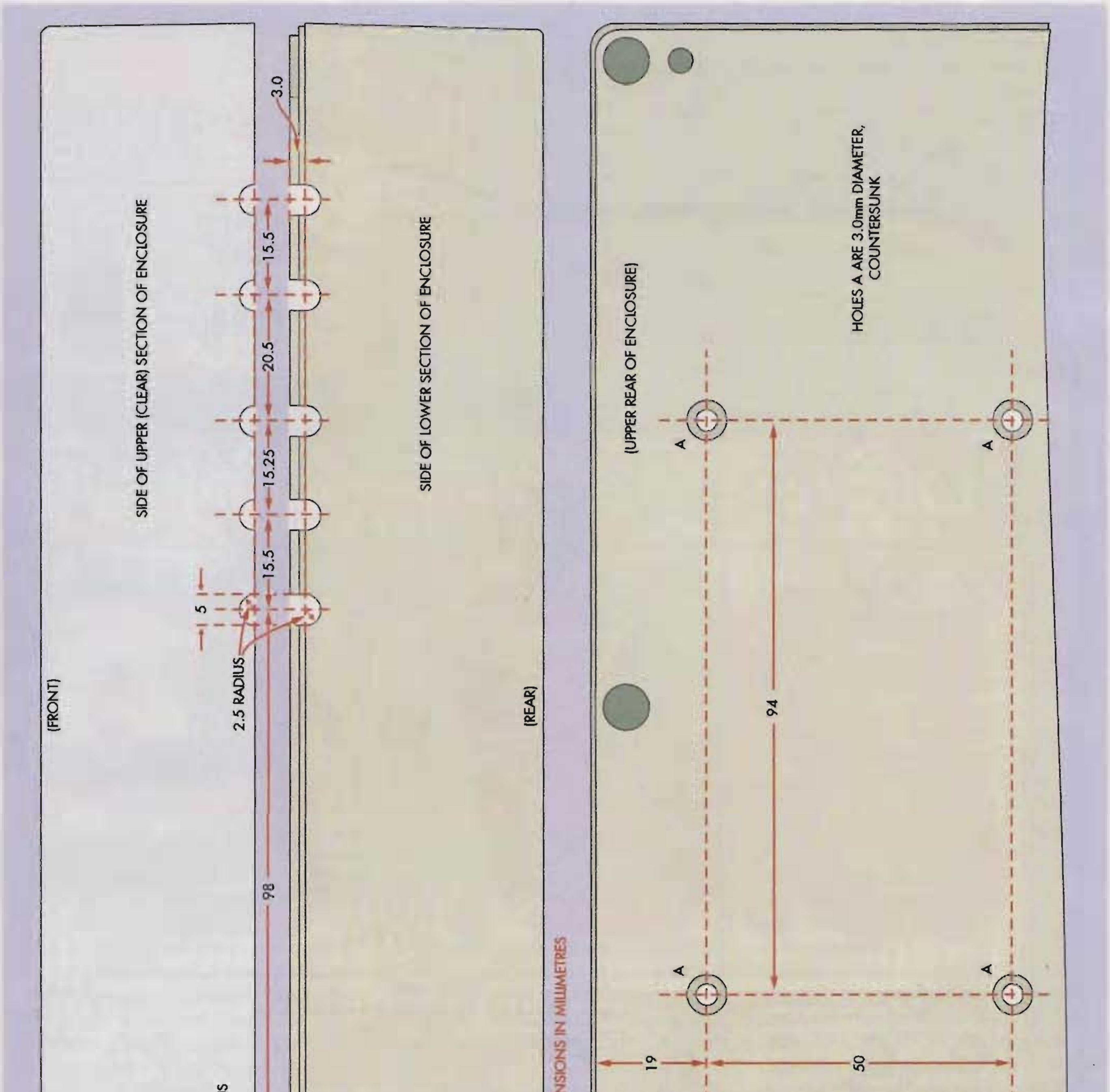


Fig.4: follow this drilling diagram to mount both the GPS driver module and the display board in the same case. The semi-circular notches along one edge of the lid and along the top of the base can be made using rat-tail files of the correct diameter. (Note: if you intend mounting just the display board in the case, using the drilling diagram published in Pt.1 last month).

leads and tin them before soldering them to the PC board. Be sure to feed the leads through the board holes in the correct sequence and note that the wire with the grey insulation goes into the uppermost hole (marked "1" on Fig.2).

After they have all been soldered, plug the end of the cable into the matching socket on the end of the EM-408 module. This is done with the module orientated socket-end-down and roughly vertical with respect to the board. Take care to ensure that the plug and socket mate correctly – they're very small and are polarised.

Once the connection is made, fit the strip of double-sided adhesive foam to the underside of the EM-408. That done, remove the protective tape from the outer surface of the adhesive foam and carefully swing the module down so that it rests on the top of the PC board. During this process, be sure to leave a small amount of slack in the cable so that the plug isn't pulled out of its socket.

Once the module is in the correct position (see photo), press it down gently to ensure that the adhesive foam "grabs".

Finally, if you intend installing the board into a separate case, fit the DC socket (CON1) and the DBF9 socket (CON2). Conversely, leave these parts out if the module is going to be installed in the same case as the display board.

That's it – the module is now complete.

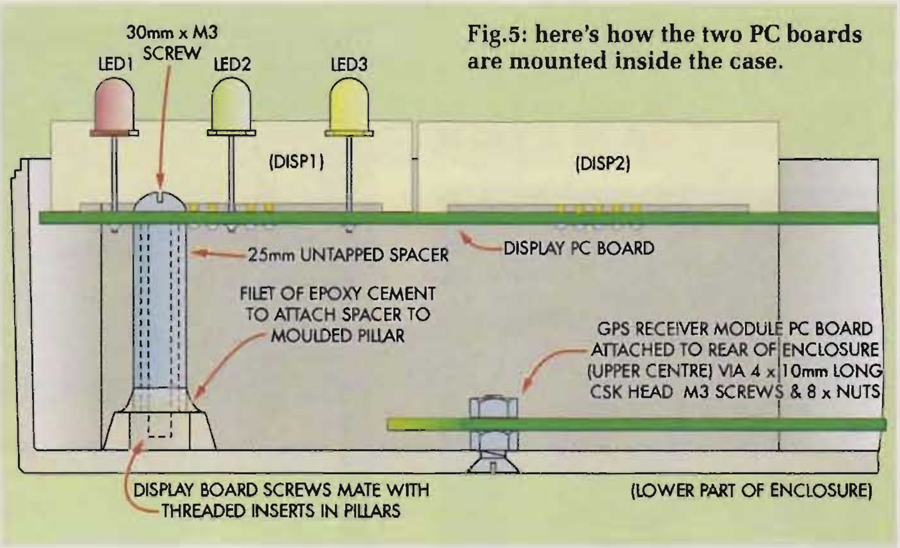


Fig.5: here's how the two PC boards are mounted inside the case.

Setting up

This simply involves adjusting trimpot VR1 to set the output of regulator REG1 to 3.3V to give the correct supply voltage for the EM-408 GPS module.

To do this, first set VR1 to mid-range then apply power from an external 12V DC source. If you're not using the DC socket, simply connect the supply's positive to D1's anode. The negative lead goes to the outside copper earth pattern.

Next, use your DMM (set to a suitable DC voltage range) to monitor the output from REG1 (eg, at its metal tab or at the lower end of any of the 1kΩ resistors). With VR1 set to mid-range, this should be close to 3.3V but may be either slightly lower or higher than this figure. Adjust VR1 to set the voltage from REG1 as close as possible to the correct 3.3V.

The driver board assembly is now finished and can be fitted into either the clock display enclosure or a separate UB3 jiffy box.

Drilling the case

We'll assume here that you want to fit the GPS driver module into the same case as the display board. If so, the first step is to connect a 200mm length of 3-way ribbon cable to the module's external wiring points – see Fig.3. The other end of this cable goes to the main display board but leave this end disconnected for the time being.

Having attached the cable, the driver module and its associated display board can be installed in the case. Fig.4 gives the case drilling details. As shown, four holes must be drilled in the base (towards the top) and these are used to mount the driver module. They should be all be countersunk (ie, on the outside of the case) using an over-size drill.

In addition, you have to cut notches along the mating edges of the top and bottom halves of the enclosure (these provide access to the DC socket and the switches on the display board). These notches are best made using rat-tail files of the correct diameter, although it may be also possible to drill them if the two halves of the case are secured together.

Note that all these holes are in quite different positions from those shown in Fig.4 last month (ie, for the

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Using A PC To Display GPS Time

Fig.6: "GPS Clock" from TimeTools shows UTC time plus longitude and latitude.

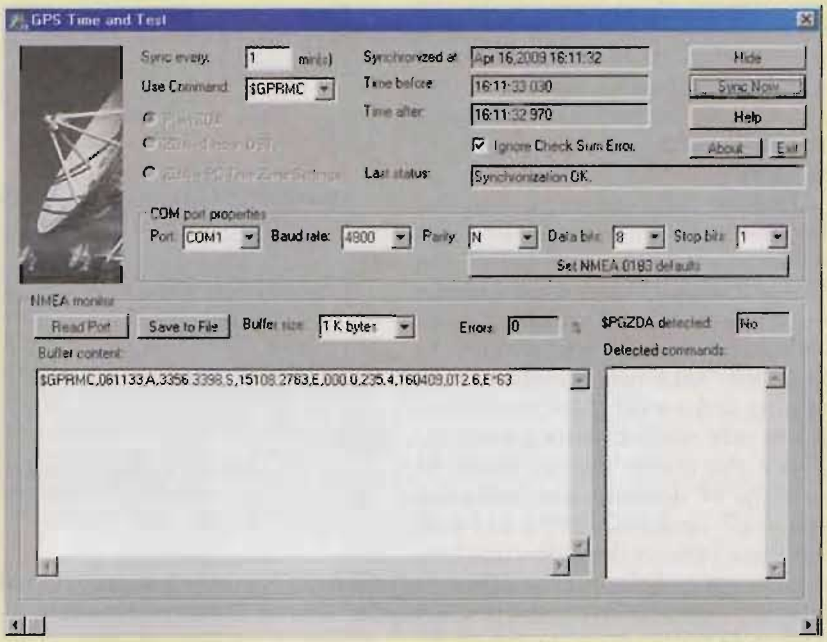


Fig.7: "GPS Time And Test" synchronises your PC's clock to the GPS signal at preset intervals down to as low as one minute. Both programs also show the incoming NMEA data sentences.

IF YOUR PC has a serial port, then you can feed the NMEA 0183 data stream from this GPS driver module directly into it and install software from the Internet to display GPS time.

Two useful programs are ***GPS Clock*** from Time Tools (freeware) and ***GPS Time And Test*** from BrigSoft (shareware but free to try for 30 days). Download them from **http://www.timetools.co.uk/atomic-clock/fw/gps-clock.htm** and from **http://www.abstime.com**

Each does a slight different job. For example, ***GPS Clock*** (Fig.6) shows the UTC time, along with the date, your longitude and latitude and the NMEA sentences.

By contrast, ***GPS Time And Test*** (see Fig.7) synchronises your PC's existing clock to the correct local time (ie, the clock is locked to the GPS time signal but displays local time). Other information displayed includes the time before and after synchronisation plus the NMEA sentence containing both the time and the co-ordinates for latitude and longitude. You can also set the synchronisation interval and set various COM port properties.

There's a lot more GPS software (both freeware and shareware) out there on the Internet. Check it out for yourself.

"display only" enclosure). Note also that you don't need to make a cutout to provide access to the DB9F socket in this version, since the driver board cable is wired directly to the back of the main board.

Final assembly

Fig.5 shows the final assembly details. The new GPS driver board assembly is attached to the base of the enclosure using four M3 x 10mm countersunk-head machine screws, with four M3 nuts used as short spacers and another four nuts used to hold the board in place.

To allow plenty of "breathing space" between the driver board and the main display board (especially to provide some clear space above the EM-408's patch antenna), in this version the main board is mounted much further forward than in the "display only" version. This is achieved by mounting it on 25mm-long untapped spacers. These sit on the existing moulded mounting pillars in the case and the assembly secured using M3 x 30mm machine screws.

Unfortunately, it's quite tricky to fit the main board into the enclosure with the 25mm spacers simply sitting on the moulded pillars. However, there is an easy way around this and that is to glue the spacers to the tops of the pillars using 5-minute epoxy cement – see Fig.5.

This is done by first "clamping" each spacer to its pillar using a 30mm screw and flat washer. That done, you can apply a small "fillet" of epoxy around the bottom of each spacer to hold it in position. Leave the assembly for a few hours to allow the epoxy to set reasonably well before removing the screws and flat washers.

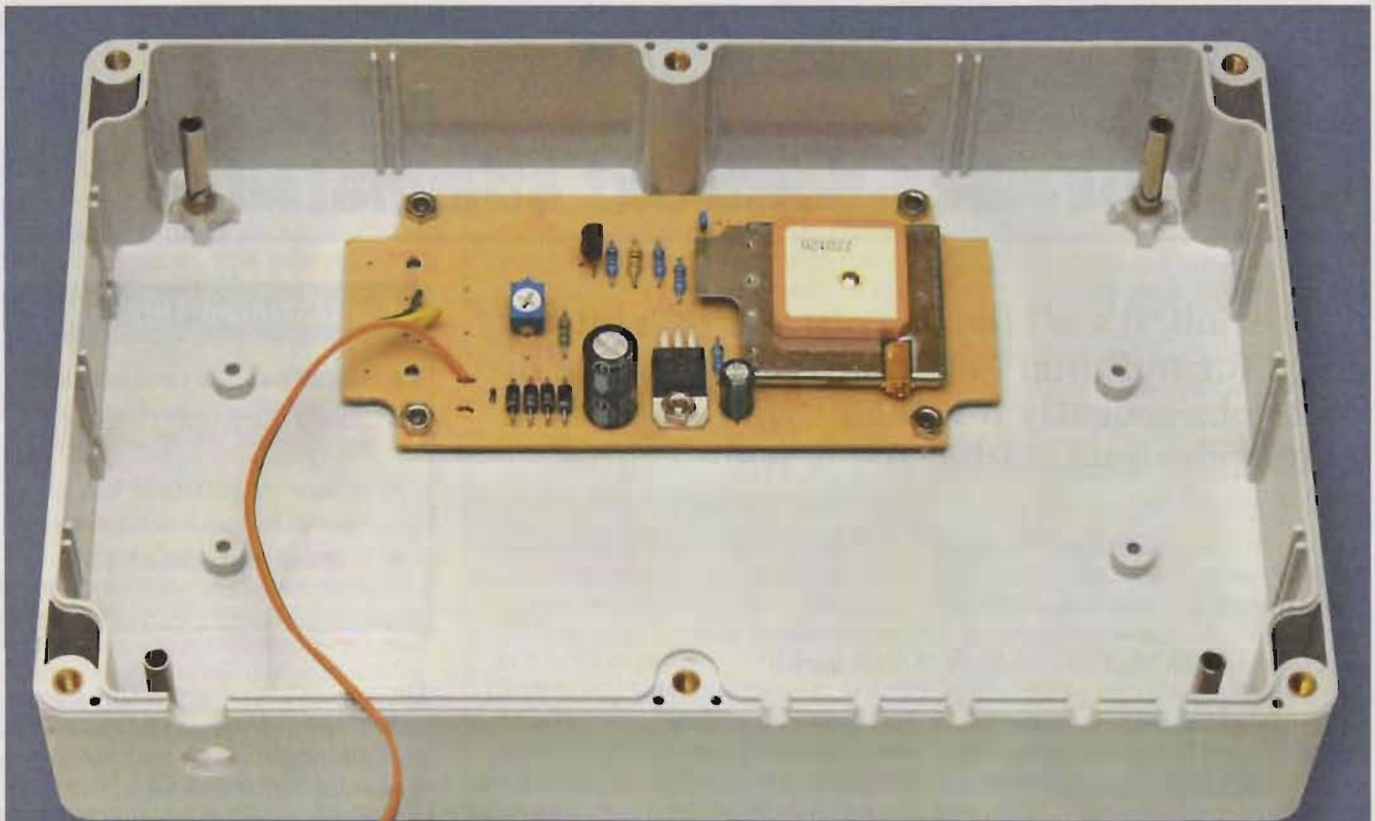
Once the cement attaching the spacers has set, the three leads from the GPS driver board can be connected to the main display board. Note that these leads should be soldered to the rear of the main board, rather than to the front of the board as shown (for the sake of clarity) in Fig.3. If you prefer, you can fit PC stakes to the three wiring points (from the copper side) to accept the lead terminations.

The assembly can now be completed by securing the display board in position using the M3 x 30mm screws and then fitting the clear lid to the case.

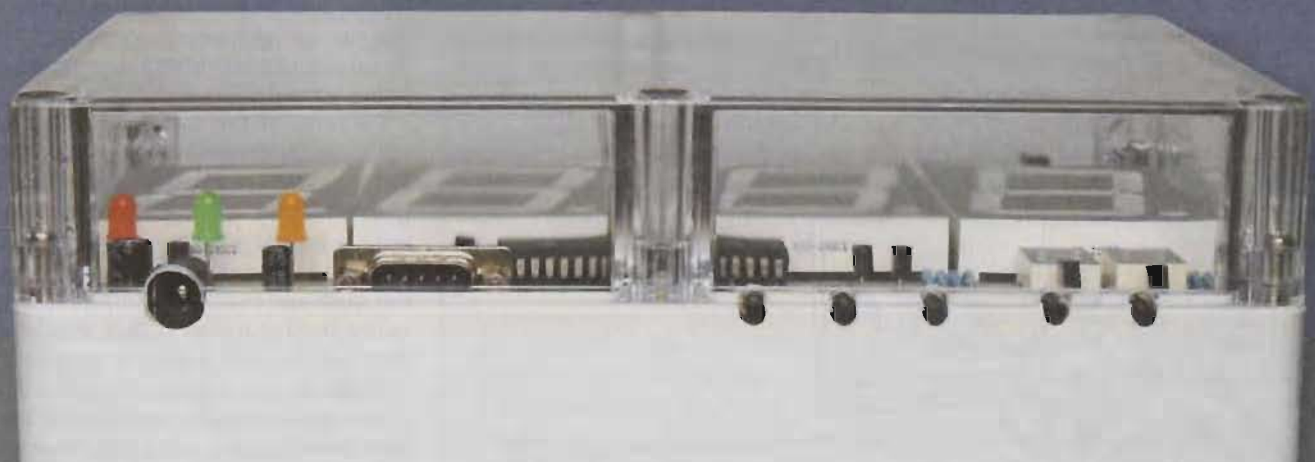
Applying power

You will need a 12V DC 300mA plugpack to power the unit. When this is connected, the displays should light up immediately and initially show "0000".

After a short time (anywhere up to about 40s), the EM-408 GPS engine should begin sending the NMEA 0183 data sentences to the clock display.



This view shows the GPS driver board mounted in the base of the case. The four 25mm untapped spacers which support the display board are also shown glued to their respective integral mounting posts (see text).



The DC power socket and pushbutton switches on the display board are accessed via holes in the side of the case (note: the DB9M connector is not necessary on the main board if mounting the GPS driver board internally).

The unit will then display either UTC time, local standard time for eastern Australia or daylight saving time for Eastern Australia, as selected by switches S1-S3.

If you live in a different time zone to eastern Australia, then it's a simple matter to program in a different offset from UTC (the default offset is +10 hours for eastern Australia). This is done by pressing buttons S4 (hours increment) and S5 (minutes increment), as described last month in Pt.1. The clock will then show the correct local time for your location.

Note that any changes you make to the offset from UTC time are stored in the micro's on-board memory and are retained even if the power is interrupted.

Note also that if the power is interrupted, the clock will automatically start displaying the correct time within 30-40s when power is subsequently re-applied. It all depends how quickly the EM-408 GPS module begins receiving data from a GPS satellite. **SC**

SERVICEMAN'S LOG

Dumbed-down but stimulated

In this job, it's all too easy to put in a lot of effort for nothing. I encountered a couple of such jobs recently but then I was stimulated by our glorious leader. All is well, I think.

Items Covered This Month

- NEC PX42VP4G Plasma TV
- Sansui 66cm LCD TV (SAN 2601)
- Pioneer PDP503G 127cm Plasma TV
- Thomson Speedtouch 536 ADSL2 Modem

One of the more alarming trends in the service business (at least, for me) is that the exact nature of many faults can no longer be determined. Factors such as cost, time and new technology often conspire to prematurely terminate fault-finding procedures. The result is that faults are increasingly being resolved by replacement at module level.

In the 1950s and 1960s we had valve jockeys and now, regretfully, we are being "dumbed-down" to board jockeys. That's progress, I guess, and all we can do is carry on and look as happy as we can.

These thoughts were triggered recently when I was called out to a wealthy suburb to attend an NEC PX 42 VP4G plasma set that would intermittently cut out on bright screens. Naturally, it had to come back to the workshop to be repaired and then soak tested.

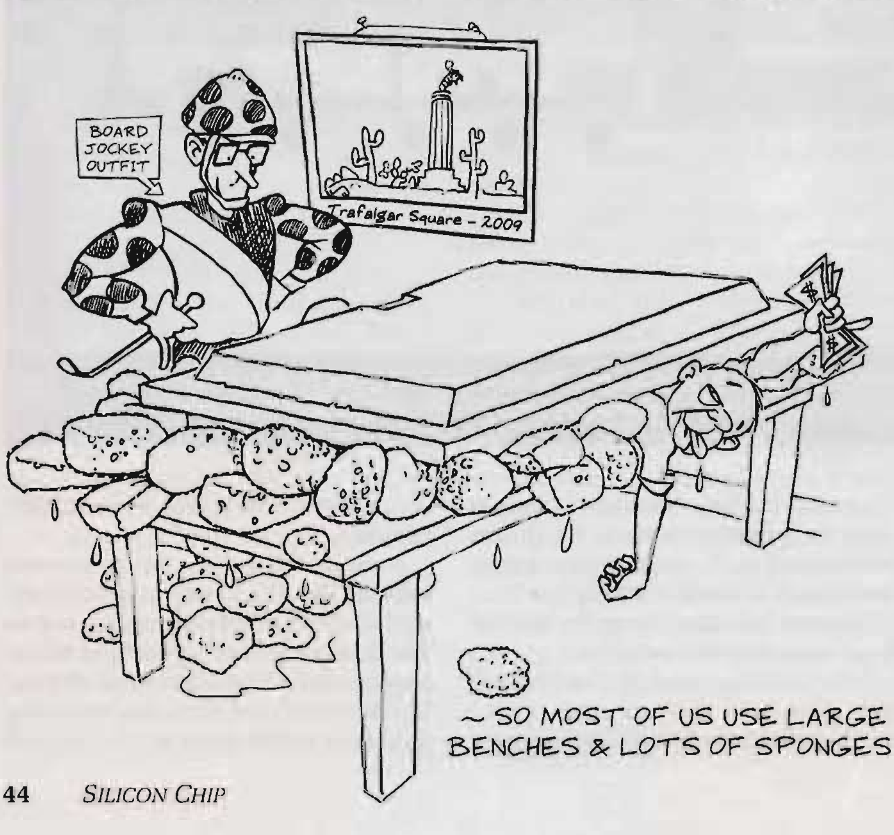
These large-screen flat-panel TV sets can tie up a lot of resources just getting them onto the workbench. First, you need two people to carry them and you also need a large station wagon or van so that they can be kept upright during transportation (the display panel is particularly fragile). Then, when you finally get the unit into the workshop, you have to lay it carefully down on three or more large soft sponges with gaps in between.

These gaps are there to allow a mirror to be slid between the sponges, so that you can see what is on the screen.

Of course, if you have the money, time and inclination, you can get a special jig that will hold a plasma or LCD at any angle you require. However, the diminishing returns from this profession mean that costs have to be kept to a minimum and so most of us use large benches and lots of sponges. I'm not going to even spend my 900 Rudd-bucks on one but I do appreciate being stimulated all the same.

Because of the intermittent nature of the fault, I initially decided to try to "accelerate" its appearance by gently heating the switchmode power supply with a hairdryer. Unfortunately, this seemed to have the opposite effect as the fault never appeared. I then tried using freezer to see if that would do the trick but that didn't work either.

Well, to cut a long story short, a whole week went by and despite running the set all day every day, there was no sign of the fault. And by now, the client's wife was beginning to phone, clearly impatient for the set's return.



Out of time

OK, so I had run out of time. The question now was what to do?

Well, there were several options: (1) return the set as it was, (2) take a punt and replace the most likely culprits in the power supply, such as the electrolytic capacitors or (3) install a new power supply for $550 plus! I explained these options as clearly as I could to the client and she assured me that she understood the situation.

Eventually, after speaking to her husband, she gave me the go-ahead for option two.

Replacing the electros in the power supply was fairly routine and I also spent some time looking for dry joints, especially to surface-mounted components. Unfortunately, I didn't have a circuit diagram, so I was unable to identify the current-sensing circuit components and concentrate on that area. This circuit typically involves using a low-value resistor in the main B+ circuit and shuts the set down if the current goes too high.

Gods not smiling

A week later, after more extensive tests, I reinstalled the set in the client's home and crossed my fingers. Unfortunately, the gods were not smiling on me because she subsequently phoned four days later to tell me, very coolly, that she had stopped the cheque. She wasn't exactly rude but there was plenty of "hoity-toity" snotty-nosed attitude. There's nothing like doing business with someone who thinks so highly of you!

Anyway, she told me that the set lasted four hours before doing precisely the same thing as before. Just my luck, I thought – I have the set for two weeks and cannot fault it; she has it for four hours and it fails. That's Murphy at his pernicious best.

I reminded her that I had emphasised that repairing the power supply would be something of a gamble but it didn't cut much ice. And even if it had, the fact was that the set was still faulty and I was obliged to give it another go.

When I called to pick it up, her husband was there and he was much more relaxed and logical about things. After some discussion, he decided to go for option three (ie, replace the power supply) and hang the expense.

And so that's how this annoying intermittent fault was finally fixed. It's the sort of repair that's all part of the "dumbing-down" trend in the

Publisher's Letter

... continued from page 2

be reduced. There are two ways to do this. The first is to reduce or stop burning fossil fuels, particularly in power stations. The second is so-called geosequestration whereby the carbon dioxide produced in the power station is separated from the other exhaust gases going up the stack (ie, nitrogen and water vapour) and then pumped underground. It turns out that this process is extraordinarily difficult.

One way to do it might be to cool the smokestack gases sufficiently (to -78.5°C) so that the carbon dioxide solidifies (to dry ice). Or you could cool the gases sufficiently to separate the water and then compress it sufficiently to liquefy the carbon dioxide and allow the gaseous nitrogen to separate out. Or another scheme that has been suggested is for the power stations to burn the coal with oxygen rather than air – so that we don't have the problem of removing the nitrogen.

Whatever scheme is used, geosequestration will use enormous amounts of energy; perhaps 40% or more than is currently needed to generate electricity. Isn't this insane? We want to get rid of carbon dioxide but we have to mine heaps more coal and burn it to do so. On the other hand, Australians mustn't use nuclear power (which generates very little greenhouse gas) because that has all sorts of radioactive nasties. Never mind that a large proportion of the electricity generated by western countries already comes from nuclear power stations.

I should note that the term "geosequestration" now seems to have been replaced by "carbon capture and storage (CCS) technologies" which seems to imply that there are lots of ways of doing it. The Federal Government proposes to spend lots of money promoting CCS – this is just more woolly thinking. And to think that Australia might take a lead with CCS and then sell it other countries that burn lots of coal just beggars the imagination. Just how gullible do we think they are?

It is time that we called a halt on all this fear-mongering about global warming and greenhouse gases. The fact is that no matter how many so-called experts forecast that the polar icecaps will melt completely (they might) and sea levels will rise, we just don't know if this will happen or how rapidly it might happen. Nor do we really know if global warming is wholly or partially caused by human activity.

By all means let us stop wasting fossil fuels, particularly oil. We need to conserve oil for the future. And by all means let us accelerate moves to use more solar power, nuclear power, geothermal power or whatever. But let us not be panicked into enormously expensive moves to reduce carbon dioxide when we don't really know if it's a problem or not.

Next time you see some politician or climate expert pontificating about global warming, ask yourself, "Do they even understand basic chemistry?" And remember, "carbon pollution" is not the problem!

Leo Simpson

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Thomson Speedtouch 536 ADSL2 Modem Repair: The Battle Of The Bulge

By Andrew Partridge

THIS STORY BEGAN when I received a call one morning from my friend Nick to say that he had just switched on his laptop to be greeted with a message that a network cable was unplugged. As a result, there was no connection to the internet and he urgently needed this working again so that he could check on a share trade later that day.

I started by asking some questions to narrow down the problem. He had been using the internet the night before without any problems and nothing had changed in his set-up. The laptop is connected to the ADSL modem via an ethernet cable, so I was spared the agony of debugging a wireless connection over the phone.

I then asked Nick whether the pattern of lights on the modem, a two year old Thomson Speedtouch 536, seemed normal and he told me that the power LED was alternating between red and green every five seconds or so.

The manual for the modem says that a steady red power LED indicates a self-test failure and so I wasn't yet convinced that the alternating red-green power LED indicated a fault with the modem. In view of this, I talked Nick through some basic tests to eliminate both the phone line and the ethernet cable from consideration. Nick then called Bigpond to ensure that there was no problem at the exchange.

At that stage, everything pointed to the modem being faulty, so I asked Nick to drop it in so that I could take a look at it. In the meantime, I would lend him a spare modem while I either repaired his or found a replacement.

When Nick arrived with the modem, I checked the output of its 15VAC plugpack. It was fine, so I connected the modem to my own ADSL line. It immediately displayed an alternating red-green power LED and failed to connect.

At this point I told Nick that his modem was definitely faulty and hinted that this might be an opportunity for him to upgrade to one with a wireless router. That way, he could use his laptop anywhere around the house. His response was that his laptop is used with an external keyboard and monitor in his office and so he wasn't at all interested in a wireless connection.

In normal circumstances, the modem would be declared a write-off. However, since it still suited Nick's needs and I wasn't charging for my time, I figured there was nothing to lose so I cracked open the case. When I did, my attention was immediately drawn to four 470μF 25V and two 1000μF 6.3V electrolytic capacitors in the power supply section. The tops of all six were bulging slightly, a sure sign that they were faulty.

Closer examination revealed that they were all CapXon brand units rated at 105°C and a quick check showed that their ESR readings were all high at between 2.8Ω and 7.7Ω. By contrast, all the other electrolytics on the PC board were fine, with low ESR readings.

Using the frequency range on my multimeter, I found that the 470μF capacitors have a 100Hz signal across them, while the 1000μF capacitors, which sit either side of a small toroidal inductor on the PC board, have around 20kHz across them. Clearly, the 470μF units were smoothing the rectified AC output of the plugpack, while the 1000μF units were on the secondary side of the switchmode power supply.

Given the different operating conditions for the two different sets of capacitor values, I was somewhat surprised that all six were at an almost identical state of bulge. The best explanation I can think of for this is that the capacitors deteriorated mainly due to heat build-up in the low-profile case. This case has a generous grid of ventilation holes in its base but none at all in the top section where the electrolytic capacitors are located (and where ventilation is most needed).

I removed the six bulging electrolytic capacitors and tested them with a capacitance meter. They were all well down in capacitance, the 470μF units measuring between 99μF and 108μF and the 1000μF units measuring 90μF and 127μF.

Replacing these capacitors fixed the problem. Nick's modem now worked on my ADSL connection and seemed even faster than my own modem. The final step before returning it to Nick was to drill a grid of ventilation holes in the top of the modem's case immediately above the power supply circuitry, to reduce the likelihood of any future heat-related failures.

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~TO TELL ME, VERY COOLLY, THAT SHE HAD STOPPED THE CHEQUE...

servicing industry but what else can you do in such situations?

Unfortunately, due to the earlier abortive repair, I didn't make any money out of that job. Thank heavens for those 900 Rudd-bucks.

Sansui LCD TV

Another incident involved a 66cm Sansui LCD TV (model SAN 2601) with very similar symptoms. In this instance, the set was intermittently not starting and/or the controls, including the remote, were not working.

By the time I got to look at this set it had already been looked at by others. They had replaced the electros in the power supply but this had made no difference. There were no service manuals or circuits available that I could find, so it looked like this job was going to be tricky.

Initially, I spent some time checking the outputs from the power supply and then I discovered something rather unusual. When the set was actually working correctly and you switched it to standby, all voltage outputs from the power supply remained fully on.

What was happening was that the control processor was switching the set "off" (or rather to standby) so it looked as though it was fully off. However, the power supply was remaining on. It reminded me of my old mum who, when she wanted to turn a TV set off, would start with the knob nearest her and turn it anticlockwise. She would do this to each control in turn, turning the volume, brightness and contrast down until there was no sound or picture. She then assumed that the set was "off"!

Anyway, I could see that there was a control voltage (SB) going into the power supply that should be switching at least part of it on and off. However, it wasn't having the desired effect. This suggested that the power supply itself was crook but I couldn't prove that this was the only fault. Other possibilities included a microprocessor fault or perhaps a faulty reset line was causing the whole control circuit to clam up in confusion (rather like my mind!).

Before I could even get an angle on the problem, the client bombarded me with the usual questions of

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cost, cost and cost. And he wanted an answer right then and there. Well how long is a piece of string?

Given time, I could have told him but for the present I could only guess. Based on this, the set was condemned and the client ended up buying a new one. Sensing that this was one job that could well turn out to be a time-consuming loss-maker, I wasn't going to argue.

Of course, I didn't make any money out of that job either. So Kevin's largesse came in handy once again.

The wet Pioneer plasma

Two days after a particularly heavy downpour in our suburb, I got a call from a lady in strife with her TV. Her problem was that her set-up, a Pioneer PDP503G 127cm plasma TV and an accompanying multimedia box, wasn't working.

Despite my prompting, she wasn't able to describe the fault(s) but she knew it was down to the rainstorm we had just had. She was also rather distraught at what had happened and wanted me to call in as soon as possible.

When I arrived, I could understand her distress. The roof of her house had sprung a leak and the deluge had flooded the lounge and saturated the TV. In fact, water was still leaking out of the back of the plasma!

Now I know Moses managed to roll back the water in the Red Sea but there was nothing I could do right then. Instead, I got the lot back into the workshop as soon as I could and removed the covers to dry the electronic circuitry with fans and heaters.

Surprisingly it still looked pretty dry inside, the wet parts being mainly along the bottom and sides. After a couple of days, I figured it was about dry enough to switch it on and see if any damage had occurred.

Well, the good news was that it didn't explode into flames or go bang. The bad news was that there was no picture, no sound and no OSD (on-screen display). Instead, the screen lit up white and a green LED came on.

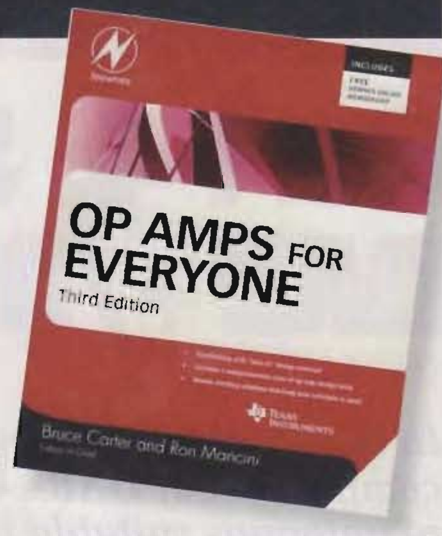
Unplugging the multimedia box and switching on the plasma panel gave an E01 error. This proved that the panel itself and its driver circuitry were OK, so the problem was somewhere inside the multimedia box.

I next examined the PDP-R03G multimedia box which has all the AV switching. Initially, with the cover off, all looked OK but removing the main PC board immediately revealed the problem. The water had already corroded the surface-mounted components underneath, especially around the high-density ICs.

And that meant that the unit was a write-off. A replacement motherboard for this multimedia box is rather expensive, so it's really not worth fixing and is one for the client's insurance company. **SC**

BOOK REVIEW

by LEO SIMPSON



Op Amps for Everyone

Edited by Bruce Carter & Ron Mancini. 3rd edition published 2009 by Elsevier Inc. 615 pages, 192 x 234, paperback. ISBN 978 1 85617 505 0 $95.00

The third edition of this well-known Texas Instruments' book has been considerably expanded. As a bonus, it is considerably cheaper than the previous edition.

At the outset, this is not a book for the beginner. It is intended for designers and technicians who already have at least some familiarity with op amps and how to use them. With over 600 pages, the text covers the subject exhaustively. There is quite a lot of reliance on formulas and graphs to discuss various parameters, so if you are not at home with equations, this might not be the book for you. On the other hand, it is very readable and if you are content to skip over the formulas, you can still learn a great deal from the associated graphs, of which there are lots.

There are 25 chapters in all plus a lot of appendices at the back which feature many useful sample circuits.

If you are a bit rusty on basic circuit theory, you will find that chapter two gives useful revision on topics such as voltage dividers, Thevenin's theorem, Superposition and basic transistor operation.

Chapter 3 is devoted to basic op amp configurations such as inverting and non-inverting op amps, adders and differential amplifiers, with a section on video amplifiers which are a special case of non-inverting amplifiers. Also discussed are capacitors and complex feedback networks.

Chapter 4 covers the topic of single supply op amps, a subject that is more complicated than you might think. With careful attention to biasing, single supply op amps can perform almost as well as those with balanced supply rails.

Chapter 6 is devoted to feedback and stability theory while chapter 7 covers non-ideal op amp equations and both of these must be regarded as fairly heavy going.

Chapter 8 is perhaps the most important topic in the book, devoted to voltage feedback op amp compensation. Without frequency compensation of some sort, all voltage feedback amplifiers will be unstable. Anyone who designs with op amps needs to be familiar with this chapter.

Chapter 9 is devoted to current feedback amplifiers. These sacrifice the precision of voltage feedback amplifiers but gain much wider bandwidth and slew rate capability. They are mainly used for applications above 100MHz. Chapter 10 compares voltage and current feedback amplifiers.

Chapter 11 covers the topic of fully differential amplifiers and this may be a puzzle to many readers since all voltage feedback op amps are inherently differential, with inverting and non-inverting inputs. However, the original op amps (which used valves or transistors) also had differential (or balanced) outputs. The discussion leads to instrumentation amplifiers and then to various forms of differential filters. Also covered are the Texas Instruments' differential amplifiers with their "voltage output common mode (level)" pin.

Chapter 12 is on another very important topic, that of op amp noise theory and applications. When you think about it, the task of any op amp circuit designer is to arrange matters so that the signal range of the circuit is comfortably above the "noise floor" but below that at which overload occurs. That seems self-evident but a lot of modern consumer audio equipment barely gets by.

Chapter 13 is on understanding op amp parameters and again, this is most important. There are myriad parameters so it is a long chapter.

Chapter 14 leads into instrumentation and discusses sensors while chapter 15 is on interfacing to analog to digital converters (ADCs). Chapter 16 is on wireless communication and the op amps used for intermediate frequencies (IF) which are typically below 25MHz. Chapter 17 carries on the theme with op amps for RF design – a discipline which used to involve discrete devices only.

Chapter 18 discusses interfacing digital to analog converters (DACs) to loads such as in the audio output stages of CD and DVD players. It includes a comprehensive look at the various types of DAC and covers DAC errors and current and voltage boosters.

Chapter 19 is on sinewave oscillators while chapter 20 is on active filter design techniques. This is a very large topic and many readers will probably skip it to go to chapter 21 which is entitled "Fast Practical Filter Design for Beginners" followed by "High Speed Filter Design" in chapter 22.

Chapter 23 is a subject close to my heart, on "Circuit Board Layout Techniques" and the author makes the profound statement that the board "is a component of the op amp design". We would extend that to say that the PC board is a vital component of every circuit design. We have seen many circuits let down by bad board layout.

Chapter 24 is very relevant to modern circuit design – on designing low voltage op amp circuits. Finally, chapter 25 is on common application mistakes.

In summary, this is a very comprehensive coverage of the subject. If you can only afford one book on op amp design, this is the one to get. It is on sale from the SILICON CHIP bookshop. SC

Digital Radio

Part 4: Signal Formats & DAB+/DRM Comparison

In this final instalment we discuss the signal formats and give a comparison of DAB+ and DRM. Also included is a brief discussion of antennas suitable for DAB+ reception.

Digital TV & radio systems have two reception conditions. They either provide good sound and picture quality or there is no reception at all.

Perhaps we should qualify this by saying that when you are on the brink of signal failure, digital TV can be plagued with partial pixellation of the picture and loud clicking in the sound as it drops in and out.

So under a variety of reception conditions, there is no gradual reduction of sound and picture quality.

To produce the designed quality there must be adequate signal and no noise, particularly impulse noise. Impulse noise is generated by lightning strikes, electrical switching, arcing power line insulators, arcing in brush motors and unsuppressed ignition systems in petrol motors.

So for digital radio it is important to get reliable reception otherwise the sound will have annoying gaps in it.

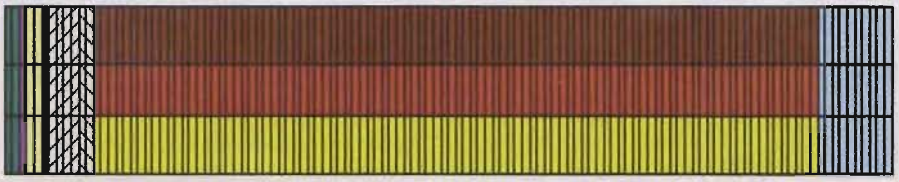
Errors in digital radio systems

The effects of errors are:

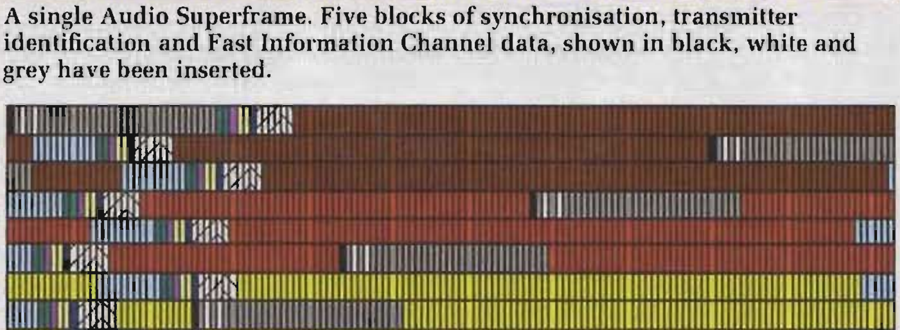
- ***Corrected*** Errors are not detectable by the listener. 8% of the transmitted signal is mathematically related to the data being sent. So the additional error correction data can be used to correct errors in the main signal.
- ***Detected*** Cyclic Redundancy Check enables the detection but not the correction of the main signal. So when an error is detected the errors are concealed as described below.
- ***Interleaving*** is shuffling the data in time. The advantage of interleaving means that a burst of noise is distributed over a much greater range of bytes so that error correction and detection is more likely to be effective.
- ***Differential Grey Code*** Absolute numbers are not transmitted, the amount of change is transmitted instead, so if one value is 7 and the next value is 0 the number 7 is converted into grey code. For any number change in Grey Code only one-bit changes in the byte. So if the Grey decode detects more than one bit change in a byte, that byte is detected as an error.

For example, a change between 7 to 0:

Decimal 7, binary 111, Grey Code 100
Decimal 0, binary 000, Grey Code 000



A single Audio Superframe. Five blocks of synchronisation, transmitter identification and Fast Information Channel data, shown in black, white and grey have been inserted.



Three Audio Units shown in three rows. This is a single Audio Superframe, which contains 120ms of audio

Error Concealment

The decoder will use the previous two audio units to guess the values for a corrupted audio unit. If subsequent

by Alan Hughes

audio units are also in error the signal will be faded out. A fade in is performed by the decoder when the data error rate drops. Errors in the Parametric Stereo signal are camouflaged by assuming that the sound source is stationary.

Data organisation

An Audio Unit Data Block consists (in time order) of the following:

- Header: two bytes of error correction, one byte of program characteristics, 14 bytes to identify which audio unit it is in an audio superframe and a CRC check. Cyan, purple, yellow & blue.
- Program Associated Data: consisting of two bytes of fixed length and some variable length data. Shown hatched
- Scaling signal: it tells the decoder to change the loudness in various sized steps.
- The filters with the loudest signal which is not masked by another loud adjacent frequency. The difference in amplitude is added to the data.
- A Spectral Band Replication signal.
- A Parametric Stereo signal to indicate the direction of the sound and the nature of the reverberation.
- 3 x 10 bits of Reed-Solomon error correction data Shown pale blue.

The advantage of having five blocks of synchronisation is that when the receiver is searching for a program it will spend less time waiting for the transmitter identification and can synchronise faster during tuning and after a noise burst.

Each program has an Audio Superframe in a sequence up to nine programs. Some Audio Superframes can be replaced with data in a block the same size if the broadcasters wish to do so.

Comparison of DAB+ and DRM

We've been concentrating on the DAB+ digital radio standard because it is the system now being introduced to

MEDIA RELEASE

1 May 2009

commercial radio australia

Perth first to switch on digital radio

Commercial radio stations in Perth – Mix 94.5, 92.9, Nova 93.7, 6PR, 96 fm, 6ix, Radar, Pink Radio and Novanation create radio history on Monday, 4 May 2009 when they begin broadcasting the first permanent DAB+ digital radio services in Australia.

Joan Warner, chief executive officer of Commercial Radio Australia the industry body that has driven the move to digital radio said Monday was a milestone for the industry in Australia and is the biggest innovation in radio since the introduction of FM in the 1970's.

"The switch on of digital radio is a culmination of seven years work with the Federal Government, the Australian Communications and Media Authority (ACMA), commercial broadcasters, the ABC and SBS, together with retailers and manufacturers of digital radios to ensure a comprehensive and coordinated switch on of a compelling new way of listening to radio," said Ms Warner.

"The Australian radio industry has invested in and created its digital future and will compete with other digital technologies and continue to maintain radio's relevance in listener's lives," said Ms Warner

Ms Warner said for the first week to 10 days the DAB+ broadcasts will be in interference test mode which means that the power may be lower at night while any interference is assessed.

Commercial digital radio services are expected to be switched on in each city from the dates below barring any weather delays. For the first 10-14 days services might be on low power at night as any potential interference is addressed.

Perth	- 4 May
Melbourne	- 11 May
Adelaide	- 15 May
Brisbane	- 25 May
Sydney	- 30 May

ABC and SBS are expected to commence digital services throughout June/July.

For further information on digital radio visit: www.digitalradioplus.com.au

Notes & Errata

The text on page 12 of the April 2009 issue on COFDM multiple carriers refers to column data being "fed into an analog to digital converter (DAC)." It should read ***Digital to Analog Converter*** (DAC).

Also Fig.2 on page 12 of the same issue is a generic functional diagram. As a result the DAC is shown feeding the Inverse Fast Fourier Transfer. In reality, the IFFT is done digitally, so the DAC will be fed from the IFFT instead of feeding it.

Fig 3. A 4-QAM only allows four conditions shown as purple dots. Note all of the 4 conditions have the highest power signal from the tower.

This gives the best signal reliability but at the expense of a low data rate of transmission.

The purple dots are also part of 16 and 64 QAM. 64-QAM's maximum radiated power is the same as 4-QAM but the minimum radiated power is 18 dB lower. So you transmit much more data but it is more likely to be affected by noise.

And Fig.4 on page 13 shows ADCs following the IFFT. In fact, the chip manufacturer controls the location of the ADCs. QAM demodulation can be done digitally or in analog then digitised.

So a single high speed ADC can digitise the IF signal or the QAM demodulation can be performed prior to the Fast Fourier Transform.

Finally, a DAB+ OFDM makes the signal on each carrier 1536 times longer than when a single carrier is used. Since the pulse is so much longer it can be sampled more than once.

This is a similar technique to eliminating contact bounce on computer keyboards. A change of state is detected and is then rechecked on the next sample period to ensure the first sample was not an error.

Once the consecutive samples are identical, any further samples can be ignored until the next change of state. Hence delayed signals can be ignored.

Parameter	DAB+	DRM
Coverage area	Region (<100km radius) Terrain affected	Local to >2,000km Regardless of terrain
Number of programs per channel	<9	1 or <4 speech
Operating Frequencies	174 – 240MHz (Band 3) 1,450 – 1,500MHz	0.5265 – 1.6065MHz, 2.3 – 2.495MHz (MF) 5.9 – 26.1MHz (HF)
Possible channels	22 (B3) + 22 (L)	69 MF, 221 HF
Repeaters	Depends on area and terrain	Not required
DAB+ Modes DRM Robustness modes	Four modes: Single Frequency Networks, Cable and two frequency bands	Four levels up to high speed moving receiver and long periods allowed for reflections.
Audio Sample rates	24ksample/s SBR	24ksample/s SBR
Sound Quality	Full audio frequency range using SBR	Full audio frequency range using SBR
Parametric Stereo	Yes	Yes
Maximum bit rates	1152kb/s thus allowing multiple channels	64 - 72kb/s (18 - 20kHz channel width)
Audio Superframe	3 Audio Units	10 Audio Units

The main differences between DAB+ and DRM are the frequencies used and therefore the coverage. DRM operates on much lower frequencies which offer significantly greater range than DAB+. This can be both a blessing and a curse!

Australia. However, it's not the only one. You may have heard of DRM (Digital Radio Mondiale) which is a system used in several overseas countries.

The table below shows the similarities and differences.

The DAB+ and DRM transmission systems are very similar except for the frequency bands used. The main advantage of DRM is that there will be reception regardless of location, not only for fixed installations but also in moving vehicles.

This would allow high quality sound regardless of location. DRM could also be used by Radio Australia for international transmissions.

Australia has 45 transmitter sites with a FM transmitter with a radiated power of 20kW. These sites each cover a regional area and are ideal for DAB+.

Four high-powered DRM sites could cover all of Australia with state-based programs for national broadcasters. There are at least 246 sites which could be replaced by the four sites.

Radio New Zealand International has been broadcasting DRM since 2006 and because of the low frequency, these signals are often receivable in Australia (particularly the east coast).

The website www.rnzi.com/index.php shows the frequency schedule. They are using a 10kHz-wide channel and ruggedness mode B. The audio is 64-level QAM. The sound is mono.

Radio Australia has been experimenting at their Brandon, Qld site with a low-powered HF DRM signal.

Standards
Australian Standard 4943.1-2009
DAB+: ETSI TS 102 563
DAB: ETSI EN 300 401
DRM: ETSI ES 201 980"

Antennas for digital radio

On portable and clock radios, etc, DAB+ channels 5A – 13F will use the same antennas as currently used – a telescopic rod, a wire or an antenna made up of the headphone leads.

The optimum lengths for FM reception are 767mm; for DAB+ Ch 5A – 13F, 362mm and for DAB+ Ch LA – LW, 204mm.

The coverage area of DAB+ channels 5A – 13F is similar to that of digital TV channels 6 – 12 (ie, 175 to 224MHz: VHF Band 3).

However, in weak signal areas a vertically-polarised Band 3 Yagi-Uda antenna (ie, mounted so that the elements are vertical) should give reliable reception.

A Yagi should be mounted so that its

A Yagi antenna is a good choice for DAB+ reception. A simple 3-element beam suitable for digital TV should be adequate in most areas. If you want to try making one yourself (and it's not that hard!), follow these dimensions.

boom is aimed at the transmitter, with the longest element *away* from the transmitter.

Do *not* connect these antennas to the downlead used for TV reception. This is likely to produce broken up pictures and sound in digital TV programs and may cause patterning to analog TV reception.

So you need to use a separate down lead to the DAB+ radio receiver – almost certainly 75Ω coaxial cable. As with all coax, you get what you pay for – and if you're in a low signal area, you're going to need high quality, low-loss type.

MATV systems will need a separate channel amplifier to control the signal level and filter out TV signals picked up by the above antenna.

What's available?

As far as we can tell, there are currently no local antenna models available to receive the whole DAB+ band, including channels 13A – 13F; however some manufacturers have indicated they will probably gear up when demand picks up.

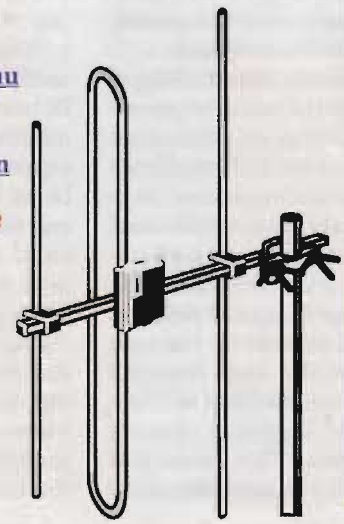
We have found one imported antenna, the Spanish-made Ikusi DAB030, which *does* cover the whole DAB band. It's available through Ikusi Australia distributors. Contact Ikusi on (03) 9720 8000 or visit their website (see below).

Some suitable antennas for the lower section of the band include:

Hills DY4 – DY14
Matchmaster 03-DR3004 – 03-DR3018
Fracarro BLV4F, BLV6F

Links

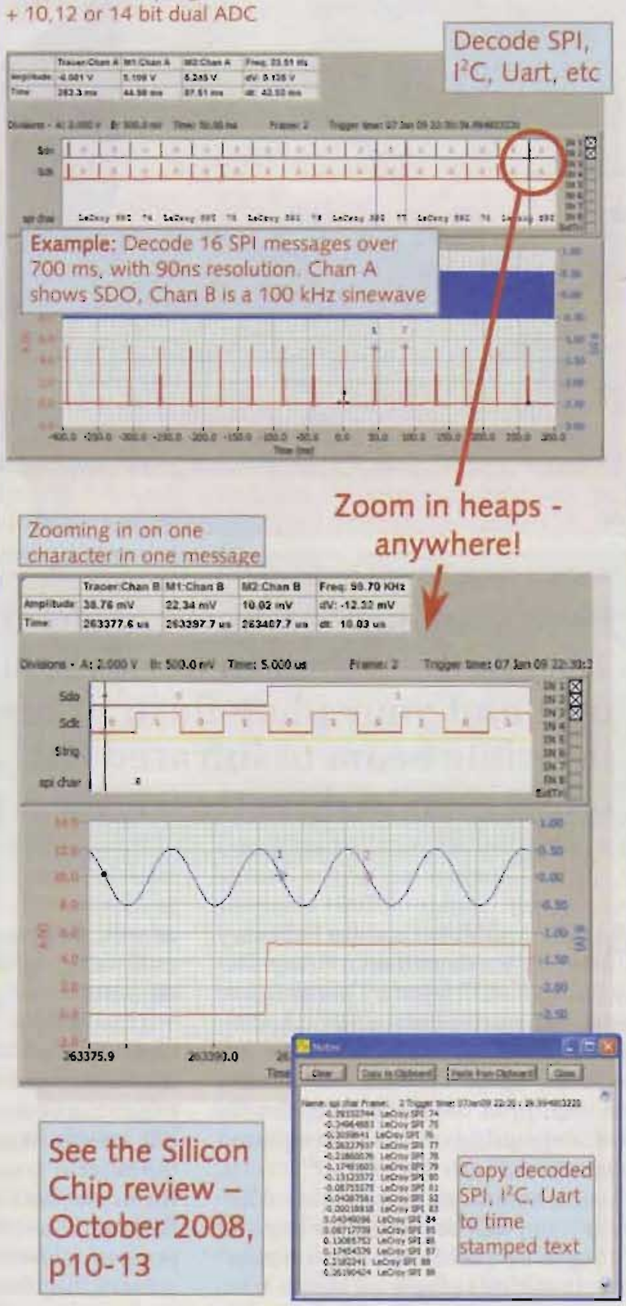
www.digitalradioplus.com.au
http://worlddab.org
http://DRM.org
http://infostore.saiglobal.com
http://pda.etsi.org/pda/
www.ikusi.com SC



The Ikusi DAB030, shown at right, covers the whole DAB+ band from 175 to 240MHz. As far as we can tell, it's the only one which currently does so.

cleverscope

Mixed Signal Oscilloscope
+ Mixed signal triggers
+ Spectrum analysis
+ Symbolic maths
+ Custom units
+ Copy & paste
+ Signal generator
+ USB or Ethernet
+ 8M samples storage
+ 100 MHz sampling
+ 10,12 or 14 bit dual ADC



See the Silicon Chip review – October 2008, p10-13

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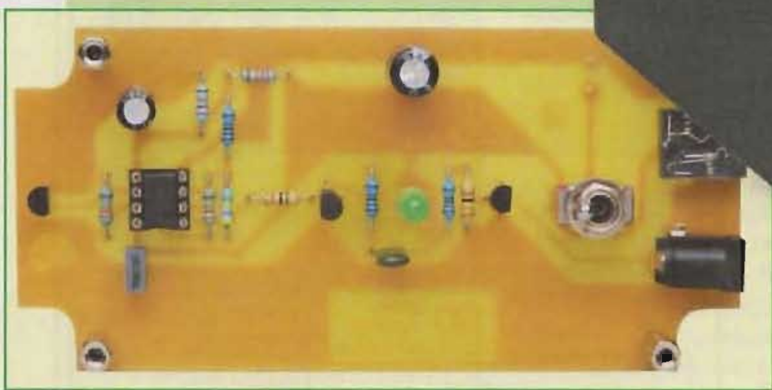
A Beam-Break Flash Trigger

By JIM ROWE



Here's an easy-to-build accessory for the Time Delay Photoflash Trigger described in our February 2009 issue. It triggers the delay unit and your photoflash in response to an object interrupting an invisible beam of infrared (IR) light. Alternatively, it can be used on its own to directly trigger a photoflash.

A FEW MONTHS ago (in February 2009), we described a "Time Delay Photoflash Trigger". This unit was triggered by a sudden sound picked up by an electret microphone. It then immediately opened the camera's shutter and then fired the photoflash shortly after, depending on the delay period programmed into the unit.

Using sound pick-up in this manner is a popular and effective method of triggering a flash for "stop motion" and other kinds of special effects photography. However, in addition to the electret mic input, we also gave the delay unit a second "contact closure" input, so that it could be triggered using other techniques. Which was just as well, because as soon as the delay unit was published we started getting requests for a light beam trigger.

This simple "Beam Break Trigger Unit" is the result of those requests. It's mainly intended as an alternative triggering front-end for the Time Delay Photoflash Trigger and is connected to the latter's "contacts" input. However, it can also be used to trigger a photoflash unit directly if you don't need the programmable time delay capabilities.

Note, however, that using the unit to directly trigger the flash has one important limitation. Unlike the Time Delay Photoflash Trigger, it doesn't also trigger the shutter. This means that you have to open the shutter manually before the infrared beam is interrupted (eg, at night or in a darkened studio).

The new project is in two parts: (1) an IR Source unit which produces the IR beam and (2) a Detector unit which monitors the IR beam and closes its output trigger contacts briefly if the beam is interrupted. These two units are linked with an interconnecting cable which supplies the Source unit with power.

By the way, if you're already wondering how you accurately line up the Source and Detector units when the IR light beam is invisible to the human eye, wonder no more. That problem has been solved by providing the detector unit with a visible green

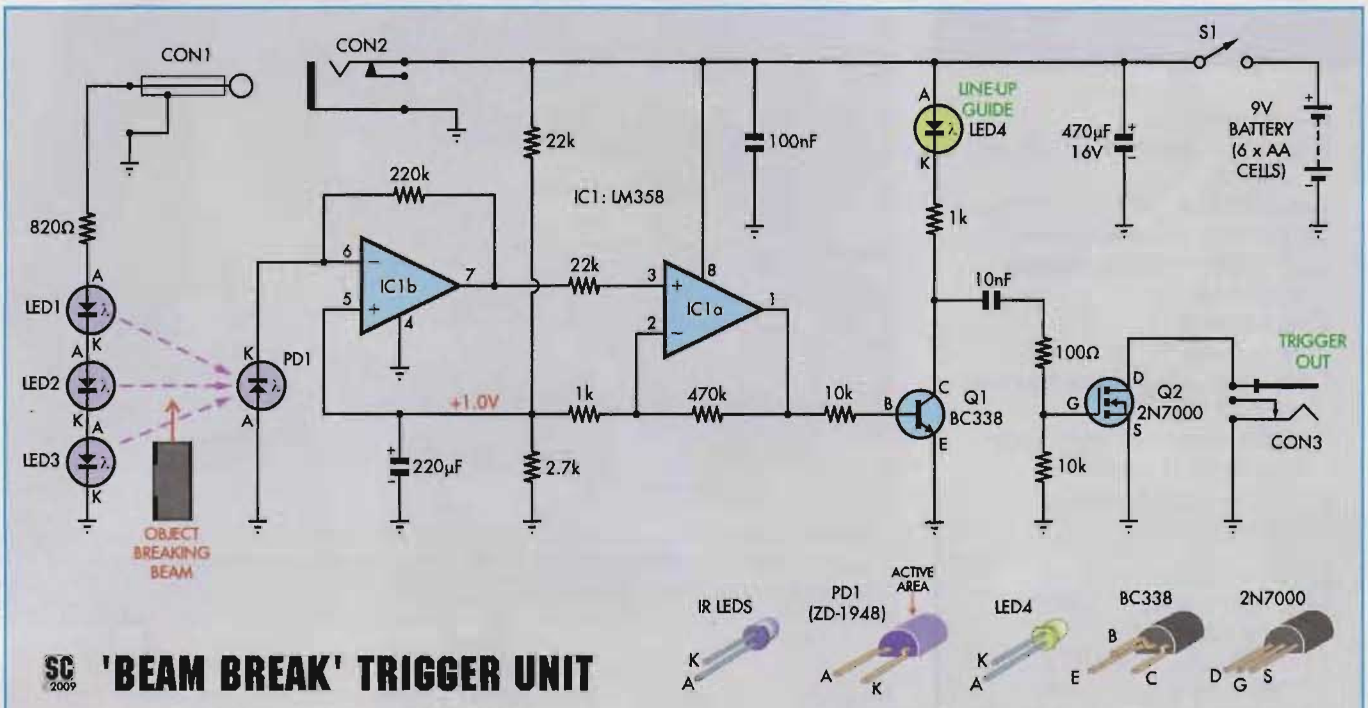


Fig.1: the infrared beam is generated by LEDs 1-3 and picked up by photodetector diode PD1. Op amp IC1b functions as a current-to-voltage converter while IC1a is wired as a non-inverting amplifier. The latter drives transistor Q1 & Mosfet Q2 to briefly switch the trigger output when the IR beam is interrupted.

LED which lights when the IR beam is being received. This makes the lining-up process easy.

Both parts of the project run from a 9V battery fitted inside the Detector unit's box. The total current drain is about 15mA **which means that the battery should be either a set of six AA (1.5V) alkaline cells or a single high-energy 9V lithium battery.** A standard 9V zinc-carbon or alkaline battery is not up to the job, as its life would be too short.

Circuit details

Take a look now at Fig.1 for the circuit details. There's really not a great deal in either part of the circuit. In fact, the IR Source unit is nothing more than three IR LEDs connected in series and with an 820Ω series resistor. This resistor limits the current from the 9V supply (and thus the current through the IR LEDs) to about 7.5mA.

Power is derived from the battery in the Detector unit via a cable fitted with a 3.5mm jack plug (CON1). This mates with CON2 on the detector unit.

In the Detector unit, the IR beam from the Source unit normally falls on PD1, an IR photodetector diode. This photodetector is connected between ground and the inverting input (pin 6) of op amp IC1b (an LM358).

Op amp IC1b is connected as a current-to-voltage converter. Its pin 7 output sits somewhere between +1.7V and +4.0V when the IR beam is present but rests close to +1.0V when no IR light is falling on PD1. This "dark" output voltage of +1.0V is basically set by the voltage divider formed by the 22kΩ and 2.7kΩ resistors, with the 220μF capacitor providing filtering. This is used to directly bias pin 5 of IC1b and to bias pin 2 of IC1a via a 1kΩ resistor.

The output at pin 7 of IC1b is fed to the non-inverting input (pin 3) of IC1a, which is configured as a non-inverting amplifier with a voltage gain of 471. Because of this very high gain, IC1a acts very much like a comparator. Its pin 1 output sits at over +8V when the IR beam is present but falls to 0V when there is no IR light falling on PD1 (ie, the IR beam is interrupted).

IC1a's output in turn drives the base of transistor Q1 via a 10kΩ resistor. As a result, Q1 is turned on or off depending on whether the IR beam is present or not. When the IR beam is present, Q1 is on and when the beam is interrupted, Q1 turns off.

LED4 and its series 1kΩ resistor form the collector load of Q1. This means that LED4 lights when Q1 is on and turns off when Q1 is off. This allows LED4 to be used as a guide when lining-up the Source's IR beam with PD1, as described previously.

Switching the trigger output

Because Q1 is switched on when the IR beam falls on PD1, its collector voltage is normally held down to about 0.4V. However, if the beam is interrupted, Q1 turns off and its collector voltage rises to nearly +9V.

This sudden voltage change is used to switch on Q2, a 2N7000 MOSFET which is used as an output switch across triggering output CON3. As shown, a 10nF coupling capacitor and Q2's 10kΩ gate resistor form a simple differentiating circuit. This results in Q2 being switched on only briefly when Q1's collector voltage rises when the beam is interrupted. The 100Ω resistor in series with the coupling capacitor is there to suppress any possible oscillation during switch-on or switch-off.

That's about it, apart from power switch S1 and the 470μF and 100nF capacitors which decouple the supply rail voltage to keep it constant. The current drain of the detector circuit varies between about 7.5mA when the IR beam is present and 1.5mA when it is interrupted, so the total battery drain for both sections varies between

Parts List

IR Source Unit
- 1 PC board, code 13106092, 57 x 26mm
- 1 UB5 jiffy box, 82 x 53 x 31mm
- 4 6mm long untapped spacers
- 4 M3 x 12mm screws, countersink head
- 4 M3 hex nuts
- 1 Nylon cable tie, 75mm long
- 1 2m length of light-duty figure-8 cable
- 1 3.5mm mono jack plug, cable type (CON1)
- 3 5mm IR LEDs (LEDs1-3)
- 1 820Ω resistor

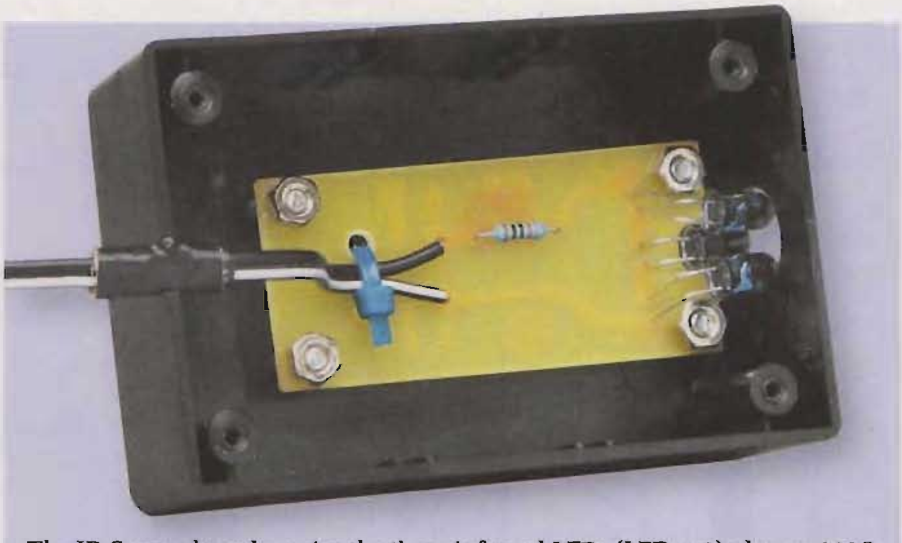
Detector Unit
- 1 PC board, code 13106091, 122 x 58mm
- 1 UB3 jiffy box, 129 x 68 x 44mm
- 1 SPDT mini toggle switch (S1)
- 1 PC-mount 3.5mm stereo jack (CON2)
- 1 PC-mount 2.5mm concentric plug (CON3)
- 4 M3 x 15mm tapped spacers
- 8 M3 x 6mm machine screws, pan head
- 2 1mm PC board terminal pins
- 1 9V battery clip lead
- 1 8-pin DIL IC socket
- 1 30mm length of 12-15mm diameter black PVC conduit or brass tubing
- 1 piece of IR-transparent red film, approx. 16mm square
- 1 9V battery snap connector OR 1 x 4-way AA cell holder plus 1 x 2-way AA cell holder – see text

Semiconductors
- 1 LM358 dual op amp (IC1)
- 1 BC338 NPN transistor (Q1)
- 1 2N7000 N-channel MOSFET (Q2)
- 1 IR photodetector (PD1) (Jaycar ZD-1948 or similar)
- 1 5mm green LED (LED4)

Capacitors
- 1 470μF 16V RB electrolytic
- 1 220μF 16V RB electrolytic
- 1 100nF metallised polyester
- 1 10nF metallised polyester

Resistors (0.25W 1%)

1 470kΩ	1 2.7kΩ
1 220kΩ	2 1kΩ
2 22kΩ	1 100Ω
2 10kΩ	



The IR Source board carries the three infrared LEDs (LEDs1-3) plus an 820Ω current-limiting resistor. It's mounted inside a UB5 case on 6mm untapped spacers and derives its power from the Detector unit.

15mA (beam present) and 9mA (beam interrupted).

Construction

As shown by the photos, the two units which make up the Beam Break Trigger are each housed in a small jiffy box. The IR Source circuit is built on a small PC board coded 13106092 (57 x 26mm), while the Detector parts are installed on a larger PC board coded 13106091 (122 x 58mm).

Start the assembly by building the IR Source board – see Fig.2. This should take you just a few minutes since there are only four components to install – the three infrared LEDs and the 820Ω current-limiting resistor.

Be sure to orientate the three IR LEDs correctly as shown in Fig.2. **In addition, these three LEDs must be fitted with their leads bent down by 90°, so they face out of the end of the box when the board is mounted inside.** In particular, note that the centre LED (LED2) is fitted with its body relatively low down near the board, while the two outer LEDs are fitted higher and with their leads bent inwards towards LED2. This is done so that they form a triangular group, to provide a relatively compact beam source (see photo).

Once these parts are in, install the power cable by soldering its leads to the +9V and 0V and pads. The cable is then anchored using a small Nylon cable tie which passes through the two 3mm holes on either side.

Having completed the board, it can be mounted inside its UB5 jiffy box on four 6mm long untapped spacers and secured using four M3 x 12mm countersunk head screws and nuts. As shown in the photos, the IR LEDs face outwards through a 10mm hole in one end of the box, while the power cable exits via a small notch filed in the top at the opposite end. Fig.3 shows where to drill the holes in both boxes.

Finally, complete the IR Source unit by attaching the front panel label to

Table 1: Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
1	470kΩ	yellow violet yellow brown	yellow violet black orange brown
1	220kΩ	red red yellow brown	red red black orange brown
2	22kΩ	red red orange brown	red red black red brown
2	10kΩ	brown black orange brown	brown black black red brown
1	2.7kΩ	red violet red brown	red violet black brown brown
2	1kΩ	brown black red brown	brown black black brown brown
1	820Ω	grey red brown brown	grey red black black brown
1	100Ω	brown black brown brown	brown black black black brown

An infrared transparent filter is fitted to the inside of the case at the receiving (PD1) end of the UB3 box, while a 30mm x 12mm-diameter "light-hood" (eg, brass or plastic tubing) is attached to the outside of the case.

Follow this photo and the parts layout diagram (Fig.2) at right to build the Detector PC board.

the lid. A full-size artwork is shown in Fig.3 and is also available for download from the SILICON CHIP website.

Detector board assembly

There are more components on the Detector board but its construction is still straightforward – see Fig.2. Install the resistors first, taking care to use the correct value at each location. Table 1 shows the resistor colour codes but it's also a good idea to check each one using a digital multimeter before soldering it in place.

Follow these parts with the metallised polyester capacitors, then fit the two electrolytic capacitors. The latter are polarised, so be sure to orientate them as shown. The two PC board terminal pins used to make the battery connections can then be fitted. **Note that both pins are fitted on the copper side of the board, to make it easier to solder the battery clip leads to them.**

Switch S1 and connectors CON2 & CON3 are next on the list, followed by an 8-pin socket for IC1. Be sure to orientate the socket with its notched end towards the adjacent 100nF capacitor, to guide you when plugging in IC1 itself later on.

Transistor Q1, photodetector PD1, MOSFET Q2 and LED4 can now all go in, again taking care to orientate them correctly. Note that PD1 is mounted vertically with its curved side facing outwards and with the centre of its body about 5mm above the PC board. LED4 should also be mounted vertically, with the bottom of its body about 12mm above the board (this ensures that it will protrude slightly from its matching hole in the box lid after assembly).

The Detector board can now be completed by plugging IC1 into its

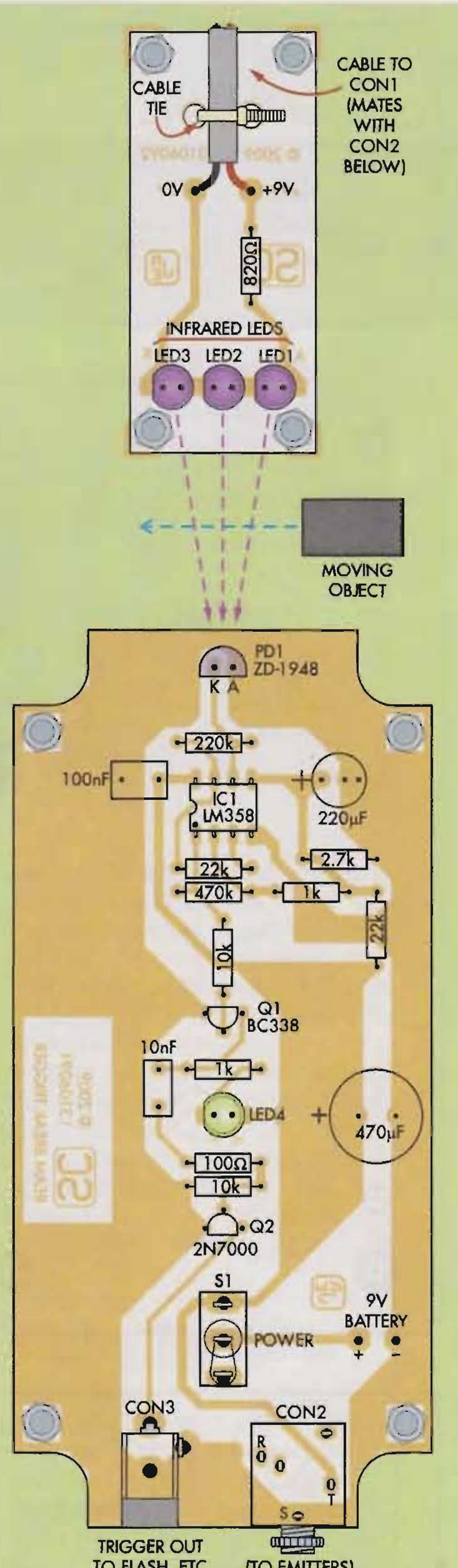


Fig.2: install the parts on the two PC boards as shown on this layout diagram. LED4 (green) on the Detector board is mounted vertically but be sure to bend the leads of IR LEDs1-3 through 90° before installing them on the IR Source board – see text & photo.

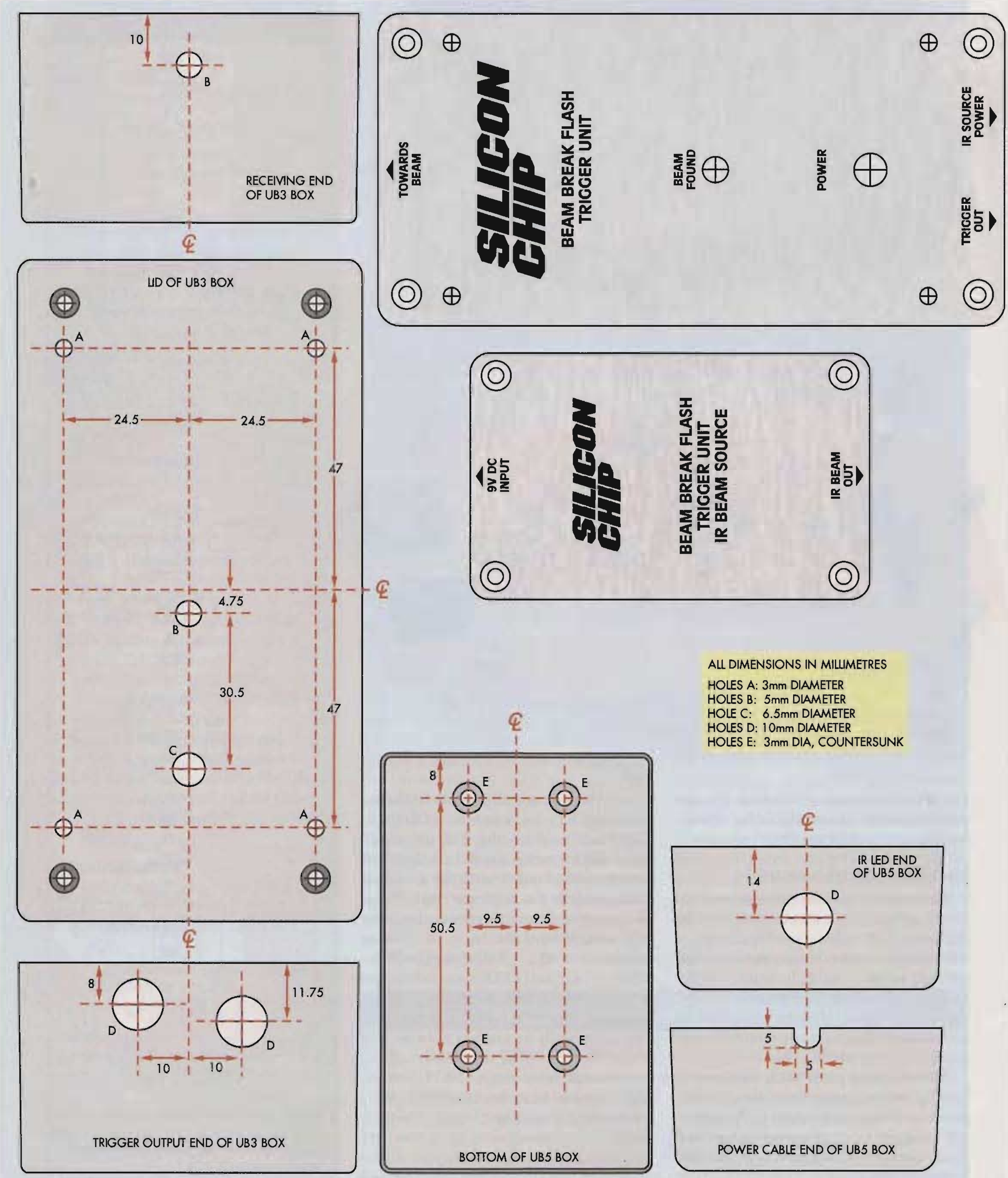


Fig.3: these drilling diagrams for the UB3 & UB5 boxes can be either be copied and used directly as templates or you can mark the holes out manually using the measurements indicated. Also shown are the two front-panel artworks. They can either be copied and used direct or downloaded from the SILICON CHIP website and printed out.

socket (take care with the orientation). The detector board is then ready to be mounted behind the lid of the UB3 box.

The first step is to drill and ream out the various holes in the base and lid, as shown in Fig.3. That done, fit the front panel label and cut out the holes using a sharp hobby knife, then secure the board to the lid using four M3 x 15mm tapped spacers and eight M3 x 6mm machine screws.

Note that you'll need to remove the upper nut from the ferrule of switch S1 before doing this, so the ferrule can pass up through its matching hole in the lid. Once the board is in place, the nut can be replaced and threaded down against the top of the lid. The lower nut and lockwasher can then be threaded up against the underside of the lid, using a small spanner.

The next step is to fit a small square of red "IR transparent" film inside the box behind the single 5mm hole at the PD1 end. It can be held in place using a couple of narrow strips of transparent tape, one on either side.

A short "light hood" is now be attached to the photodetector (PD1) end of the box. This must cover the 5mm hole and be as close as possible to concentric with it.

The hood itself can be fashioned from a 30mm length of 12mm diameter brass tubing (see photos) or from a similar length of opaque (preferably black) PVC conduit. Whichever you use, it's simply glued to the end of the box using 5-minute epoxy cement.

Now for the final assembly. First, connect the battery snap lead to the terminal pins on the underside of the board, then place the battery in the bottom of the box and fasten it in place using either a small aluminium "U" bracket or a strip of gaffer tape. Finally, lower the lid and PC board assembly into the box before fitting the screws to hold everything together.

Trying it out

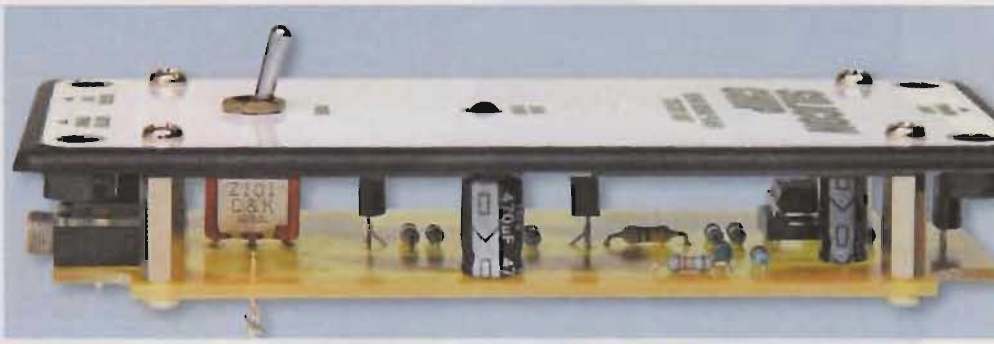
No adjustments are required, so you can try it out simply by plugging the power cable from the IR Source into CON2 on the Detector unit and turning on power switch S1.

If the Detector's light hood is now aligned with the output from the IR Source (or any other source of IR radiation), LED4 should immediately begin glowing. If it does, block the end of the hood with your thumb or a small piece of opaque material and check that the LED immediately switches off.

The same thing should happen if you turn the IR Source away from the Detector or if you simply block the beam with your hand or some other small opaque object. If this happens, then your Beam Break Trigger Unit is probably working correctly and is ready for use.

If you're going to be using it in conjunction with the Time Delay Photoflash Trigger unit, all that remains is to make up a suitable cable to connect the two together. This simply involves connecting the Detector's trigger output to the "external trigger contacts" input (CON4) of the delay unit.

By the way, the Beam Break Trigger Unit should give reliable triggering with the IR Source unit placed up to a metre or so from the Detector box in normal room lighting. This "beam length" range can be extended considerably in dark (eg, night-time) conditions but in bright sunlight it will be shortened due to the relatively high level of IR in the ambient light. SC



Above: the Detector board is secured to the lid of the UB3 case using four M3 x 15mm tapped spacers and eight M3 x 6mm machine screws

Left: a "light hood" is fitted to the end of the Detector unit to prevent interference from stray IR light sources.

Direct Flash Triggering: Making The Cable

As mentioned in the article, the Beam Break Trigger can also be used to trigger an electronic flash directly, rather than via the Time Delay Photoflash Trigger. To do this, trigger output CON3 is simply connected to the photoflash via a suitable cable.

However, when you're making up this cable, make sure that the positive side lead from the flash input is connected to the centre contact of the plug that goes to CON3. If the polarity is reversed, MOSFET Q3 in the Beam Break Trigger Unit could be damaged.

The procedure is to first use your DMM to check the polarity of the voltage at the end of the cable that's plugged into the flash unit (ie, with the flash unit powered up and ready for triggering). Once that's done, you'll then know which way around to connect the cable to the plug that goes to CON3 on the Detector unit.

While you're checking the polarity of the cable leads, make a note of the actual voltage itself. If it is below 60V, that won't be a problem. Conversely, if it's higher than 60V, you'll need to replace the 2N7000 MOSFET with one having a higher voltage rating – such as a IRF540N.

Digital Audio Oscillator

Design By DARIAN LOVETT
Words by MAURO GRASSI

Do you need to test audio equipment, including amplifiers and speakers, in the field and in the workshop? If so, you could use this compact and inexpensive digital audio oscillator. It can produce sine, square, triangle and sawtooth waveforms in the frequency range from 10Hz-30kHz and features three output ranges: 20mV, 200mV & 1V.

THIS COMPACT HAND-HELD digital audio oscillator will allow you to quickly test wiring and to diagnose faults in audio systems. It is ideal for testing amplifier and speaker set-ups and is portable and easy to use.

To use it, you simply select one of four waveforms – sine, square, triangle or sawtooth – and set it to a frequency between 10Hz and 30kHz. The digitally synthesised waveform is then available at the two RCA outputs. These two outputs are in parallel and are doubled-up simply for your convenience. It means you can test a stereo amplifier and speaker set simultaneously.

Turning to the front panel, there is a 4-position slide switch that selects one of three levels for the output signal: 20mV, 200mV and 1V. Each selected level can be continuously varied down to zero with the "Level" control.

There are also three pushbuttons on the front panel. The two on the right increase or decrease the frequency of the output waveform. The output frequency and the waveform type are shown on a blue backlit LCD screen.

Pressing the "Wave" button on the left while at the same time pressing the "Down" button on the right lets you scroll through the four different waveform types: sine, square, triangle and sawtooth. It's that easy!

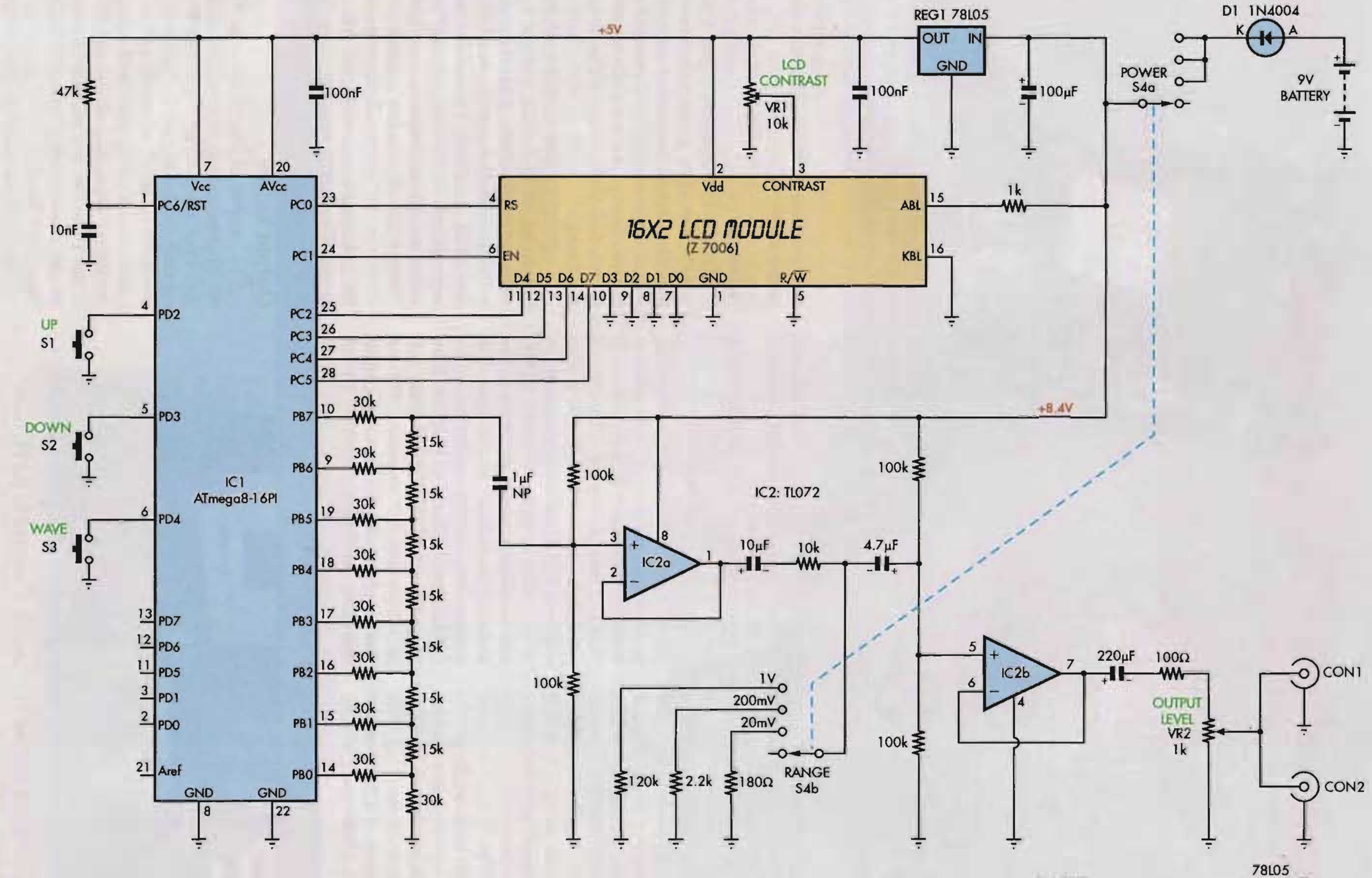
Circuit details

Fig.1 shows the circuit details. It uses an Atmel microcontroller (IC1) to implement most of the features.

The unit is powered from a single 9V battery. As shown, the +9V rail is fed via reverse polarity protection diode D1 to one pole of a 2P4T (2-pole 4-throw) switch, S4a. In three of the four positions, the switch feeds the resulting +8.4V rail on D1's cathode to voltage regulator REG1.

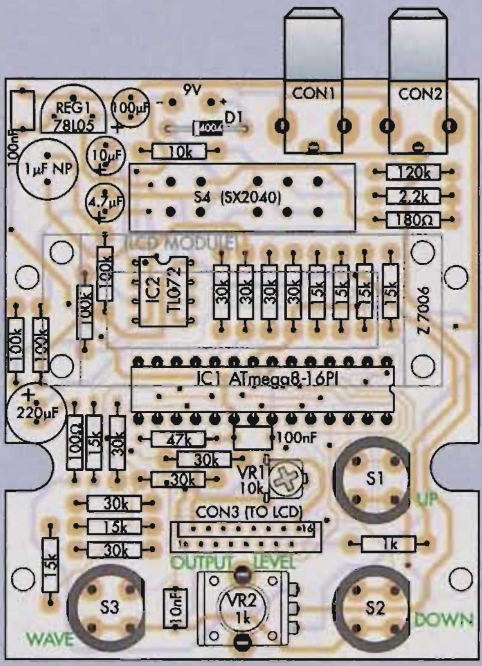
REG1, in turn, outputs a +5V rail which is used to power the microcontroller, while the +8.4V rail from diode D1 is used to power op amps IC2a & IC2b.

In operation, IC1 monitors pushbuttons switches S1-S3. These switches are respectively connected to digital inputs PD2-PD4 which have weak internal pull-ups. When a switch is pressed, the relevant input is pulled low and this is detected by IC1 and



SC DIGITAL AUDIO OSCILLATOR

Fig.1: the circuit diagram of the Digital Audio Oscillator. The design is based around a microcontroller (IC1), which drives an LCD module and a DAC made up of a R-2R ladder network and an op amp buffer stage. The blue backlit LCD screen shows the waveform shape and the frequency.



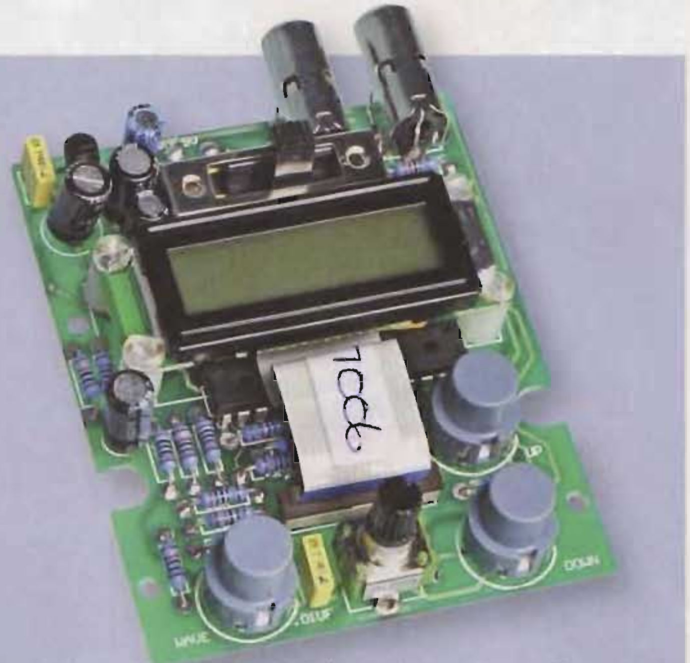


Fig.2: follow this parts layout to build the digital audio oscillator. Be sure to install the electrolytic capacitors and semiconductors with the correct polarity and note the orientation of switches S1-S3.

processed by the internal software. This sets the waveshape (sine, square, triangle or sawtooth) and the frequency and displays the result on a 16x2 LCD module.

As shown, the microcontroller drives the 16x2 LCD module using its PC0-PC5 digital output lines. Trimpot VR1 sets the display contrast, while power for the LCD is derived directly from the +5V rail. The 47kΩ resistor and 10nF capacitor on pin 1 of IC1 reset the microcontroller at switch on.

D-to-A converter

As well as the LCD module, the microcontroller also drives a digital-to-analog (D/A) converter via its PB0-PB7 digital output lines. This D/A converter is made up of a R-2R ladder network and has 8-bit resolution. In this case, R = 15kΩ and there are seven 15kΩ resistors and nine 30kΩ resistors in the ladder network.

The output of any N-stage R-2R network is given by:

$$V_{OUT} = D_N \times V/2^N$$

where V_{OUT} is the output voltage, D_N is the digital value as an N-bit number and V is the supply rail.

In our case, N = 8 (so $2^N = 256$), V = 5 and D_N is given by bits PB7 (MSb) to PB0 (LSb) which are digital outputs of IC1. The accuracy of such a DAC is constrained by the accuracy of the resistors. Note that, in this case, 1% resistors are used throughout.

The output of the DAC is AC-coupled to op amp stage IC2a (TL072) via a 1µF non-polarised (NP) capacitor. This op amp stage has its non-inverting input biased to half-supply by two 100kΩ resistors and is wired as a unity-gain buffer stage.

Attenuator

IC2a's output appears at pin 1 and is AC-coupled to an attenuator stage (switch S4b and associated parts) via a 10µF capacitor and 10kΩ resistor. As shown, the signal is fed to the wiper of switch S4b which selects the output level range.

In operation, S4b selects a divider consisting of the 10kΩ resistor and either a 120kΩ, 2.2kΩ or 180Ω resistor to GND, in parallel with the two 100kΩ bias resistors for IC2b. These selections correspond to the 1V, 200mV and 20mV amplitude ranges, respectively.

Selecting the 120kΩ resistor provides the 1V range, while selecting the 2.2kΩ resistor provides the 200mV range. The 180Ω resistor gives the 20mV range.

This side-on view shows how the LCD module is secured to the PC board using Nylon spacers and screws.

Output buffer

The output of the divider is AC-coupled to op amp output stage IC2b, this time via a 4.7µF capacitor. This op amp is also biased to half-supply using two 100kΩ resistors and also operates as a unity-gain buffer stage. Its output signal at pin 7 is fed via a 220µF capacitor and series 100Ω resistor to potentiometer VR2 which sets the output level.

The resulting signal at VR2's wiper is then fed to RCA output sockets

CON1 & CON2 which are connected in parallel.

Construction

The Digital Audio Oscillator is built on a double-sided PC board measuring 76 x 62mm. Fig.2 shows the parts layout.

Begin by carefully inspecting the PC board for hairline cracks and for shorts between adjacent tracks. It will be rare to find any problems but such checks are easier done at this stage than later on, when all the parts are in place.

Once you have inspected the board, start the assembly by installing the resistors. Table 1 shows the resistor colour codes but it's also a good idea to check them using a DMM as some colours can be difficult to distinguish. The diode can then be installed, taking care to orientate it exactly as shown on the parts layout diagram.

Voltage regulator REG1 in the TO-92 package can be soldered in next. It can only go in one way! Don't force the body down too close to the PC board or you may damage its connecting leads. It should ideally sit about 7mm off the board.

The PC board is secured inside the case using metal screws that go into integral mounting posts. Note that the battery leads are run under the PC board and into the battery compartment via a slot in the back wall.

The non-polarised MKT capacitors are installed next, followed by the polarised electrolytic capacitors. Make sure the latter are orientated correctly. Note also that the electrolytic capacitors must all be installed so that they sit flush with the PC board, to ensure they don't later foul the lid of the case.

A 28-pin IC socket is used for the microcontroller and this can be installed now. Be sure to orientate it with its notched end to the right, as indicated on Fig.2. Leave IC1 out for the time being – its plugged in later on, after some basic checks of the supply rail have been performed.

IC2 (TL072) is next on the list. It's directly soldered to the PC board and goes in with its notched end towards switch S4. Be sure not to apply too much heat at any one time to its pins, as this could damage it.

The LCD connector (CON3) can now be soldered in, followed by potentiometer VR1, the two RCA sockets (CON1 & CON2), the 2P4T switch (S4) and trimpot VR1. Follow these with the three pushbutton switches (S1-S3) making sure that they are orientated correctly. Note that each has a straight edge and this must go to the right as shown on the component overlay.

The last thing to do is to solder in the battery clip lead. The red lead goes to the +9V PC pad, while the black lead goes to the negative (-) pad. These pads are located at the top of the PC board, immediately to the left of the two RCA sockets.

That completes the PC board assembly, apart from plugging in IC1. As mentioned earlier, that's done only after making a few basic checks.

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	120kΩ	brown red yellow brown	brown red black orange brown
❑	4	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	9	30kΩ	orange black orange brown	orange black black red brown
❑	7	15kΩ	brown green orange brown	brown green black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	1	180Ω	brown grey brown brown	brown grey black black brown
❑	1	100Ω	brown black brown brown	brown black black black brown

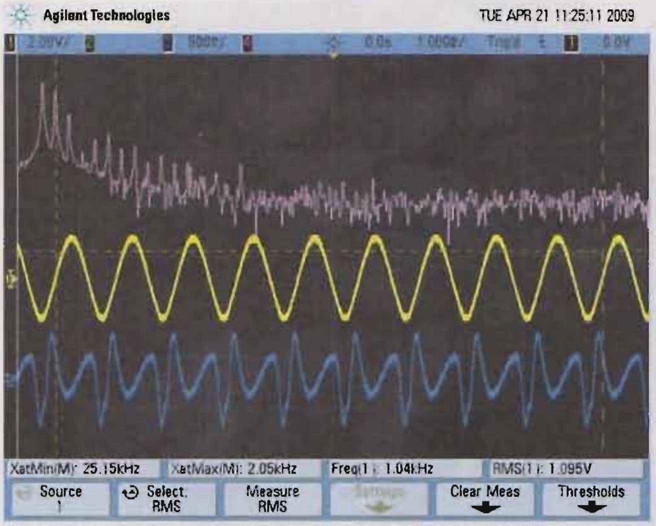


Fig.3: this oscilloscope screen grab shows a 1kHz sinewave (yellow trace), as captured at the output. The distortion waveform for THD+N (blue trace) can also be seen, as well as the FFT (Fast Fourier Transform) of the distortion. Note that the highest distortion peak is at the lower harmonics.

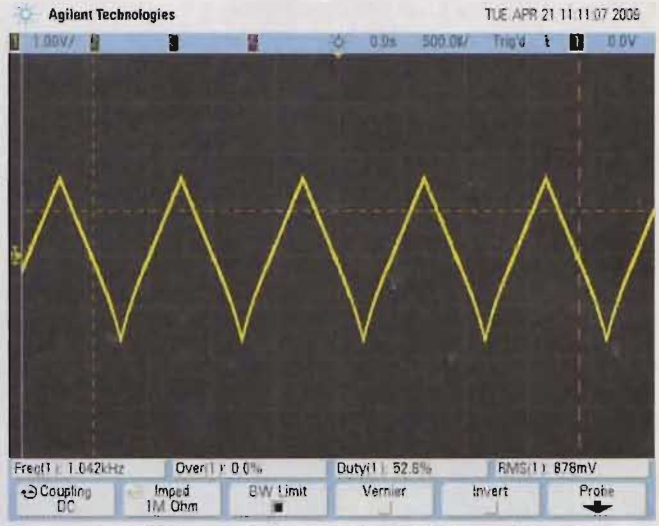


Fig.4: an oscilloscope screen grab of a triangular wave at around 1kHz. This shows that the waveform is very close to linear on the rising and falling slopes although there is some very slight drooping discernible at the waveform troughs.

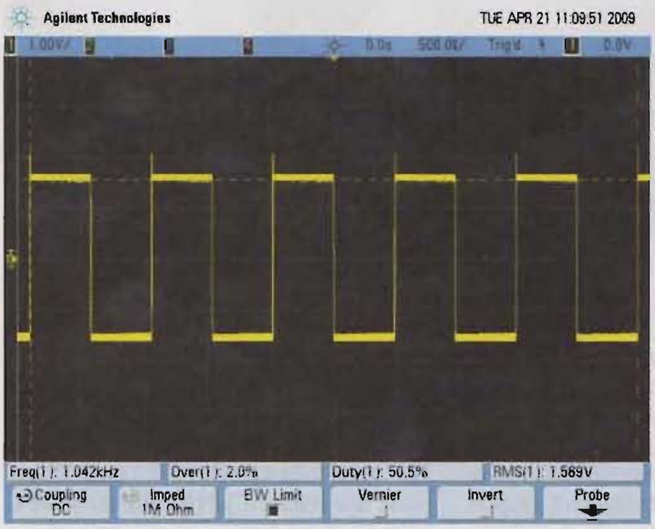


Fig.5: this shot shows the square wave output from the unit at around 1kHz. There is a 2% overshoot on the rising edge of the waveform but little droop. Droop will only be apparent at low frequencies in the tens of Hertz.

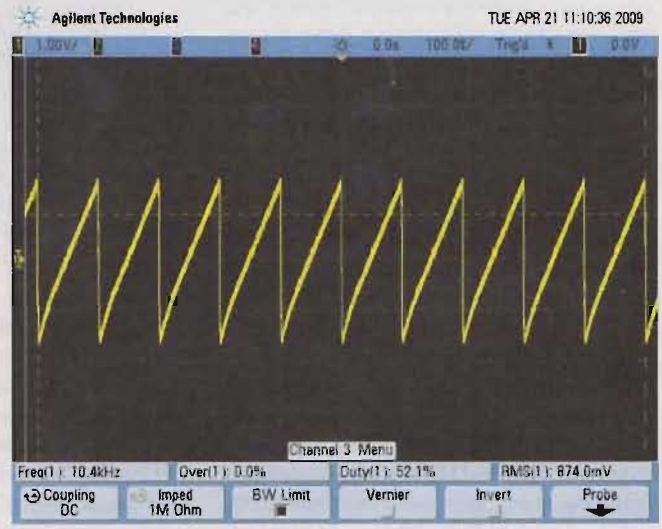


Fig.6: a sawtooth waveform at a nominal 10kHz. As shown, the actual frequency is 10.4kHz and the RMS value is also indicated. Note: this screen grab was obtained with the unit at full level on the 1V range.

Specifications

Frequency Range: 10-200Hz in 10Hz steps, 200Hz-1kHz in 100Hz steps & 1-30kHz in 500Hz steps

Amplitude Ranges: 0-20mV, 0-200mV & 0-1V RMS (output amplitude adjustable within the selected range)

Waveforms: sine, square, triangle & sawtooth

Frequency Accuracy: ±4%

Total Harmonic Distortion + Noise: approximately 3%

Output connectors: 2 x RCA parallel mono outputs

Power supply: 9V alkaline battery

Current drain: 25mA

Note also that the LCD module is not attached at this stage.

Initial tests

To test the assembly, first connect a 9V alkaline battery to the battery clip, then switch on and use a DMM to check the voltage between the OUT terminal of REG1 and the body of either RCA socket. You should measure close to 5V and this voltage should also be present on pin 7 of IC1's socket.

If this voltage is correct, you can jump to the final installation section. If not, you should disconnect power immediately and perform a few checks: (1) Are you using a fresh 9V battery?

Performance

WE CHECKED the Digital Audio Oscillator on our Audio Precision Test set and the results are shown in Fig.7. Keep in mind, though, that it is not intended as a high-precision instrument.

For the sinewave output, we measured the THD+N (Total Harmonic Distortion + Noise) over the frequency range with four different bandpass filters – see Fig.7. The typical THD+N figure was around 3% which is higher than most amplifier and speaker sets.

While this is not enough to worry about, it means you cannot use this oscillator in precision applications, where low distortion is paramount. It's quite good enough, however, for most troubleshooting tasks.

Figs.3-6 on the facing page show screen grabs of the four different waveforms that can be selected. The frequency accuracy is within ±4% across the whole range from 10Hz to 30kHz.

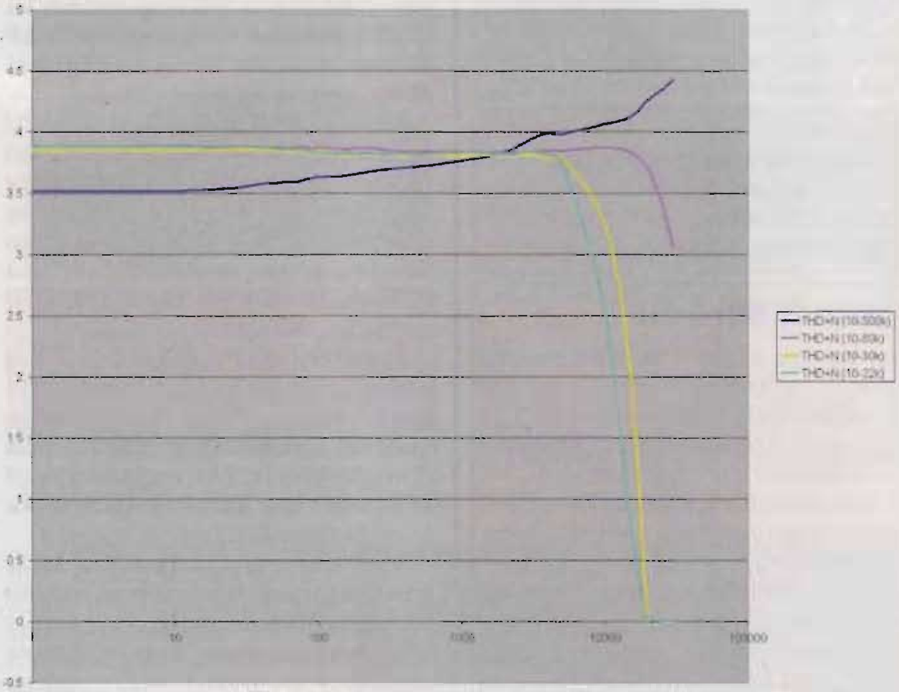


Fig.7: the sinewave THD+N vs Frequency for four different filter combinations. The filters range from <10Hz – >500kHz), <10Hz – 22kHz , <10Hz – 30kHz and <10Hz – 80kHz. The distortion is less with a more restrictive filter.

(2) Is there between 7-8.4V at the cathode of diode D1? If there isn't, then you may have D1 in the wrong way around.
(3) If the voltage is still incorrect, double-check the PC board assembly. In particular, check for incorrect component orientation and for incorrectly placed parts. Check also for dry solder joints on the underside of the board.

Assuming that REG1's output is correct, switch off and plug IC1 into its socket (notched end to the right). The LCD module can then be installed.

To do this, mount the LCD module in position on the PC board using four M3 x 9mm Nylon spacers and eight M3 x 6mm Nylon screws. The module's flexi connector is then plugged into CON3 on the PC board.

The PC board can now be mounted inside the case and secured using the four Phillips-head 10mm screws supplied with the kit. When doing this, make sure that the two battery-clip wires pass underneath the PC board and into the battery compartment – see photo. The top of the case can then be fitted into position and secured using the two Phillips-head 18mm screws.

Your Digital Audio Oscillator is now complete and ready for use. You can check that it is working properly by monitoring its output with a scope or failing that, feeding its output into an audio amplifier system. SC

Parts List

- 1 plastic case, 79 x 117 x 24mm, Altronics H-8971 (supplied drilled & screen-printed)
- 1 16x2 LCD with blue backlight, Altronics Z-7006
- 2 PC-mount RCA sockets
- 1 28-pin 0.3-inch machined IC socket
- 1 16-way PC-mount FFC/FPC connector, Altronics P-4516
- 1 10kΩ horizontal 5mm trimpot (VR1)
- 1 1kΩ log pot (9mm PC-mount), Altronics R-2480B
- 3 PC-mount pushbutton switches, Altronics S-1094
- 1 2-pole 4-position PC-mount slide switch, Altronics SX-2040
- 4 M3 x 9mm Nylon spacers
- 8 M3 x 6mm Nylon screws
- 1 9V battery snap connector

Semiconductors

- 1 programmed Atmel ATmega8-16PI microcontroller (IC1)
- 1 TL072 dual op amp (IC2)
- 1 78L05 regulator (REG1)
- 1 1N4004 silicon diode (D1)

Capacitors

- 1 220μF 16V
- 1 100μF 16V
- 1 10μF 16V
- 1 4.7μF 16V
- 1 1μF 16V NP
- 2 100nF MKT polyester
- 1 10nF MKT polyester

Resistors (1%, 0.25W)

1 120kΩ	1 10kΩ
4 100kΩ	1 2.2kΩ
1 47kΩ	1 1kΩ
9 30kΩ	1 180Ω
7 15kΩ	1 100Ω

Where To Buy a Kit

This Digital Audio Oscillator was designed by Altronics who own the design copyright. A complete kit of parts is available from Altronics for $89.00 (Cat. K-2543).
The kit includes the PC board, the machined case and all specified components (including a pre-programmed microcontroller) but does not include a battery.

PRODUCT SHOWCASE

OK, so what's a Wurli-Gig?

According to the people at Altronics, the 'soon to be famous' Wurli-Gig is the greatest time and labour-saving device PA speaker installers will ever see.

The Wurli-Gig is a two-part speed fixing bracket which cuts the installation time of a horn (PA) speaker by about 70% – a cost saving of around $10 per horn.

Designed to work with the Redback C-2053 and C-2056 horn speakers, the bracket fixes to walls with a couple of wall plugs and allows the horn to be simply clipped in place, without removing the horn from its bracket and subsequent replacement.

Not only does the Wurli-Gig save on installation time, it also saves on fasteners so on an installation of 50 horns, Altronics claim a total saving of between $500 and $600.

Removal of the horn from the bracket is just as easy and quick with a simple unlock-and-twist action.

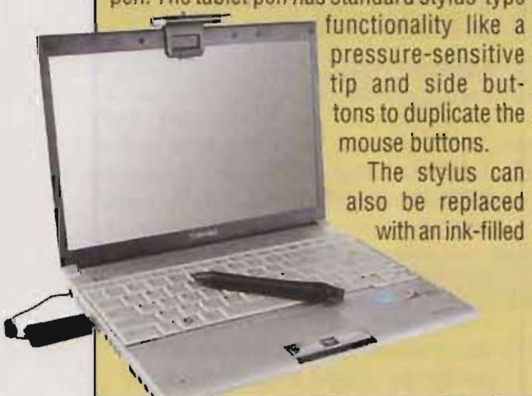
Retail price of the Australian-made Wurli-Gig bracket is $8.65 (Cat C2052) but is significantly less in quantity.

Contact:
Altronic Distributors Pty Ltd
PO Box 8350, Perth Busn Centre, WA 6849
Tel: 1300 780 999 **Fax:** 1300 790 999
Website: www.altronics.com.au

Convert any LCD into a touch screen

MicroGram's USB Tablet Attachment is an innovative pen input device providing full tablet function with simple installation.

The device is a webcam-sized receiver that sits on the top of a laptop's screen and captures movement through a special tablet pen. The tablet pen has standard stylus-type functionality like a pressure-sensitive tip and side buttons to duplicate the mouse buttons.



The stylus can also be replaced with an ink-filled tip. You then simply move the transceiver from your notebook screen to what you plan to write on and you can now produce hard copies of your drawings and written text while simultaneously creating a digital copy.

It's compatible with Microsoft Windows XP and Vista and works with multiple software applications such as Photoshop, Illustrator, PDF, Microsoft Outlook, Sticky Note and more, making it possible to draw, write, sketch, and illustrate.

You don't even have to touch the pen to the screen – it works on the air, just like the Nintendo Wii!

Contact:
Microgram Computers
PO Box 8202, Tumbi Umbi, NSW 2261
Tel: (02) 1800 625 777 **Fax:** (02) 4389 0234
Website: www.mgram.com.au

Cheltenham marks Jaycar's 10th store in Victoria

Jaycar Electronics has opened its 10th store in Victoria and 57th store across Australia and New Zealand,

The 380m^2 open-plan store, managed by John Dundas, is at 315 Warragal Road, Cheltenham and will be open seven days a week. It has plenty of customer parking and also has disabled access.

Jaycar Electronics has recently opened a number of stores in various areas of Australia and saw Cheltenham as an opportunity to add to its stable of stores.

For the latest product information call 1800 022 888 or visit www.jaycar.com.au.

Lowest sleep current nanoWatt XLP micros

Microchip Technology's next-generation low-power PIC microcontroller (MCU) families with nanoWatt XLP eXtreme Low Power Technology has sleep currents as low as 20nA.

Three new eight- and 16-bit MCU families join three other recent 8-bit families that are all part of Microchip's nanoWatt XLP portfolio, providing designers with a rich and compatible low-power migration path that includes on-chip peripherals for USB and mTouch sensing solutions

NanoWatt XLP Technology's key advantages are: sleep currents down to 20nA, real-time clock currents down to 500nA and watchdog timer currents down to 400nA. The vast majority of low-power applications require one or more of these features.

The three new nanoWatt XLP MCU families include the four-member, 16-bit PIC24F16KA family. This family enables applications to run for more than 20 years from a single battery. The six-member PIC18F46J11 and the six-member PIC18F46J50 8-bit MCU families feature typical sleep currents of less than 20nA.

The general-purpose PIC18F46J11 MCUs provide up to 64KB of Flash program memory and the peripheral set of a typical 64- or 80-pin device in only 28 or 44 pins, while the PIC18F46J50 devices add integrated full-speed USB 2.0 to enable connectivity for embedded applications requiring remote field upgrades or the downloading of data.

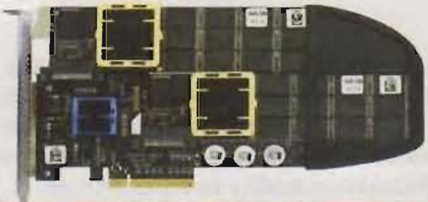
Contact:
Microchip Technology Australia
PO Box 260, Epping, NSW 1710.
Tel:(02) 9868 6733 **Fax:**(02) 9868 6755
Website: www.microchip.com/xlp

The world's fastest solid-state drive

The ioDrive Duo, which doubles the slot capacity of Fusion-io's successful PCI Express-based ioDrive storage solution, is now available locally from Pixel IT.

With the ioDrive Duo, it is now possible to get previously unheard-of levels of performance, protection and capacity utilisation from a single server. Performance for multiple ioDrive Duos scales linearly, allowing any enterprise to scale performance to six gigabytes per-second of read bandwidth and over 500,000 read IOPS by using just four ioDrive Duos.

Based on PCI Express x8 or PCI Express 2.0 x4 standards, which can sustain up to 20 gigabits per-second of raw throughput, the ioDrive Duo can easily sustain 1.5 Gbytes/sec of read bandwidth and nearly 200,000 read IOPS.



Contact:
Pixel IT Pty Ltd
Suite 22, 1 East Ridge Dve, Chirnside Pk, 3116
Tel: 1800 674 935 **Fax:** (02) 9798 3668
Website: www.pixel.com.au

Want multiple screens? ViBook them!

Italian-based Village Tronic's ViBook technology enables you easily to put together several, low cost screens to create as big a work area as you want at a really low cost per square inch of screen area.

The unique, multi-screen software makes it easy to arrange programs on the screens exactly how you want them, to improve your efficiency. For example, one or two programs can be dedicated to each screen so that they are always viable or a spreadsheet can be run seamlessly across all the displays.

Everything you need to work effectively can be always on display to multi-task without the delay of having to scroll or open and close panes, which really improves productivity for very little cost.

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34 Thomas St, Ashfield NSW 2131
Tel: (02) 9798 3288 **Fax:** (02) 9798 3668
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Email: sales2009@ozitronics.com
50W Amplifier kit using TDA7294

Hi-fi class AB audio amplifier. Over 50W RMS into 4 or 8Ω at less than 0.1% THD. 20Hz - 200kHz -3dB, +/-35VDC.
K106 - $50.05

DC power supply kit for use with K106 above. Onboard diode bridge and filter capacitors. Transformer not supplied. **K186 - $26.40**

More kits & all documentation available on website:
www.ozitronics.com

World's first 8x DL DVD

Verbatim is now shipping the world's first LightScribe 8X DVD+R Double Layer (DL) discs. The new media provides about 3.5 hours of DVD-quality video, one hour of HD video or 8.5GB of data on the DVD's storage side and direct-to-disc burning of silkscreen-quality text and graphics on the label side without having to flip the disc.

Contact:
Verbatim Australia
6 Weir St, Glen Iris, Vic 3146
Tel: (03) 9823 0999 **Fax:** (03) 9824 7011
Website: www.verbatim.com.au

Agilent's new 1000 series economy scopes

Agilent have expanded their digital-storage oscilloscope (DSO) portfolio with six new models that comprise its next-generation 1000 Series.

These new scopes offer bandwidths between 60 MHz and 200MHz and deliver features normally found on more expensive scopes. They are available with two or four channels and each comes in a package that is just 125mm deep and weighs around 3kg.

They offer a bright LCD display with a sharper image which is visible from a much wider viewing angle than competitive scopes. And with up to 20kpts of memory per channel, the 1000 Series allows engineers to use the full sample rate of the scope up to eight times longer than other scopes in its class.

They can display 23 automatic measurements – up to 21 simultaneously – including measurements from a built-in six-digit counter.

Additional information about Agilent's new DSO1000 Series oscilloscopes and the company's complete line of oscilloscopes is available at www.agilent.com/find/1000

Contact:
Agilent Technologies
347 Burwood Hwy, Forest Hill, Vic 3131
Tel: (03) 9210 5555 **Fax:** (03) 9210 5899
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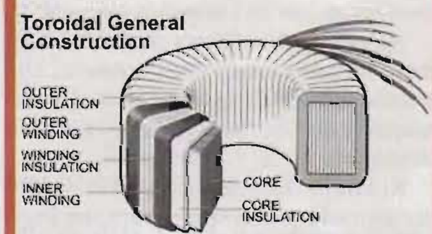


Comprehensive data available:
www.harbuch.com.au

Harbuch Electronics Pty Ltd
9/40 Leighton Pl, HORNSBY 2077
Ph (02) 9476 5854 Fax (02) 9476 3231

PICAXE humidity using the HopeRF

Recent SILICON CHIP articles on HopeRF 433MHz data transceivers have drawn our attention to other monitoring modules made by this Chinese firm. Amongst their offerings is a well-priced and calibrated humidity sensor, the HH10D. This has shown itself capable of extremely simple interfacing to even the humblest PICAXE, although factory calibration values first need reading via an I²C-level PICAXE such as the 18X.

Although atmospheric humidity levels may not be considered as interesting as temperature, numerous environmental situations arise when humidity insights can be crucial.

Relative humidity (RH) levels range from a bone dry 0% to 100% (when the air is so saturated that dew forms). Although temperature dependant, human comfort levels typically range between 40-60% RH.

Drier air may cause skin conditions, static discharges and thirst due to excessive sweating. Higher RH levels are associated with food spoiling, disease, moulds and human discomfort, due to an inability for perspiration to evaporate.

In contrast plants may wilt in dry air (and hence usually favour higher humidity levels) but food preservation, equipment storage and crop drying best suits low RH levels.

Naturally the likely onset of rain may be associated with a rise in the atmospheric RH levels too – a technique used by many home weather stations.

Relative humidity is classically measured by techniques ranging from paper and hair stretching to more scientific dual "wet and dry bulb" thermometers, with simple instruments based around this latter approach still capable of very good results.

Although inconvenient, a couple of similar thermometers and a moist cotton shoelace can readily give do-it-yourself RH insights.

The moist bulb cools as the evaporating water takes thermal energy from it, with the degree of "wet" temperature drop being inversely related to the RH.

(Refer to www.picaxe.orconhosting.net.nz/humtable.jpg for the resulting wet/dry tables).

Electronic humidity measuring has predictably developed, being normally now done with specialised capacitors, since an exposed and porous dielectric slowly changes its moisture content in response to humidity levels in surrounding air. If used in an RC oscillator circuit, small frequency changes can be linked to the altered capacitance value.

Humidity module

The HopeRF HH10D relative humidity sensor module, available from Microzed and Futurlec for around $13, utilises a capacitive-type sensor element linked to two on-board ICs. The first is an M24C01 EEPROM which is used to hold two factory calibration related values required to calculate the relative humidity as a percentage.

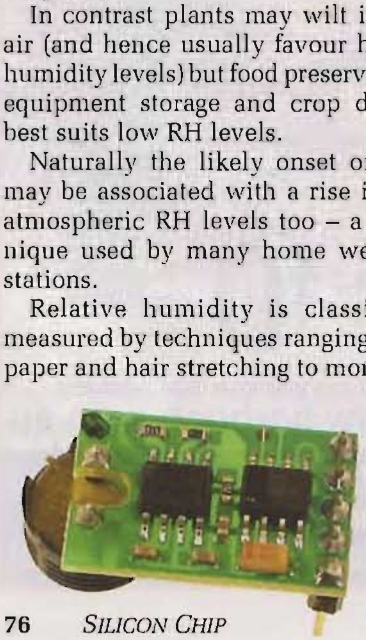
The second IC is a humble CMOS 555 timer whose output signal varies in frequency with the change in capacitance as the humidity level changes. Of course, such an RC oscillator is a classic 555 application, although the frequency is usually altered by resistor variation.

Accessing the EEPROM calibration data

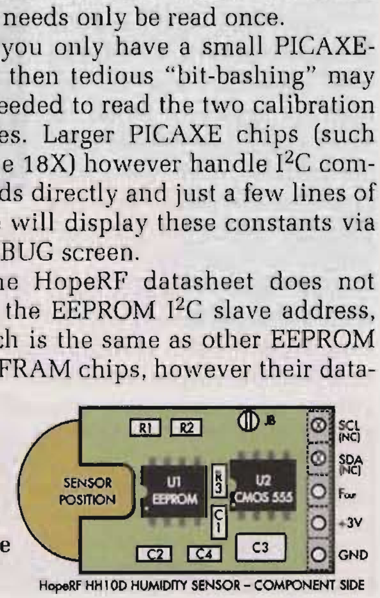
The EEPROM requires an I²C communications bus to read the calibration data but as these are fixed values, the data needs only be read once.

If you only have a small PICAXE-08M then tedious "bit-bashing" may be needed to read the two calibration values. Larger PICAXE chips (such as the 18X) however handle I²C commands directly and just a few lines of code will display these constants via a DEBUG screen.

The HopeRF datasheet does not give the EEPROM I²C slave address, which is the same as other EEPROM and FRAM chips, however their data-



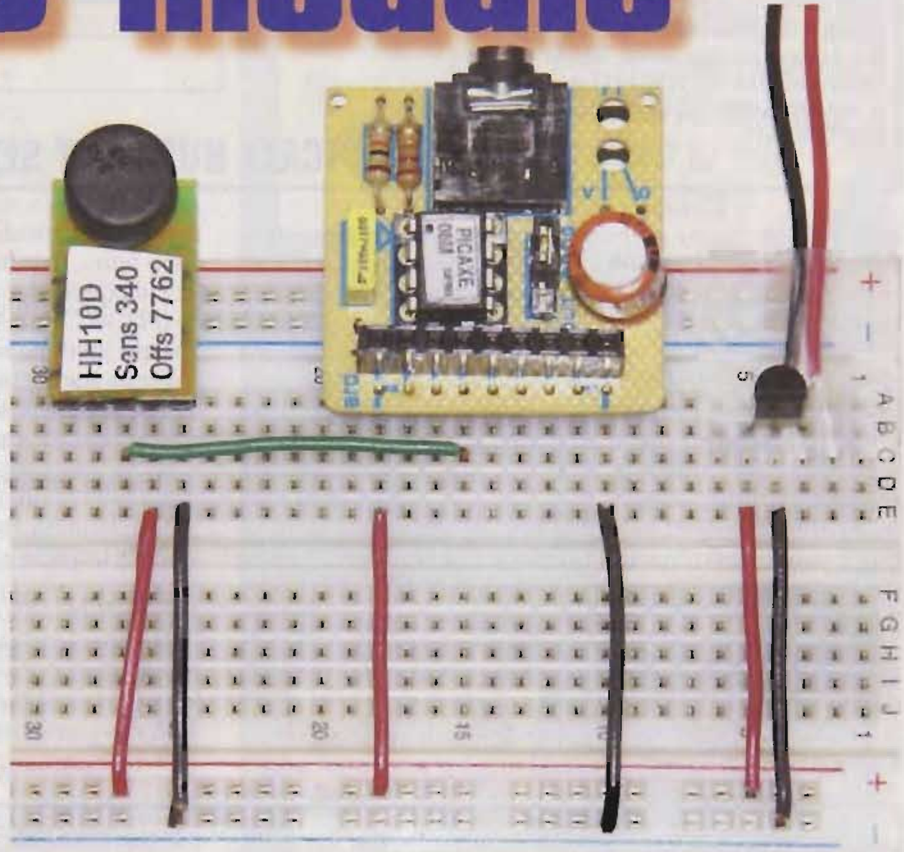
(Left): an enlarged photo of the HopeRF HH10D humidity measureing module, with the physical component layout shown at right. The same module can be seen from the opposite side in the breadboard layout on the opposite page. Note the label fixed to the back of the PC board – this is explained in the text.



HopeRF HH10D HUMIDITY SENSOR – COMPONENT SIDE

measuring HH10D module

By Wayne Geary and Stan Swan



Almost any classic PICAXE layout could be used, since only a single monitoring wire is needed! Here's a hybrid PC board and breadboard approach, with the PICAXE-08M mounted on a trimmed AXE021 protoboard. That TO-92 package is a 78L03C low power 3V regulator. Although PICAXEs are more tolerant,the HH10D must not be supplied any more than 3.3V.

sheet does indicate that the EEPROM external address pins are configured to address 01.

While the HH10D datasheet indicates that there are three calibration values, only two are in fact used:

- The Sensitivity value is stored in EEPROM locations 10 and 11
- The Offset value is stored in EEPROM locations 12 and 13.

Here is an example of the program lines required to use a PICAXE with inbuilt I2C communications bus. This has been written using commands that any PICAXE X, X1 or X2 type chip can use.

```
I2CSLAVE %10100010, i2cfast, i2cbyte

READI2C 10, b0, b1, b2, b3

DEBUG
```

The PICAXE DEBUG command will display theses byte variables in a Programming Editor window for recording.

Those experienced with the PICAXE chips will know that word variables (w) use the byte variable (b) with the odd number as the Least Significant Byte (LSB) and the byte variable with the even number as the Most Significant Byte (MSB) The HH10D humidity module however has the even location as the LSB and the odd location as the MSB.

As an example, using the above lines of program, we might see the byte variables in decimal format as:

b0 = 01, b1 = 85, b2 = 30 and b3 = 29

From these byte values we can determine the calibration values as:

Sensitivity (Sens) = 1 * 256 + 85 = 341

Offset Value = 30 * 256 + 29 = 7709

It's suggested you make a note of these calibration values, perhaps printing them on a small label to stick to the rear side of the small humidity module PCB. An example is given below:

HH10D
Sens 341
Offs 7709

For users without I^{2}C capable PICAXEs at hand, it may be tolerable to just use values approximating ours – testing of several HH10D units showed most modules were close in value to these anyway.

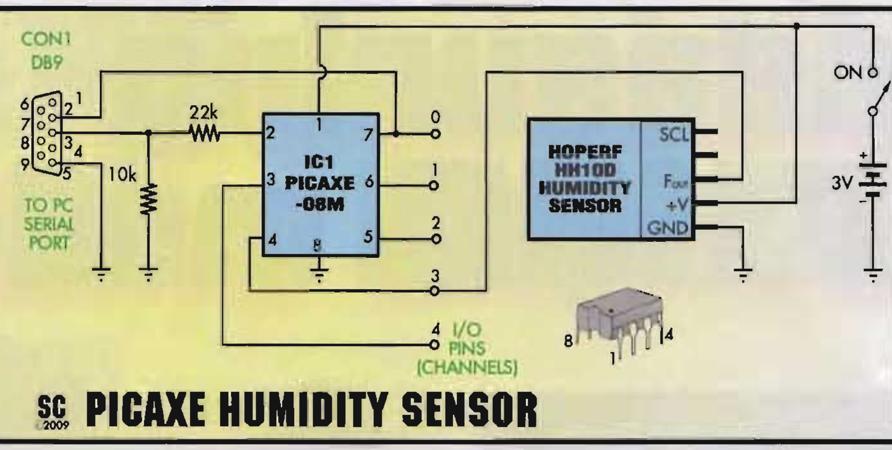
However cross-checks against readings from a known good weather station (or even a classic dual thermometer "wet and dry bulb" hygrometer) could aid later fine tuning calibration.

Humidity Module connection and output.

Once the calibration data is read, the HH10D humidity module is very easy to use. Of the 5 connections only three are required for VDD supply (3V), Gnd (0V) and FOUT (Soh).

Note that the 3V rated module must

Don't you just love how PICAXEs make circuitry so simple? The HopeRF HH10D Humidity Module interfaces dirctly with PICAXE chips, albeit with a bit of fiddling around with programming to overcome some of the lower-end PICAXE chips' limitations. Note the supply voltage in this circuit – 3V instead of the usual 4.5V – even though the PICAXE is quite happy at the higher voltage, such would make short work of the HH10D (absolute maximum 3.3.V, as shown in the spec table below).



NOT be run on any more than 3.3V – a supply value that fortunately PICAXE-08Ms still readily work with.

For testing, two AA 1.5V cells should hence be suitable to supply the entire reading setup.

For breadboard or soldered prototype mounting, the module's 5-pin SIP header terminal strip connectors may better suit being resoldered from the other side of their holder PC board, as this then allows the capacitive sensor to be more conveniently mounted away from other circuitry and upright into clear air.

Ensure the correct module connections are being used if this simple modification is made! Right-angle SIP strips could also be used for vertical mounting – the exact choice depends on your application.

The output signal on the pin F_{OUT} (called Soh in the datasheet formula) is a frequency of approximately 6-8kHz which varies as the humidity level varies.

The PICAXE COUNT command, which rapidly counts the number of times a designated input pin changes from a low to a high state within a given time period, can readily help here. This makes use of the frequency of a signal being of course the number of such cycles per second (recall f=1/T), so simply COUNTing the HH10D signal for 1 second should give the frequency.

From the HH10D module datasheet we are given the following formula to calculate the Relative Humidity as a percentage value:

RH(%)= (offset-Soh) * sens/2^{12}

Substituting the calibration values extracted from the sample module gives:

RH(%)= (7709-Soh) * 341/4096

However, a few minor problems experienced with PICAXE maths now arise:

- only integer (whole number) maths are performed
- the largest number held by a word variable (W) is 65535
- it does not support brackets for precedence.

```
#PICAXE 08M
'Sample HopeRF HH10D humidity module program for June 2009 SiChip
'Ref resources => www.picaxe.orconhosting.net.nz/hopehum.htm
'IO DEFINITIONS
SYMBOL humid        = 3
'
' VARIABLE DEFINITIONS
SYMBOL axefactr     = b2
SYMBOL Soh          = w2                'w2 = b5:b4
SYMBOL diff         = w3                'w3 = b7:b6
SYMBOL RH           = w4                'w4 = b9:b8
'
' CONSTANTS -strictly need to be read via I2C for each module, but can be assumed close
SYMBOL Offset       = 7709              'HH10D offset calibration constant - a second module has 340
SYMBOL Sens         = 341               'HH10D sensitivity calibration constant - a second module has 7762
'
' MAIN PROGRAM
Main:
    COUNT humid, 1000, Soh              'read the frequency (ie cycles in 1 second)
    diff = Offset - Soh
    axefactr = diff / 19 + 1            'factor prevents number roll over error if >65535
    RH = 10 * Diff / axefactr * Sens    'int. result (x10 gives possible 0.1 resolution)
    axefactr = 4096 / axefactr          'a factor to prevent number roll over error
    RH = RH / axefactr                  'final value for RH%
    RH = RH / 10                        'divide by 10 (for now) as just whole integer RH%
    SEROUT 1, N2400, ("RH% = ", #RH)
    PAUSE 5000                          'wait for 5 seconds until next reading
GOTO Main
```

As might be seen, multiplying a number greater than 192 by 341 will result in an overflow of the values! Likewise, dividing by 4096 may result in loss of accuracy as no fractional part is retained.

To improve the accuracy of the maths, allow one decimal place and also avoid overflow within the PICAXE maths, we have introduced a factor. This factor is a variable number defined to keep the intermediate results as large as possible which will help minimise error.

Our variable called Axefactr (short for "PICAXE factor") is a value determined as follows:

Axefactr = (offset- Soh) / 19 + 1

This number will calculate correctly with the PICAXE. The result will be a number from 1 to 64 inclusive. Using this factor and multiplying the early part of the calculation by 10 makes it possible to extract 1 decimal place (if required), at the completion of the calculation.

RH10(%)= (((offset - Soh) / 19) + 1) * 10) * Sens / (4096 / Axefactr)

This awkward calculation needs to be broken over several lines of code in the PICAXE. To save on the limited number of variables available to the PICAXE chips, some are reused for a new variable part way through the calculation.

After all the number crunching and formula tweaking, just a single PICAXE-08M input pin (here 3) suffices for eventual reading of this final value, with a SERTXD showing %RH readings on the Editors F8 terminal.

The code shown at left can also be downloaded from www.picaxe.orconhosting.net.nz/hopehum.bas. In future, we plan to extend use of this humidity module with the HopeRF 433 MHz wireless data transceivers.

Article resources and references can be linked to, from www.picaxe.orconhosting.net.nz/hopehum.htm **SC**

Sensor Performance Specifications and HH10D Humidity Module Characteristics

Parameters	Min	Typ	Max	Units
Resolution	0.3	0.08	0.05	%
Accuracy		3		%
Repeatability	-0.3		0.3	%
Uncertainty		2		%
Response Time		8		s
Hysteresis		1		%
Interchangeability	Fully Interchangeable			
Humidity Range	1		99	%
Temperature range	-10		+60	°C
Working voltage	2.7	3	3.3	V
Stability versus time		1%		per year
Power consumption	120	150	180	µA
Output Frequency Range	5.0	6.5	10	kHz

Here are the manufacturer's specifications for the HH10D Humidity Module. All it needs are supply and data output lines to interface with the PICAXE.

Salvage It!

BY LEO SIMPSON

Gather up those discarded monitors now – before it's too late

There is a massive change happening in Australian offices and homes at the moment: CRT monitors are being discarded in their thousands in a wholesale changeover to LCD monitors. This represents a great chance to get a big stock of useful components but you need to do it now because CRT monitors will become a rarity within the next few years.

POSSIBLY YOU HAVE seen lots of monitors being thrown out in the streets during your local council clean-ups. Lots of computers are being thrown out as well. But while the computers themselves might present limited possibilities for salvaging parts, CRT monitors, particularly the older ones, are a treasure trove of good components.

Consider also that many CRT monitors being thrown out are still working perfectly. Their owners have simply upgraded and because they don't want to keep them in the garage or wherever, they are being tossed out. So if you pick up a monitor from a council street clean-up, the chances are that all of its components are still quite OK.

Even our own office at SILICON CHIP has made an almost complete switch to LCD monitors during the last year, so we had a good range of old CRT monitors, some dead, some nearly dead (with worn-out picture tubes) and some relegated to standby, just in case a monitor failed and we needed a quick substitute. So we only had to take a few steps out to the warehouse to pick a random candidate for this story.

The one we picked was probably well over 10 years old and a very good 17-inch (diagonal) monitor in its day. And it was destined for the tip, along with a couple of very large 21-inch monitors and a bunch of others which were dead. I must admit that I hate throwing this stuff out, because I know that it once represented some of the finest technology that money could buy. Now, it is just old stuff that takes up space.

Down to work

Anyhow, it was out with the tools and down to work. Removing the cabinet back was simple, with just a couple of screws and a few clips to unlatch. Before that though, we pulled off the swivel base which incorporated a USB input and output. We pulled this apart and found a well-shielded PC board which had provision for more inputs – just why it was there was a mystery. However, these were perfectly good USB sockets which could be pressed into service for some future project.

Having removed the back off the cabinet, you have to wonder if this might have a use. We racked our brains and could only come up with two possibilities: a waste paper basket or as plant holder in a garden pond. They have a lot of ventilation slots so they cannot be used as conventional plant pots unless lined with plastic; perhaps readers can come up with some other uses. If so, we would like to hear about them.

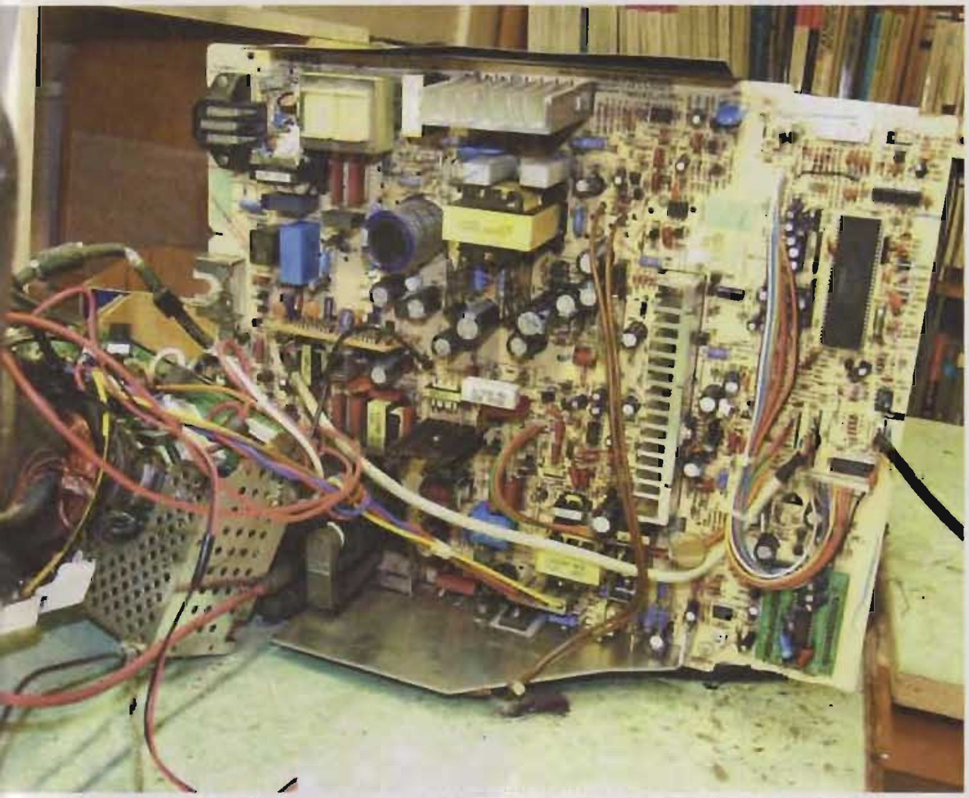
We also removed four screws to remove the front escutcheon from the picture tube frame. This incorporates three small PC boards. One board has two potentiometers (brightness & contrast) with push-on knobs, another board has miniature pushbuttons and the third, the on-off switch assembly, has a miniature pushbutton switch and LED. All of these could be useful to have in your junk-box.

Then we pulled the main board off the picture assembly – a few screws and clips did this but it was still tethered by numerous leads to the neck-board assembly and to the picture tube via the EHT connector and earthing leads. Well, there is no need to desolder any other these – just clip them off with side cutters.

And what a magnificent resource is the main PC board! Measuring 370 x 290mm, it literally had hundreds of components. Not all are worth salvaging, since it would take too much time and many would be damaged by desoldering. However, virtually all the capacitors can be safely removed as can the relays and a number of toroidal inductors.

Heatsinks

Many of the discrete semiconductors such as power transistors also have very useful clip, flag and extruded aluminium heatsinks which



There's lots to salvage inside an old CRT monitor, including aluminium heatsinks of all shapes and sizes, trimpots, capacitors, semiconductors and high-power resistors. Don't forget the tinplate shielding around the neck board.

are worth salvaging, even if you don't want the semis themselves. A lot of the power diodes are mounted with long leads (to give them plenty of ventilation) so they can be easily removed simply by clipping them off close to the board.

Also mounted well off the PC board were a lot of metal film power resistors of about 2-watt rating. These should not have drifted much in value so they are probably worth saving too, merely clipping them off the board. The bigger wirewound resistors are also worth removing.

Removing the parts

To remove the multitude of capacitors and the bigger semiconductors, you will need a large soldering iron, preferably one rated at 60W or more. You don't want to be fiddling around with a small temperature controlled iron with a small tip – it will take forever to get even a small number of bits off the board. The process here is to heat all leads of the component simultaneously, as quickly as possible.

In a previous Salvage-It article, the author suggested using a heat gun to get the bits off PC boards. That is OK if you are being highly selective in getting bits off. But if you want to remove lots of plastic and electrolytic capacitors, the heat gun will apply too much heat over too big an area and while you are concentrating on just one component, others may well be damaged.

Remember that each small plastic capacitor you salvage is probably worth an average of 50 cents and the larger electrolytics may be worth quite a few dollars. The main electrolytic reservoir capacitor on the board was a 330μF can type rated at 400V. This is quite a valuable component if you are going to build a high-voltage power supply.

If you are into restoring vintage radios you need to grab as many of the capacitors as you can, particularly those with the higher voltage ratings. This main board had dozens of capacitors that were worth saving.

If you want a selection of multi-coloured hook-up wire, don't neglect the various cable assemblies. Most of the transformers probably are not worth saving, as they will usually be special high-frequency types with ferrite cores.

Also not worth bothering with will be all the small resistors, small plastic transistors and any ICs, unless you are able to identify ones that you particularly want.

Neck board

Don't overlook the neck board. This will be in a tin-plate shielding cage and will accommodate an array of well-made vertical or horizontal trimpots, high-voltage video transistors with big flag heatsinks, more power resistors mounted on long legs and various toroids used for suppression purposes.

We would not bother trying to salvage the passive components on the neck board as they will have been subjected to a lot of heat and voltage stress over the years.

It goes without saying that any salvaged components should be tested before they are re-used – some might be quite marginal such as leaky capacitors and resistors that have drifted high in value. Some pots and trimpots will also tend to be dodgy, as their wipers tend to make poor or intermittent contact as they get older.

So what else is worth saving? What about the degaussing coil around the picture? In fact, the set we dismantled had two degaussing coils, one around the main body of the CRT near the metal frame and a smaller one near the yoke. The larger one could perhaps be pressed into service, together with a plastic tuning capacitor, to make an AM loop antenna (see Stan Swan's article on this subject in the January 2008 issue).

Don't forget any useful screws, nuts, washers, lockwashers, brackets and other small pieces of hardware. Any metal bits that you are not going to save should go into your regular recycling bin.

Don't hoard too much

While you might be keen to save good components, remember that you can have too much of a good thing. Organise your saved bits into parts bins or jars with a marked range of values. There is no point in having lots of recycled parts if you cannot easily access them when you have a particular need.

When you have salvaged the parts you need, put the rest in your garbage bin. You can do this with a clear conscience, knowing that you have saved many useful and often expensive components from the tip, to see useful life in another application. **SC**

Voice Me!

VoiceMe is a voice-activated remote control. It can be used to control up to ten functions on your TV, DVD player, Home Theatre system or whatever and it can have up to four separate users. If you are one of those who often loses remote controls, it could be an attractive option.

While anyone can see the attractions of voice-activated control, it could be even more advantageous if the prospective user is blind, elderly, quadriplegic or otherwise handicapped and unable to use conventional remote controls.

In fact, the potential for this device seems almost unlimited for these people. And since one of my relatives is blind, I was particularly keen to see if it would suit that situation.

VoiceMe main unit

The unit has two modes of operation: voice control or via an RF (radio frequency) remote. As you can see from the photograph the unit only has four buttons. Each button selects a user (1-4).

It also has an infrared receiving window in front of the buttons and IR emitting windows to the left, right and rear. Each window has two IR LEDs. Finally, there is an electret microphone under a hole at the apex of the dome.

Power for the unit comes from a 9V 300mA DC plugpack or it can be used with four AA cells which are fitted into a compartment underneath the unit. The unit apparently saves all commands in non-volatile memory, so loss of power (ie, when you change batteries) does not result in any loss of commands.

VoiceMe extender

The VoiceMe Extender RF remote control has four buttons corresponding to those on the main unit, plus mode and mute.

The iPod-like circle at the top allows channel up and down with the left and right symbols and volume decrease and increase with the top and bottom symbols. A red LED at the top right corner lights whenever a button is pressed.

Three AAA cells power this unit. In the majority of situations we assume that the Extender will only be used by a person who has not trained VoiceMe.

Getting it working

Now to the nitty gritty! The unit comes with the ability to distinguish the voices of up to four different users, with each user having a repertoire of 30 commands or at the other extreme, one user with 120 commands or any combination in between.

Pressing any of the four buttons on VoiceMe will trigger the device into issuing a list of 11 functions. This is called manual setup and is the default method.

The 11 functions are listed on the setup chart in the 4-page manual. Unless you plan to use the remote control, functions six, eight, nine and ten can be ignored, as these are only relevant to that device.

Selecting a name

The first step is to decide what you are going to call the device. R2D2 and C3PO were possible but black box won the day, even though it is silver and grey.

We pressed the left front button again and as soon as 'train keyword' was spoken we pressed it again. If you have already entered a keyword it gives you the opportunity to change it. If you take no action the keyword remains, otherwise you overwrite the old keyword with a new one.

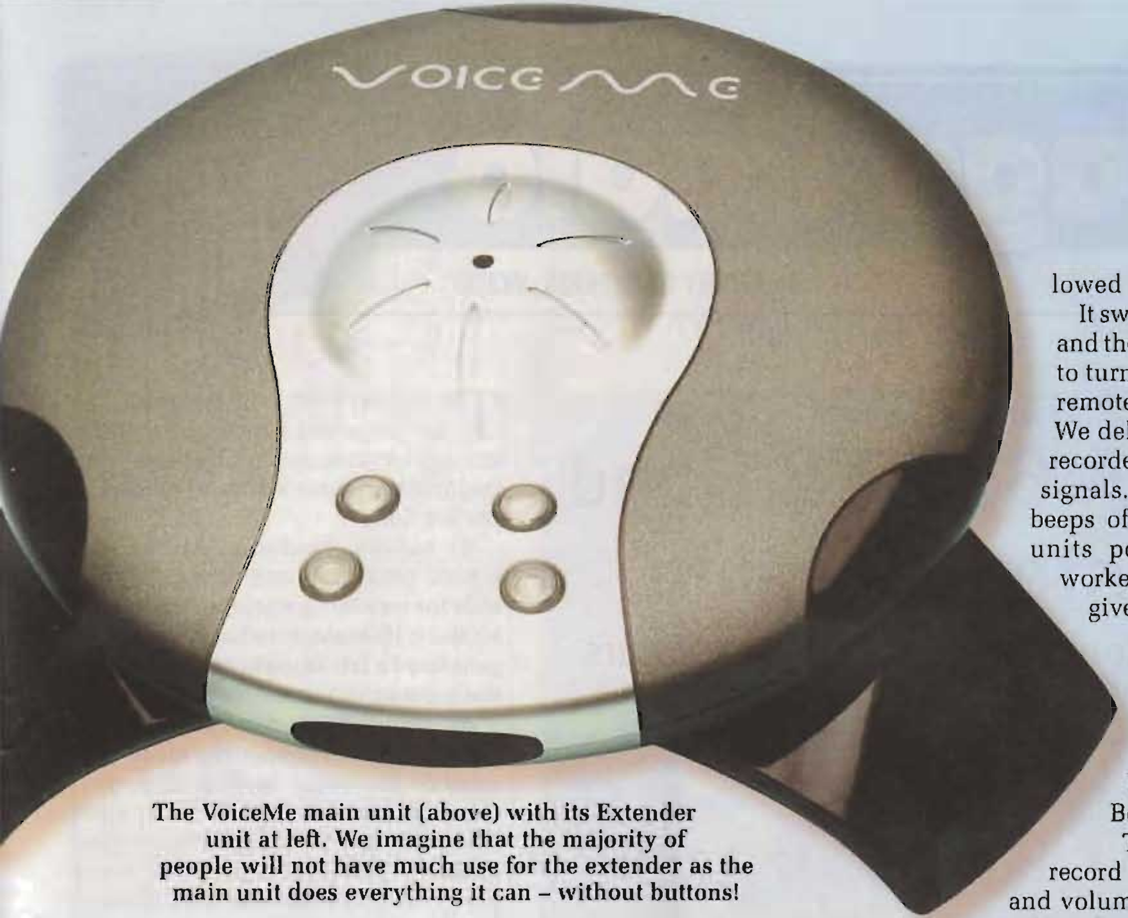
We decided to initially test VoiceMe using an amplifier which had a remote control with the ability to turn the amplifier on and off, mute and raise and lower the volume. A single-page instruction sheet recommends using commands of three to four syllables as keywords or commands, in order to get better recognition results.

Recording commands

The next step was to record some commands. Each time you do this you are asked to repeat the command and evidently the software is doing some fancy analysis. Most remotes use the same command to turn a device on and off but we decided the command 'listen to amplifier' would be used for the on function and 'turn off' to do this. 'Louder volume' and 'make sound softer' are self-explanatory.

We found commands like 'volume up' and 'volume down' were too similar and could not readily be differentiated by the device. Whether this was due to my voice or the device, I can't say. Press and release the button and wait until it steps to 'train command' then push it again. 'Listen to amplifier', 'turn off', 'louder volume' and 'make sound softer' were recorded along with the IR codes for each action.

Review by
RICK WALTERS



The VoiceMe main unit (above) with its Extender unit at left. We imagine that the majority of people will not have much use for the extender as the main unit does everything it can – without buttons!

We tried several remote controls but had no success with 'mute sound'. The voice command was recorded and the IR code was supposedly recognised according to the beep, which acknowledges acceptance of the IR code.

Now that you can command VoiceMe you need to select its response to you, ranging from 'yes sir/ma'am' through 'what can I do for you' to a lot of fancy sounds.

We chose 'how can I help you'. Thus the voice sequence is you address 'Black Box' which responds with 'How can I help you'? You respond with 'Listen to amplifier'.

If your voice command is recognised the pre-recorded command is repeated back to you, then the IR signal is output. If your command is not recognised, you are ignored.

Testing

When we said 'black box' it responded with 'how can I help you?' 'Listen to amplifier' turned the amplifier on and 'louder volume' or 'make sound softer' increased or decreased the volume by 2dB (the amount programmed for the remote control).

'Mute sound' replayed the recorded command mute sound but did not affect the volume.

Eventually after several tries we got 'shut off sound' to work satisfactorily. Obviously what you actually say is irrelevant. As long as it is recognised, the IR signal should be accepted.

To re-program the IR code you have to delete the command, re-record it and then supply the IR code once again.

So far everything seemed to work as claimed. Now for the big test! VoiceMe was installed in a lounge room, which has a TEAC High Definition decoder, an LG Home Theatre system and an LG Plasma screen.

'Turn Television on' seemed an appropriate command. The individual devices were then programmed into VoiceMe. It accepted the three power-on IR signals, beeping after each was recognised.

We were initially worried whether, with the VoiceMe sitting in the same plane and above the units, the IR output would reflect off the walls and actuate the units.

Our worries were justified: it refused to operate at two metres distance from me but for a different reason – my voice was not loud enough to trigger the response. Moving it much closer, so that it was about 1m distant, allowed it to recognise commands.

It switched on the Plasma screen and the TEAC decoder but refused to turn on the sound system. The remote was an LG 6710CDAP01B. We deleted the command and re-recorded it and the three remote signals. Again there were three beeps of acceptance but only two units powered on. However, it worked on the third try, so don't give up!

An interesting outcome was that we did not use VoiceMe for a couple of weeks and when I began using it again it had trouble recognising the 'Black Box' command.

The instructions say to record with "regular tone, speed and volume". You tend to raise your voice when you issue an instruction but with sufficient practice we believe you could address it in a normal conversational voice.

We did not test the RF remote control. Who wants another remote? The main function of VoiceMe is to do away with remotes!

However, after all the problems we had with different remotes and with getting the mute function to work with the amplifier, there was one major problem in attempting to get it trained so my mother could use it. Her voice was simply too soft!

So unless the prospective "user" is able to speak fairly loudly and precisely, VoiceMe will have difficulty.

To sum up: VoiceMe is an interesting device with enormous potential. If you can train it successfully, it will let you relegate all your pushbutton IR remotes and simply state your commands.

Now, I wonder if it could also be trained to get me a beer when the cricket is on?

Where from, how much?

VoiceMe is available from Microgram Computers for $389 including GST. For further information, contact Microgram (www.mgram.com.au) at 3/7 Tumbi Creek Road, Berkeley Vale NSW 2261. Phone 1800 625 7777. SC

Vintage Radio

By RODNEY CHAMPNESS, VK3UG

The AWA 693P 3-Band 8-Transistor Portable

. . . the transition from valves to transistors

The AWA 693P is an impressive 3-band 8-transistor set that was manufactured by AWA in Australia during the early 1960s. It doesn't use a PC board but instead employs point-to-point wiring, just like the valve radios of that era.

TRANSISTORS WERE introduced into domestic radios in Australia around 1958. I can actually remember the first transistor set that I owned, a pocket Sony.

By today's standards, this set was a poor performer and was only suitable for receiving stations in the near vicinity. Its main drawback was that it generated a fair amount of noise due to the germanium transistors used.

By about 1960, Australian manufacturers were producing quite reasonable transistor radios. However, although Japanese sets were by then using PC boards (of greatly varying quality), Australian manufacturers took longer to make the transition. In fact, some Australian manufacturers didn't use PC boards until well into the early 1960s.

As a result, some early Australian-made transistor sets were built just like valve sets, with components wired point-to-point. Some even used sockets for the transistors, just as valve sets used sockets. However, Australian manufacturers did eventually move over to PC boards – the benefits of using PC boards were simply too great to ignore, especially in terms of cost and ease of assembly.

The AWA 693P

The AWA 693P 8-transistor radio featured here is one such Australian-made set that used valve-radio construction techniques. It is a well-made 3-band receiver that was manufactured some time around 1960.

In keeping with the era, it is housed in a wooden cabinet covered with leather and leatherette. It is similar in size to the valve receivers it was intended to replace and was no lightweight either, tipping the scales at a hefty 7.2kg (ie, about the same as a valve set).

Inside, the circuit used two second-generation PNP germanium transistors for the critical RF and autodyne converter stages, while all the other

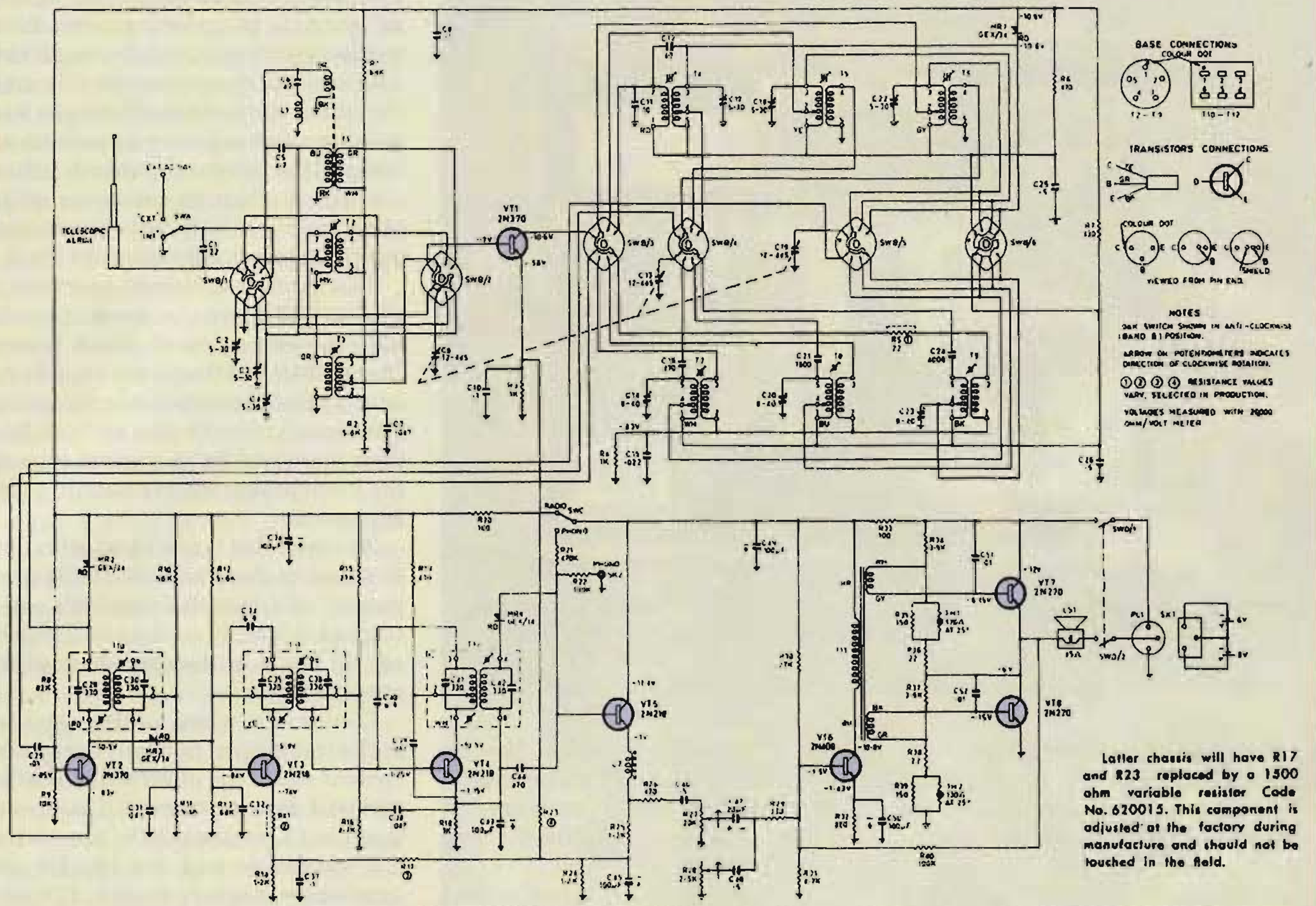


Fig.1: the circuit is a conventional 8-transistor superhet design, with transistor VT1 functioning as an RF amplifier stage, VT2 as the converter, VT3 & VT4 as IF amplifiers and VT5-VT8 as the audio stages. Diode MR4 is the detector.

stages used first-generation germanium transistors. It also used an internal telescopic antenna but there are also terminals on the rear so that an external antenna and earth can be connected for improved performance. In addition, terminals are provided to allow a portable turntable to be connected to the audio input of the receiver.

The latter feature was probably rarely used. Battery powered turntables of that era were thin on the ground and their quality left much to be desired.

Lantern batteries

Power for the set is derived from two 509 lantern batteries connected in series to give a 12V supply. In addition, the junction of the two batteries provides a centre-tap for the audio output stage, so that it could be used without an output transformer. However, this meant that the speaker had to be a non-standard type with a 45-ohm voice coil to match the transistor output stage.

Because of the size of the batteries, their life is quite good in this set and is somewhere in the region of hundreds of hours.

Tuning range

The tuning range of this set is quite useful, particularly for those living in more remote areas. As well as the broadcast band ((530-1650kHz), there are also two shortwave bands covering 2-6MHz and 6-18MHz.

Normally, portable receivers which cover these latter ranges have rather direct tuning. This can make tuning to shortwave stations rather difficult but this problem has been solved in the AWA 693P. In this set, the dial-drive is a 2-speed type. Once the station has been roughly tuned, it is then tuned in the opposite direction. This engages the "slow-motion" reduction tuning mechanism, allowing the station to be easily fine-tuned.

It's interesting to note that lifting the front cover of the receiver to access the controls reveals the Royal Flying Doctor Service shortwave frequencies. These are attached to the inside of the panel along with a map of the world with the various time zones listed.

The set is quite a good performer on shortwave too, thanks to the inclusion of a radio frequency (RF) stage in the front-end. In fact, this receiver can be considered a serious replacement for the much earlier 7-band AWA valve receivers.

Circuit details

The circuit (see Fig.1) is really quite conventional for a set of that era. As shown, the antenna input consists of a network that allows the use of either the in-built telescopic antenna or an external long-wire antenna on all bands.

On the broadcast band, a loop-stick antenna is used most of the time but connecting a long-wire antenna can boost the performance of the loop-stick in difficult reception areas. Note that the broadcast band input also has a series tuned intermediate frequency (IF) rejection circuit (L1, C6) across

This is the view inside the back of the set with the two 6V lantern batteries in place. Note the point-to-point wiring and the components around the band-change switch at top left.

the tuned antenna loop-stick winding. This is intended to prevent maritime radio transmissions close to 455kHz from breaking through into the IF amplifier stage.

RF transistor VT1 (2N370) amplifies the input signal from the antenna and passes it via further tuned circuits to an autodyne converter stage based on VT2 (2N370). The output from this stage is then applied to the first IF transformer and thence to a 2-stage IF amplifier consisting of transistors VT3 & VT4 (2N218). Both stages are neutralised by C33 & C40 respectively.

From there, the signal passes to a detector and AGC diode (MR4), after which the detected signal is fed to VT5 (2N218). This stage acts as both an AGC amplifier and first audio amplifier. The resulting AGC is directly applied to VT3 and VT1 and also from VT3 to the first two IF transformers via MR3 to control the gain through the amplifier.

The detected audio signal at the emitter of VT5 is fed through an RF choke (L2) to filter out any remaining IF signals in the audio. The audio is then applied via volume control R27 and tone control R28 to audio driver stage VT6 (2N408).

VT6 is turn feeds a driver transformer with three windings. One goes to the collector lead of VT6, while the other two drive the base leads of output transistor pair VT7 and VT8 (2N270).

As shown, these two output transistors are wired in series and each has a thermistor in its base-bias circuit to stabilise the quiescent current against variations in temperature. Germanium transistors are particularly sensitive to heat and will draw considerably more current as the transistor junction temperature rises unless precautions are taken. If the current rises to any extent, a runaway situation can occur where more and more current is drawn until the transistor finally destroys itself.

The emitter-collector junction of VT7 & VT8 drive the speaker's voice coil, the other side of which goes to the centre tap of the power supply. Assuming that the output transistors and their base bias networks are matched, then there will be no current through the loudspeaker when no audio signal is present.

At least, that's the ideal situation. In practice, there will always be some current through the speaker's voice coil but this will be very small if there are no faults in the class-B amplifier output stage.

Conversely, when audio is applied to the transistors, one will draw more current while the other will be cut off and will draw no current. This means that the DC voltage at the junction of the transistors and the speaker can vary between nearly 0V and -12V with reference to the chassis with the volume control set for maximum output.

This in turn means that the amplifier side of the speaker coil can vary between -6V and +6V with reference to the other side of the speaker voice coil (which is connected to the midpoint of the battery pack). Of course, at normal listening levels, the voltage excursions are much less severe.

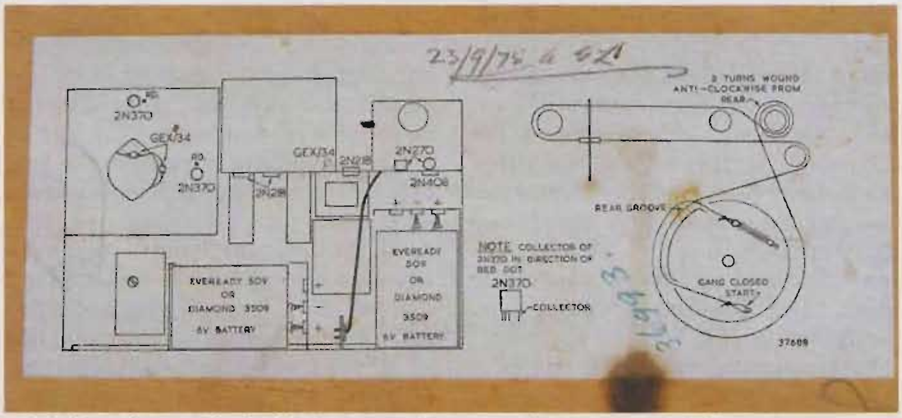
Finally, to reduce the distortion in the class-B output stage, negative feedback is applied to the base of VT6 via a 100kΩ resistor (R40).

The overhaul

My first impressions of this set when it was loaned to me was that it had had a hard life. The leatherette, leather surfaces and the metal grill of the cabinet all showed signs of wear.

The first job in the restoration was to remove the chassis from the cabinet. This proved to be quite easy. First, the back of the set is removed by undoing a single screw. The batteries are then removed, after which you undo three screws from the base of the cabinet and unplug the internal whip antenna.

The chassis and battery holder are then simply slid out of the cabinet.



A label on the inside-back of the set gives some basic service information, including the transistor types and locations plus the dial-cord arrangement.

The set's owner was uncertain as to whether or not it was working, so I obtained a couple of 6V 509 lantern batteries, slipped them into their holders and switched the set on. Well, the set did work but its performance was woeful. It was quite insensitive, picking up very few stations, and its audio output was quite distorted. In short, it sounded rather sick so it was time for some troubleshooting

I began by measuring the voltages around the front-end of the set but could only get 5-6V where I should have been measuring close to 12V. As a result, I checked the batteries and found that one was open circuit, even though it was brand new!

With a good battery fitted in its place, the set sounded much more like it should. The distortion had gone but it was still not performing at all well in terms of sensitivity. As a result, I checked the alignment of the IF amplifier stages but found that they were near enough to spot on.

RF alignment

It was a different story with the RF and converter stages and the oscillator tuned circuits. A cursory examination revealed that one Philips trimmer was missing its adjustment cap, an extra capacitor had been fitted across the broadcast-band oscillator coil and the core of the oscillator coil was sitting much further out of the coil than I would have expected.

This all indicated that the front-end had been tweaked by someone who clearly didn't know what they were doing.

The oscillator tuned circuit on each of the shortwave bands appeared to be reasonably accurate, so I first concentrated on aligning the RF and antenna circuits. First, a Leader (LSG11) signal generator was pressed into service to determine the tuning range on each band. That done, I then adjusted each coil and trimmer capacitor for best signal (or maximum noise). And what an improvement that made – the performance on the shortwave bands was now quite good.

According to the service information for this set, the broadcast band is normally aligned first. However, I left it until last as it appeared to have more problems than the shortwave bands. The tuning range was well out and stations were appearing in the wrong locations on the dial.

These two photos show the front and rear views of the chassis after it has been removed from the cabinet. The oval-shaped speaker is a special type with a 45-ohm voice coil.

My first suspect here was padder capacitor C16. Perhaps its value had changed or maybe the wrong one had been fitted. As a result, I disconnected one leg of C16 and tested it on the capacitance range of my multimeter. It gave the correct value so that theory bit the dust.

Next, I removed the extra capacitor that had been installed across C14. I then adjusted the oscillator circuit so that it covered the correct range. This is done by adjusting the coil at the low-frequency end of the dial and the trimmer capacitor at the high-frequency end (this has to be done several times, as each adjustment interacts with the other). However, because the rest of the RF and antenna circuits were so badly out of tune, I had to use a very high output from the signal generator in order to force signals through the set during this procedure.

Now that the oscillator was tuning correctly, it was time to look at the other tuned circuits for the broadcast band. The location of the antenna coil on the loop-stick antenna had not been altered since the set was manufactured but I decided to check it all the same.

Photo Gallery: Astor JN Dual-Wave Receiver

NICKNAMED "SYDNEY HARBOUR BRIDGE" after its smooth arch shape, the Astor JN dual-wave receiver was housed in an attractive, dark-chocolate bakelite cabinet with a faint embedded pattern. Its copious size enabled Astor to enclose a quality chassis with power and performance comparable to a radiogram, so this model is on most enthusiasts' must-have list.

An unusual feature is the roll-tuning dial. The station tuning is a normal linear action but turn the thumbnail dial and the stations from another state appear. Its interesting to note that the Victorian dial also has Devonport shown, such was the performance of the chassis with an external wire antenna (there was also lower electrical interference in the 1950s).

The valve line-up was as follows: 2x 6U7G, 6J8GA, 6B6G, 6V6GT/G and 5Y3GT/G. Photograph by Kevin Poulter for the Historical Radio Society of Australia. www.hrsa.net.au; phone (03) 9539 1117.

To do this, I tuned to the low-frequency end of the tuning range and moved my fingers close to the tuned winding on the loop-stick. The set's performance immediately improved, which indicated that the coil needed to be moved towards the centre of the loop-stick to increase its inductance.

This is easier said than done, as you first have to remove the "gunk" holding the coil in position. This was done using a sharp hobby knife, after which the coil was moved along the loop-stick to peak the performance. The coil was then secured in this new position.

The RF coil was also peaked at this time. I use an old plastic knitting needle as an alignment tool, filed down so that it has a screwdriver tip at one end (a metal screwdriver would affect the tuning).

First, I tuned to the high-frequency end of the dial and peaked the trimmers on each tuned circuit. However, I initially couldn't peak the trimmer on the loop-stick, as this was the one without its adjustment cap. Fortunately, that was easily solved by substituting one from a spare trimmer in my junk box.

With the substitute cap in place, I was then able to peak this trimmer. The RF stage could be peaked as well. I then tuned from each end of the dial to the other, readjusting the coils and trimmers until there was virtually no interaction between the adjustments.

Instability

The set was now working quite well except for some instability at about 910kHz. This was caused by the second harmonic of the IF being picked up by the loop-stick antenna. However, when the shield that normally sits between the IF amplifier and the loop-stick was put back in place, this instability disappeared. This shield piece is held in place with three metal thread screws and is bonded with flexible straps to adjoining metalwork to ensure effective shielding.

Having completed the alignment, all the trimmer adjustments were sealed in position using clear nail polish. In addition, the adjustment slugs inside the various coils were secured using a drop of bees wax (this can be easily broken free if adjustment is needed later on). A better method is to secure the cores using some very thin rubber-core "string" (for want of a better name). Unfortunately I've been unable to source any of this rubber-core string in recent years.

Final tweaks

The volume and tone controls were both noisy in operation. This is a common problem with old sets. This was solved by giving them both a squirt of Inox contact cleaner. In addition, the dial-drive pulleys and the reduction drive were each given a drop of oil to ensure smooth operation. I do this using an oil-filled hypodermic syringe with a needle attached so that I can get the oil where it needs to be (the tip of the needle is ground square to avoid accidental "jabs").

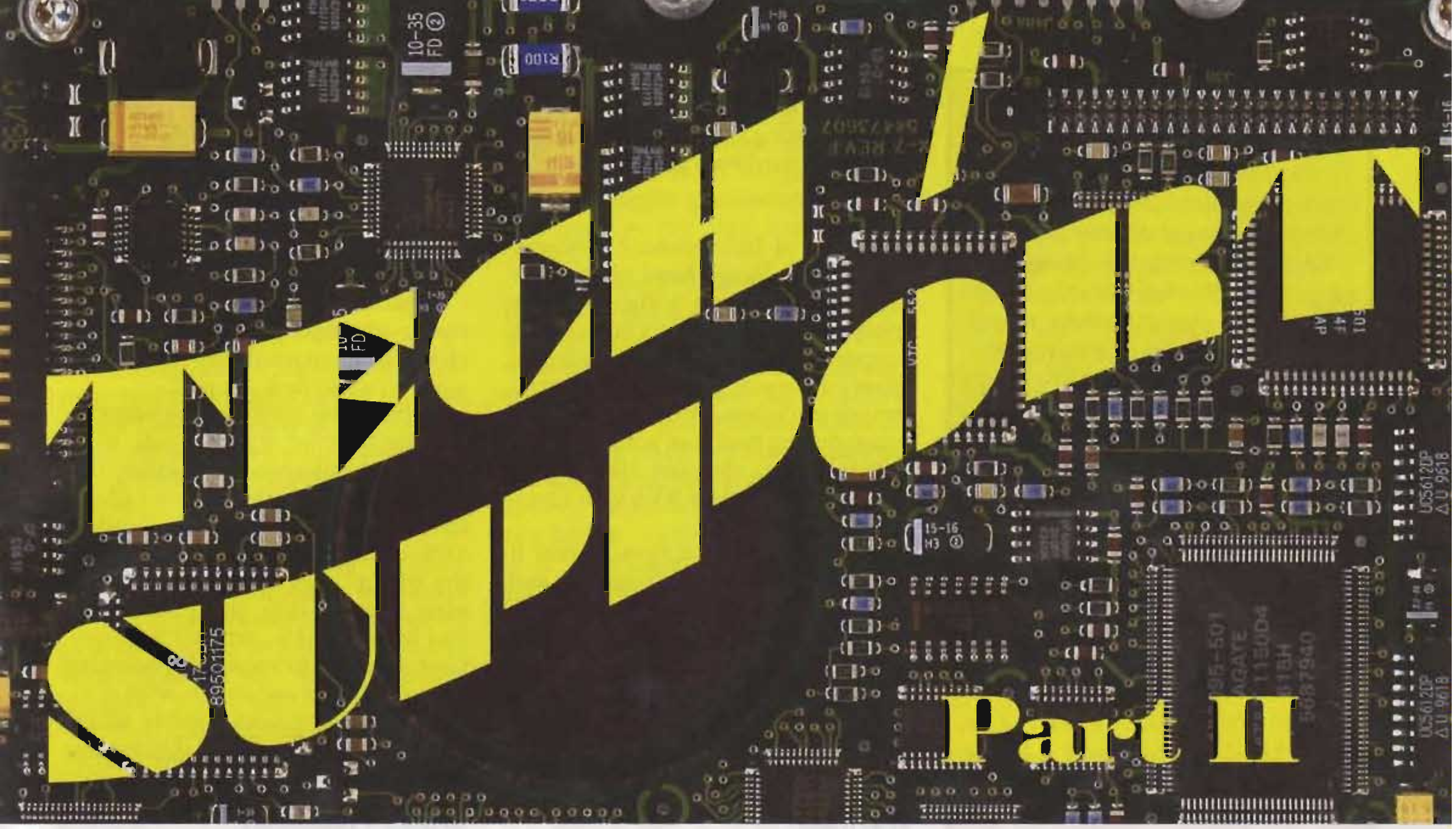
Despite the set's age, none of the resistors or capacitors required replacement. The paper capacitors may well have been leaky but this is not usually a problem in transistor circuits due to their low impedances and low operating voltages.

Finally, the leather/leatherette cabinet was spruced up using a dark tan shoe polish. This produced quite a reasonable finish although there was no way to repair the damaged leatherette

Summary

In summary, this radio is easy to work on and adjust. Its performance is quite good and during the early 1960s, it would have been one of the best transistor sets available.

This set was probably AWA's first multi-band transistor portable and they did a really good job. It doesn't use a PC board but is still a well-made set, built to valve construction standards. In short, it is well worth having in a collection. **SC**



TECH SUPPORT Part II

In the first part of this story in May SILICON CHIP Barrie Smith tipped us into the maelstrom of the funny yarns about Tech Support. Now he gets serious and investigates how the major companies handle the floods of enquiries and queries that rain upon enterprises brave enough to market their products... and daring enough to back them up with help and comfort for the buying public.

Tech support can be confronting for the caller. It can also be a challenge for the operator at the call centre... but the feedback from the buying public can be worth every cent of the centre's operational cost in the way it channels into the hearts and minds of the customer.

To get a feel for the business I spoke to a number of companies: Adobe, Canon, Microsoft and Sony.

Adobe

Adobe's Asia Pacific area provides support in English, Mandarin, Cantonese and Korean.

Adobe operators can access an internal knowledge base to assist them with both technical and other information to resolve customer questions.

Adobe describe this as a "living document", compiled from three sources: core product knowledge derived from the development teams during product development; information gained from the beta-testing stages of the product; then the continuously-added product information gathered after the product hits the market.

Backing this is an on-line knowledge base providing customers with the appropriate information to resolve their own issues. Adobe feels the best tech support resolution it can provide is the one that does not involve the customer contacting Adobe at all!

Canon

Canon Australia support every consumer product the company has ever made (and sold in Australia). Some of that dates back a long time, so they have customers ringing in with a product that might have been last sold in the early 90s.

Twenty operators and two team leaders are based in the company's North Ryde NSW centre. Over many years Canon has built up an information base that can also be accessed by callers; much of this has come from Canon Japan. In addition to that, an internal knowledge base swells every time a customer calls, possibly with a unique problem and a unique solution... this is documented and added to the knowledge base

Microsoft

Based in Singapore, Microsoft's Customer Service and Support provides more than 100 services, including tech support. Backing this up is a mix of resources in Australia, in the form of customer service, support and field engineering teams. Asia-Pacific callers can access care hot lines operating in 10 languages around 14 countries in the Asia Pacific region.

STRESSED OUT

You may find the long wait for a tech support operator sometimes stressful ... but what about the operator?

Adobe admits that the role of a tech support operator "can be a high-pressure job," so they try to mitigate this impact, even at the recruiting process, by assessing the motivational 'fit' of an applicant. If this indicates someone does not cope well under pressure, then they are likely not going to be a successful operator.

Once on the job, Adobe attempts to put fun into work and reduce stress level, by running 'events' that range from holding fun competitive games during their breaks and asking staff to arrive at work in costume.

Also admitting the stressful nature of the job, Sony compares it to the stress levels of aircraft controllers. The company recruits "people who really want to help customers. The only thing that would ever stress one of them out is if they get a really angry customer. Then they can take a couple of minutes off after that call and go and have a chat with their team leader.

Microsoft admits that by the time a customer calls them, they must have encountered difficulties with their products or systems and are probably desperate for a fix.

Their customer service and support teams have to handle different challenges with various levels of complexity and they have to tap on a wide range of capabilities to balance the demands that come with the job. They all acquire deep technical expertise, strong problem solving ability, communication skills and cross-culture knowledge and understanding.

Sony believes they have the right levels of support for them now. Tech support staff have access to the information to do their jobs quite effectively, so they're not scared of what the next call will be and whether they'll know the solution or not ...

The truth is, no-one who is calling a call centre, is calling just to say everything is OK.

A different sort of challenge is faced by Microsoft, with its mix of globally-used operating system and office software plus hardware products.

Sony

A team of four product specialist engineers at Sony's head office interact with the various designer factory groups. Then a further six branch tech support people, in each of the capital cities, between the service centres, service providers, Sony and the customer during business hours.

This covers devices like digital cameras, camcorders, TVs, VAIO computers etc.

Sony's approach differs in that it uses two front line call centres and from there calls can be bounced off to the various other service centres. Sony's Tim Simons explains that "if it can't be resolved over the phone or via the Internet then access to a knowledge base is made. This is growing all the time."

Training

For Adobe, training of operators can take anywhere from four to eight weeks. Even then, past the initial training there is ongoing education on a regular basis. This is mostly computer-based training and, depending on the detail and importance of the new information, can also be instructor lead. Training covers new tools, processes, software skills etc or new product information or upgrade releases.

Canon's company training is "quite intensive". Recruits start off with about a two-day induction training program, a sort of 'welcome to Canon', emphasising the 'quality first' approach. Then they get an overview of all Canon products, followed by a buddy system where they'll sit with experienced operators, watching them deal with callers.

In general, Microsoft adheres to a 20-70-10 rule as guiding principles for training: 20% instructor-led, 70% on the job and 10% mentoring.

Before every major product launch, a set of well-designed readiness routines are put in place to equip operators with all the knowledge, skill and tools necessary to serve customers.

Tech support staff receives additional educational training courses as well as internal technical conferences.

Sony begins with a two-week induction, including some system and phone training, followed by product training and then further customer service training. Then they go into a so-called 'nursery group' for four to six weeks, dealing with a limited product range.

More going on line for help

Regardless of their level – beginner or advanced – any user can face challenges and need help, so need to make a call to tech support.

It would be very hard to place an average time for a phone call. More and more customers are submitting their questions online versus a phone call. For one particular application, 91% of all issues were handled via the phone with only 8% online — nine months later the phone calls had fallen to 63%, with 37% online. Customers are increasingly preferring to go online for assistance, with companies focusing considerable efforts on making more tools and information available there.

Tricky Questions

Typical questions include assistance with installation, help on how to use a specific feature, dealing with error messages and issues when a feature fails to work as expected, often when interacting with a second party product, be it hardware or software.

One of the trickier questions received frequently is when a customer calls in and states that they need to reset their password; this becomes tricky since some customers have a hard time explaining which password they wish to reset!

Ocasionally slightly off beat queries are received; for instance a call from a customer "I purchased a very powerful PC — do you have software powerful enough for it?"

And then there are customers call the support number by mistake. One example is a customer who called and started complaining about the amount of their phone bill!"

Some of the tricky ones are where customers do call in with a really old product – like the query about a veteran electronic StarWriter 60 typewriter.

Occasionally a customer calls in and they'll rattle off a model number which tech support hasn't heard of. When they check the data base, they find out it's not even one of their products!

Or the customer who called in saying he had given out his fax number and people are faxing him and he's not getting any of the faxes. So after a bit of trouble shooting it was confirmed that the fax machine was working fine – he had given out the wrong fax number!"

And if they can't help?

Microsoft has 'escalation engineers' who deal with more critical support issues. There's also a group of program managers who work with the product groups to ready our service infrastructure when new products are released or updated.

Given that the company supports a wide range of customers, questions land on everyday use of its products, as well as very technical questions from customers who deploy the systems on a large scale.

Typical questions include installing updates and configuration issues.

One customer had an ongoing, nagging problem when their servers malfunctioned every evening at around the same time. Sensing the urgency in the case, Microsoft dispatched an engineer and flew him to the customer site to take a closer look at the problem.

While there were no visible system errors or malfunctions, they finally found the air-conditioning unit automatically shut off in the evening and the server performances were disrupted by the high heat and humidity.

In these days of integration with AV products, connection between brands is relatively straightforward. They mate relatively easily across common connectors but where the trickiness comes in is probably more in the computer space which is where a customer has got a Sony VAIO laptop and they are trying to hook it up to an HP printer or a Belkin modem or something like that... that's where it becomes a little bit harder for tech support.

Improving the breed

The major benefit of running tech support call centres, apart from happy customers, is that the feedback from callers is a valuable resource, ready to be mined in the pursuit of product development.

For one, Adobe's product management teams ensure that customer feedback is considered in new product releases and that customers' reported issues are part of the planning process for future versions.

Who You Gonna Call?

So your setup has gone bung, frozen, flat-lined, dealt a mortal blow by a cause unknown. You have to call Help HQ.

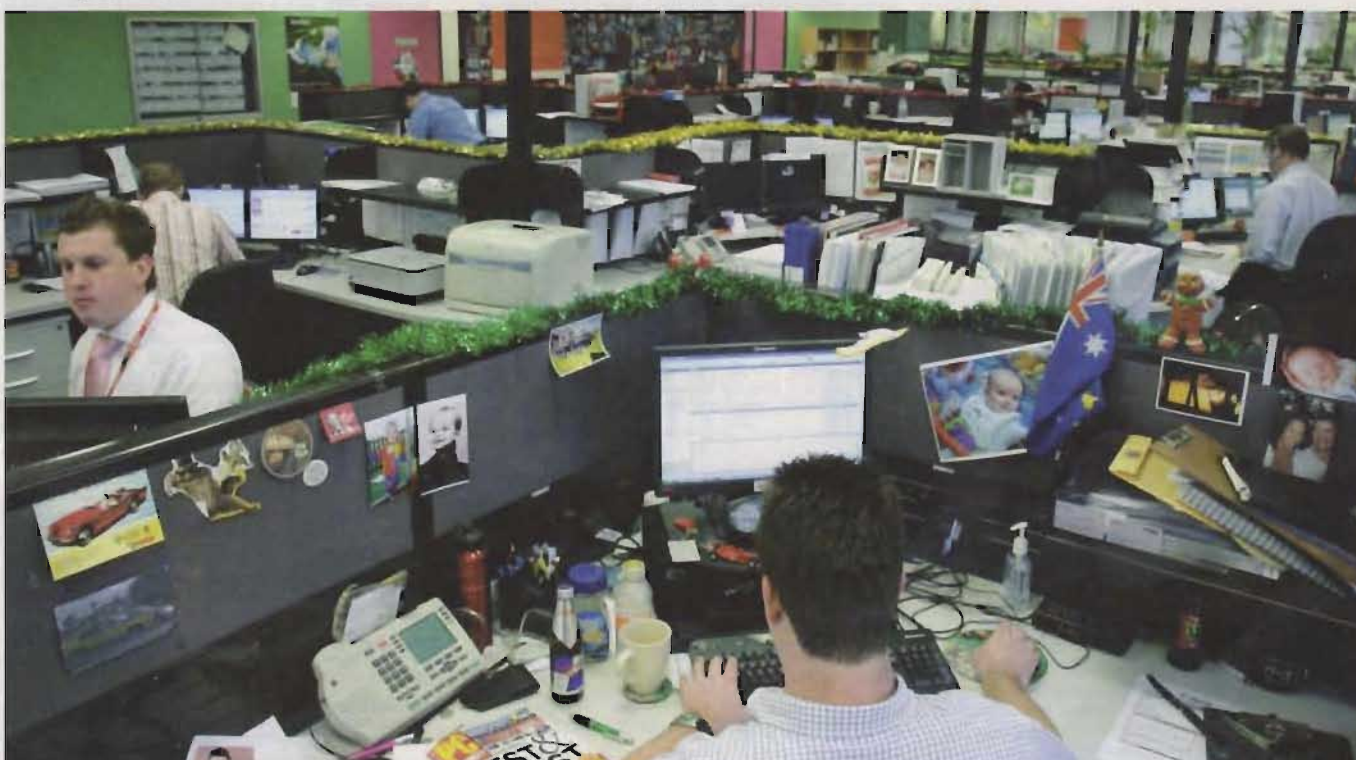
Once you've made the decision to call tech support, make sure you have the following information on hand:

- **Device name and model.**
- **Serial number.**
- **If the device is computer-based, what operating system it is using.**
- **What other devices are linked.**
- **And finally, allow enough time to make the call and get an answer.**

In Canon's case, customer feedback is channelled to the marketing team who send that back to Canon in Japan and that feeds back into R&D.

Sony captures feedback on every call that comes in to the call centre. Any comment, whether it be the manual, the packaging, anything is passed back to the regional head in Singapore every month.

So, it seems those long waits for an operator to respond are worthwhile in the long term and can sometimes lead to an improvement in the breed... a TV set, DVD recorder, digicam, software etc. **SC**



Call centre operators often have to deal with a mix of home users, hobbyists, prosumers, and professionals. Typical caller questions include assistance with installation, help on how to use a specific feature, dealing with error messages and issues when a feature fails to work as expected.

Silicon Chip Back Issues

January 1994: 3A 40V Variable Power Supply; Solar Panel Switching Regulator; Printer Status Indicator; Mini Drill Speed Controller; Stepper Motor Controller; Active Filter Design; Engine Management, Pt.4.

February 1994:90-Second Message Recorder; 12-240VAC 200W Inverter; 0.5W Audio Amplifier; 3A 40V Adjustable Power Supply; Engine Management, Pt.5; Airbags In Cars – How They Work.

March 1994: Intelligent IR Remote Controller; 50W (LM3876) Audio Amplifier Module; Level Crossing Detector For Model Railways; Voice Activated Switch For FM Microphones; Engine Management, Pt.6.

April 1994: Sound & Lights For Model Railway Level Crossings; Dual Supply Voltage Regulator; Universal Stereo Preamplifier; Digital Water Tank Gauge; Engine Management, Pt.7.

May 1994: Fast Charger For Nicad Batteries; Induction Balance Metal Locator; Multi-Channel Infrared Remote Control; Dual Electronic Dice; Simple Servo Driver Circuits; Engine Management, Pt.8.

June 1994: A Coolant Level Alarm For Your Car; 80-Metre AM/CW Transmitter For Amateurs; Converting Phono Inputs To Line Inputs; PC-Based Nicad Battery Monitor; Engine Management, Pt.9.

July 1994: Build A 4-Bay Bow-Tie UHF TV Antenna; PreChamp 2-Transistor Preamplifier; Steam Train Whistle & Diesel Horn Simulator; 6V SLA Battery Charger; Electronic Engine Management, Pt.10.

August 1994: High-Power Dimmer For Incandescent Lights; Dual Diversity Tuner For FM Microphones, Pt.1; Nicad Zapper (For Resurrecting Nicad Batteries); Electronic Engine Management, Pt.11.

September 1994: Automatic Discharger For Nicad Batteries; MiniVox Voice Operated Relay; AM Radio For Weather Beacons; Dual Diversity Tuner For FM Mics, Pt.2; Electronic Engine Management, Pt.12.

October 1994: How Dolby Surround Sound Works; Dual Rail Variable Power Supply; Talking Headlight Reminder; Electronic Ballast For Fluorescent Lights; Electronic Engine Management, Pt.13.

November 1994: Dry Cell Battery Rejuvenator; Novel Alphanumeric Clock; 80-M DSB Amateur Transmitter; 2-Cell Nicad Discharger.

December 1994: Car Burglar Alarm; Three-Spot Low Distortion Sinewave Oscillator; Clifford – A Pesky Electronic Cricket; Remote Control System for Models, Pt.1; Index to Vol.7.

January 1995: Sun Tracker For Solar Panels; Battery Saver For Torches; Dual Channel UHF Remote Control; Stereo Microphone Preamplifier.

February 1995: 2 x 50W Stereo Amplifier Module; Digital Effects Unit For Musicians; 6-Channel LCD Thermometer; Wide Range Electrostatic Loudspeakers, Pt.1; Remote Control System For Models, Pt.2.

March 1995: 2 x 50W Stereo Amplifier, Pt.1; Subcarrier Decoder For FM Receivers; Wide Range Electrostatic Loudspeakers, Pt.2; IR Illuminator For CCD Cameras; Remote Control System For Models, Pt.3.

April 1995: FM Radio Trainer, Pt.1; Balanced Mic Preamp & Line Filter; 50W/Channel Stereo Amplifier, Pt.2; Wide Range Electrostatic Loudspeakers, Pt.3; 8-Channel Decoder For Radio Remote Control.

May 1995: Guitar Headphone Amplifier; FM Radio Trainer, Pt.2; Transistor/Mosfet Tester For DMMs; A 16-Channel Decoder For Radio Remote Control; Introduction To Satellite TV.

June 1995: Build A Satellite TV Receiver; Train Detector For Model Railways; 1W Audio Amplifier Trainer; Low-Cost Video Security System; Multi-Channel Radio Control Transmitter For Models, Pt.1.

July 1995: Electric Fence Controller; How To Run Two Trains On A Single Track (Incl. Lights & Sound); Setting Up A Satellite TV Ground Station; Build A Reliable Door Minder.

August 1995: Fuel Injector Monitor For Cars; Build A Gain-Controlled Microphone Preamplifier; Identifying IDE Hard Disk Drive Parameters.

September 1995: Railpower Mk.2 Walkaround Throttle For Model Railways, Pt.1; Keypad Combination Lock; Build A Jacob's Ladder Display.

October 1995: 3-Way Loudspeaker System; Railpower Mk.2 Walkaround Throttle For Model Railways, Pt.2; Build A Nicad Fast Charger.

November 1995: Mixture Display For Fuel Injected Cars; CB Transverter For The 80M Amateur Band, Pt.1; PIR Movement Detector.

May 1996: High Voltage Insulation Tester; Knightrider LED Chaser; Simple Intercom Uses Optical Cable; Cathode Ray Oscilloscopes, Pt.3.

June 1996: Stereo Simulator (uses delay chip); Build A Rope Light Chaser; Low Ohms Tester For Your DMM; Automatic 10A Battery Charger.

July 1996: VGA Digital Oscilloscope, Pt.1; Remote Control Extender For VCRs; 2A SLA Battery Charger; 3-Band Parametric Equaliser.

August 1996: Introduction to IGBTs; Electronic Starter For Fluorescent Lamps; VGA Oscilloscope, Pt.2; 350W Amplifier Module; Masthead Amplifier For TV & FM; Cathode Ray Oscilloscopes, Pt.4.

September 1996: VGA Oscilloscope, Pt.3; IR Stereo Headphone Link, Pt.1; HF Amateur Radio Receiver; Cathode Ray Oscilloscopes, Pt.5.

October 1996: Send Video Signals Over Twisted Pair Cable; 600W DC-DC Converter For Car Hifi Systems, Pt.1; IR Stereo Headphone Link, Pt.2; Multi-Channel Radio Control Transmitter, Pt.8.

November 1996: 8-Channel Stereo Mixer, Pt.1; Low-Cost Fluorescent Light Inverter; Repairing Domestic Light Dimmers.

December 1996: Active Filter For CW Reception; Fast Clock For Railway Modellers; Laser Pistol & Electronic Target; Build A Sound Level Meter; 8-Channel Stereo Mixer, Pt.2; Index To Vol.9.

January 1997: Control Panel For Multiple Smoke Alarms, Pt.1; Build A Pink Noise Source; Computer Controlled Dual Power Supply, Pt.1; Digi-Temp Thermometer (Monitors Eight Temperatures).

February 1997: PC-Controlled Moving Message Display; Computer Controlled Dual Power Supply, Pt.2; Alert-A-Phone Loud Sounding Telephone Alarm; Control Panel For Multiple Smoke Alarms, Pt.2.

March 1997: 175W PA Amplifier; Signalling & Lighting For Model Railways; Jumbo LED Clock; Cathode Ray Oscilloscopes, Pt.7.

April 1997: Simple Timer With No ICs; Digital Voltmeter For Cars; Loudspeaker Protector For Stereo Amplifiers; Model Train Controller; A Look At Signal Tracing; Pt.1; Cathode Ray Oscilloscopes, Pt.8.

May 1997: Neon Tube Modulator For Light Systems; Traffic Lights For A Model Intersection; The Spacewriter – It Writes Messages In Thin Air; A Look At Signal Tracing, Pt.2; Cathode Ray Oscilloscopes, Pt.9.

June 1997: PC-Controlled Thermometer/Thermostat; TV Pattern Generator, Pt.1; Audio/RF Signal Tracer; High-Current Speed Controller For 12V/24V Motors; Manual Control Circuit For Stepper Motors.

July 1997: Infrared Remote Volume Control; A Flexible Interface Card For PCs; Points Controller For Model Railways; Colour TV Pattern Generator, Pt.2; An In-Line Mixer For Radio Control Receivers.

October 1997: 5-Digit Tachometer; Central Locking For Your Car; PC-Controlled 6-Channel Voltmeter; 500W Audio Power Amplifier, Pt.3.

November 1997: Heavy Duty 10A 240VAC Motor Speed Controller; Easy-To-Use Cable & Wiring Tester; Build A Musical Doorbell; Replacing Foam Speaker Surrounds; Understanding Electric Lighting Pt.1.

December 1997: Speed Alarm For Cars; 2-Axis Robot With Gripper; Stepper Motor Driver With Onboard Buffer; Power Supply For Stepper Motor Cards; Understanding Electric Lighting Pt.2; Index To Vol.10.

January 1998: 4-Channel 12VDC or 12VAC Lightshow, Pt.1; Command Control For Model Railways, Pt.1; Pan Controller For CCD Cameras.

February 1998: Telephone Exchange Simulator For Testing; Command Control For Model Railways, Pt.2; 4-Channel Lightshow, Pt.2.

April 1998: Automatic Garage Door Opener, Pt.1; 40V 8A Adjustable Power Supply, Pt.1; PC-Controlled 0-30kHz Sinewave Generator; Understanding Electric Lighting; Pt.6.

May 1998: 3-LED Logic Probe; Garage Door Opener, Pt.2; Command Control System, Pt.4; 40V 8A Adjustable Power Supply, Pt.2.

June 1998: Troubleshooting Your PC, Pt.2; Universal High Energy Ignition System; The Roadies' Friend Cable Tester; Universal Stepper Motor Controller; Command Control For Model Railways, Pt.5.

July 1998: Troubleshooting Your PC, Pt.3; 15W/Ch Class-A Audio Amplifier, Pt.1; Simple Charger For 6V & 12V SLA Batteries; Automatic Semiconductor Analyser; Understanding Electric Lighting, Pt.8.

August 1998: Troubleshooting Your PC, Pt.4; I/O Card With Data Logging; Beat Triggered Strobe; 15W/Ch Class-A Stereo Amplifier, Pt.2.

September 1998: Troubleshooting Your PC, Pt.5; A Blocked Air-Filter Alarm; Waa-Waa Pedal For Guitars; Jacob's Ladder; Gear Change Indicator For Cars; Capacity Indicator For Rechargeable Batteries.

October 1998: AC Millivoltmeter, Pt.1; PC-Controlled Stress-O-Meter; Versatile Electronic Guitar Limiter; 12V Trickle Charger For Float Conditions; Adding An External Battery Pack To Your Flashgun.

November 1998: The Christmas Star; A Turbo Timer For Cars; Build A Poker Machine, Pt.1; FM Transmitter For Musicians; Lab Quality AC Millivoltmeter, Pt.2; Improving AM Radio Reception, Pt.1.

December 1998: Engine Immobiliser Mk.2; Thermocouple Adaptor For DMMs; Regulated 12V DC Plugpack; Build A Poker Machine, Pt.2; Improving AM Radio Reception, Pt.2; Mixer Module For F3B Gliders.

January 1999: High-Voltage Megohm Tester; A Look At The BASIC Stamp; Bargraph Ammeter For Cars; Keypad Engine Immobiliser.

March 1999: Build A Digital Anemometer; DIY PIC Programmer; Build An Audio Compressor; Low-Distortion Audio Signal Generator, Pt.2.

April 1999: Getting Started With Linux; Pt.2; High-Power Electric Fence Controller; Bass Cube Subwoofer; Programmable Thermostat/Thermometer; Build An Infrared Sentry; Rev Limiter For Cars.

May 1999: The Line Dancer Robot; An X-Y Table With Stepper Motor Control, Pt.1; Three Electric Fence Testers; Carbon Monoxide Alarm.

June 1999: FM Radio Tuner Card For PCs; X-Y Table With Stepper Motor Control, Pt.2; Programmable Ignition Timing Module For Cars, Pt.1.

July 1999: Build A Dog Silencer; 10µH to 19.99mH Inductance Meter; Audio-Video Transmitter; Programmable Ignition Timing Module For Cars, Pt.2; XYZ Table With Stepper Motor Control, Pt.3.

August 1999: Remote Modem Controller; Daytime Running Lights For Cars; Build A PC Monitor Checker; Switching Temperature Controller; XYZ Table With Stepper Motor Control, Pt.4; Electric Lighting, Pt.14.

September 1999: Autonomouse The Robot, Pt.1; Voice Direct Speech Recognition Module; Digital Electrolytic Capacitance Meter; XYZ Table With Stepper Motor Control, Pt.5; Peltier-Powered Can Cooler.

October 1999: Build The Railpower Model Train Controller, Pt.1; Semiconductor Curve Tracer; Autonomouse The Robot, Pt.2; XYZ Table With Stepper Motor Control, Pt.6; Introducing Home Theatre.

November 1999: Setting Up An Email Server; Speed Alarm For Cars, Pt.1; LED Christmas Tree; Intercom Station Expander; Foldback Loudspeaker System; Railpower Model Train Controller, Pt.2.

December 1999: Solar Panel Regulator; PC Powerhouse (gives +12V, +9V, +6V & +5V rails); Fortune Finder Metal Locator; Speed Alarm For Cars, Pt.2; Railpower Model Train Controller, Pt.3; Index To Vol.12.

January 2000: Spring Reverberation Module; An Audio-Video Test Generator; Parallel Port Interface Card; Telephone Off-Hook Indicator.

February 2000: Multi-Sector Sprinkler Controller; A Digital Voltmeter For Your Car; Safety Switch Checker; Sine/Square Wave Oscillator.

March 2000: 100W Amplifier Module, Pt.1; Electronic Wind Vane With 16-LED Display; Build A Glowplug Driver.

May 2000: Ultra-LD Stereo Amplifier, Pt.2; LED Dice (With PIC Microcontroller); 50A Motor Speed Controller For Models.

June 2000: Automatic Rain Gauge; Parallel Port VHF FM Receiver; Switchmode Power Supply (1.23V to 40V) Pt.1; CD Compressor.

July 2000: Moving Message Display; Compact Fluorescent Lamp Driver; Musicians' Lead Tester; Switchmode Power Supply, Pt.2.

August 2000: Theremin; Spinner (writes messages in "thin-air"); Proximity Switch; Structured Cabling For Computer Networks.

September 2000: Swimming Pool Alarm; 8-Channel PC Relay Board; Fuel Mixture Display For Cars, Pt.1; Protoboards – The Easy Way Into Electronics, Pt.1; Cybug The Solar Fly.

October 2000: Guitar Jammer; Breath Tester; Wand-Mounted Inspection Camera; Subwoofer For Cars; Fuel Mixture Display, Pt.2.

November 2000: Santa & Rudolf Chrissie Display; 2-Channel Guitar Preamplifier, Pt.1; Message Bank & Missed Call Alert; Protoboards – The Easy Way Into Electronics, Pt.3.

December 2000: Home Networking For Shared Internet Access; White LED Torch; 2-Channel Guitar Preamplifier, Pt.2 (Digital Reverb); Driving An LCD From The Parallel Port; Index To Vol.13.

January 2001: How To Transfer LPs & Tapes To CD; The LP Doctor – Clean Up Clicks & Pops, Pt.1; Arbitrary Waveform Generator; 2-Channel Guitar Preamplifier, Pt.3; PIC Programmer & TestBed.

February 2001: An Easy Way To Make PC Boards; L'il Pulser Train Controller; A MIDI Interface For PCs; Build The Bass Blazer; 2-Metre Groundplane Antenna; LP Doctor – Clean Up Clicks & Pops, Pt.2.

March 2001: Making Photo Resist PC Boards; Big-Digit 12/24 Hour Clock; Parallel Port PIC Programmer & Checkerboard; Protoboards – The Easy Way Into Electronics, Pt.5; A Simple MIDI Expansion Box.

April 2001: A GPS Module For Your PC; Dr Video – An Easy-To-Build Video Stabiliser; Tremolo Unit For Musicians; Minimitter FM Stereo Transmitter; Intelligent Nicad Battery Charger.

May 2001: 12V Mini Stereo Amplifier; Two White-LED Torches To Build; PowerPak – A Multi-Voltage Power Supply; Using Linux To Share An Internet Connection, Pt.1; Tweaking Windows With TweakUI.

June 2001: Universal Battery Charger, Pt.1; Phonome – Call, Listen In & Switch Devices On & Off; Low-Cost Automatic Camera Switcher; Using Linux To Share An Internet Connection, Pt.2.

July 2001: The HeartMate Heart Rate Monitor; Do Not Disturb Telephone Timer; Pic-Toc – A Simple Alarm Clock; Fast Universal Battery Charger, Pt.2; Backing Up Your Email.

August 2001: DI Box For Musicians; 200W Mosfet Amplifier Module; Headlight Reminder; 40MHz 6-Digit Frequency Counter Module; Using Linux To Share An Internet Connection, Pt.3.

September 2001: Making MP3s; Build An MP3 Jukebox, Pt.1; PC-Controlled Mains Switch; Personal Noise Source For Tinnitus; Directional Microphone; Using Linux To Share An Internet Connection, Pt.4.

November 2001: Ultra-LD 100W/Channel Stereo Amplifier, Pt.1; Neon Tube Modulator For Cars; Audio/Video Distribution Amplifier; Build A Short Message Recorder Player; Useful Tips For Your PC.

January 2002: Touch And/Or Remote-Controlled Light Dimmer, Pt.1; A Cheap 'n'Easy Motorbike Alarm; 100W /Channel Stereo Amplifier, Pt.3; Build A Raucous Alarm; FAQs On The MP3 Jukebox.

February 2002: 10-Channel IR Remote Control Receiver; 2.4GHz High-Power Audio-Video Link; Touch And/Or Remote-Controlled Light Dimmer, Pt.2; Booting A PC Without A Keyboard; 4-Way Event Timer.

March 2002: Mighty Midget Audio Amplifier Module; 6-Channel IR Remote Volume Control, Pt.1; RIAA Pre-Amplifier For Magnetic Cartridges; 12/24V Intelligent Solar Power Battery Charger.

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April 2002: Automatic Single-Channel Light Dimmer; Pt.1; Water Level Indicator; Multiple-Output Bench Power Supply; Versatile Multi-Mode Timer; 6-Channel IR Remote Volume Control, Pt.2.

May 2002: 32-LED Knightrider; The Battery Guardian (Cuts Power When the Battery Voltage Drops); Stereo Headphone Amplifier; Automatic Single-Channel Light Dimmer; Pt.2; Stepper Motor Controller.

August 2002: Digital Instrumentation Software For PCs; Digital Storage Logic Probe; Digital Therm./Thermostat; Sound Card Interface For PC Test Instruments; Direct Conversion Receiver For Radio Amateurs.

September 2002: 12V Fluorescent Lamp Inverter; 8-Channel Infrared Remote Control; 50-Watt DC Electronic Load; Spyware – An Update.

October 2002: Speed Controller For Universal Motors; PC Parallel Port Wizard; Cable Tracer; AVR ISP Serial Programmer; 3D TV.

November 2002: SuperCharger For NiCd/NiMH Batteries, Pt.1; Windows-Based EPROM Programmer, Pt.1; 4-Digit Crystal-Controlled Timing Module.

December 2002: Receiving TV From Satellites; Pt.1; The Micromitter Stereo FM Transmitter; Windows-Based EPROM Programmer, Pt.2; SuperCharger For NiCd/NiMH Batteries; Pt.2; Simple VHF FM/AM Radio.

January 2003: Receiving TV From Satellites, Pt 2; SC480 50W RMS Amplifier Module, Pt.1; Gear Indicator For Cars; Active 3-Way Crossover For Speakers.

February 2003: PortaPal PA System, Pt.1; SC480 50W RMS Amplifier Module, Pt.2; Windows-Based EPROM Programmer, Pt.3; Fun With The PICAXE, Pt.1.

March 2003: LED Lighting For Your Car; Peltier-Effect Tinnie Cooler; PortaPal PA System, Pt.2; 12V SLA Battery Float Charger; Little Dynamite Subwoofer; Fun With The PICAXE, Pt.2 (Shop Door Minder).

April 2003: Video-Audio Booster For Home Theatre Systems; Telephone Dialler For Burglar Alarms; Three PIC Programmer Kits; PICAXE, Pt.3 (Heartbeat Simulator); Electric Shutter Release For Cameras.

May 2003: Widgybox Guitar Distortion Effects Unit; 10MHz Big Blaster Subwoofer; Printer Port Simulator; PICAXE, Pt.4 (Motor Controller).

June 2003: PICAXE, Pt.5; PICAXE-Controlled Telephone Intercom; PICAXE-08 Port Expansion; Sunset Switch For Security & Garden Lighting; Digital Reaction Timer; Adjustable DC-DC Converter For Cars; Long-Range 4-Channel UHF Remote Control.

July 2003: Smart Card Reader & Programmer; Power-Up Auto Mains Switch; A "Smart" Slave Flash Trigger; Programmable Continuity Tester; PICAXE Pt.6 – Data Communications; Updating The PIC Programmer & Checkerboard; RFID Tags – How They Work.

August 2003: PC Infrared Remote Receiver (Play DVDs & MP3s On Your PC Via Remote Control); Digital Instrument Display For Cars, Pt.1; Home-Brew Weatherproof 2.4GHz WiFi Antennas; PICAXE Pt.7.

September 2003: Robot Wars; Krypton Bike Light; PIC Programmer; Current Clamp Meter Adapter For DMMs; PICAXE Pt.8 – A Data Logger; Digital Instrument Display For Cars, Pt.2.

October 2003: PC Board Design, Pt.1; JV80 Loudspeaker System; A Dirt Cheap, High-Current Power Supply; Low-Cost 50MHz Frequency Meter; Long-Range 16-Channel Remote Control System.

November 2003: PC Board Design, Pt.2; 12AX7 Valve Audio Preamplifier; Our Best Ever LED Torch; Smart Radio Modem For Microcontrollers; PICAXE Pt.9; Programmable PIC-Powered Timer.

December 2003: PC Board Design, Pt.3; VHF Receiver For Weather Satellites; Linear Supply For Luxeon 1W Star LEDs; 5V Meter Calibration Standard; PIC-Based Car Battery Monitor; PICAXE Pt.10.

January 2004: Studio 350W Power Amplifier Module, Pt.1; High-Efficiency Power Supply For 1W Star LEDs; Antenna & RF Preamp For Weather Satellites; Lapel Microphone Adaptor For PA Systems; PICAXE-18X 4-Channel Datalogger, Pt.1; 2.4GHZ Audio/Video Link.

February 2004: PC Board Design, Pt.1; Supply Rail Monitor For PCs; Studio 350W Power Amplifier Module, Pt.2; Shorted Turns Tester For Line Output Transformers; PICAXE-18X 4-Channel Datalogger, Pt.2.

March 2004: PC Board Design, Pt.2; Build The QuickBrake For Increased Driving Safety; 3V-9V (or more) DC-DC Converter; ESR Meter Mk.2, Pt.1; PICAXE-18X 4-Channel Datalogger, Pt.3.

April 2004: PC Board Design, Pt.3; Loudspeaker Level Meter For Home Theatre Systems; Dog Silencer; Mixture Display For Cars; ESR Meter Mk.2, Pt.2; PC/PICAXE Interface For UHF Remote Control.

May 2004: Amplifier Testing Without High-Tech Gear; Component Video To RGB Converter; Starpower Switching Supply For Luxeon Star LEDs; Wireless Parallel Port; Poor Man's Metal Locator.

June 2004: Dr Video Mk.2 Video Stabiliser; Build An RFID Security Module; Simple Fridge-Door Alarm; Courtesy Light Delay For Cars; Automating PC Power-Up; Upgraded Software For The EPROM Programmer.

July 2004: Silencing A Noisy PC; Versatile Battery Protector; Appliance Energy Meter, Pt.1; A Poor Man's Q Meter; Regulated High-Voltage Supply For Valve Amplifiers; Remote Control For A Model Train Layout.

August 2004: Video Formats: Why Bother?; VAF's New DC-X Generation IV Loudspeakers; Video Enhancer & Y/C Separator; Balanced Microphone Preamp; Appliance Energy Meter, Pt.2; 3-State Logic Probe.

September 2004: Voice Over IP (VoIP) For Beginners; WiFry – Cooking Up 2.4GHz Antennas; Bed Wetting Alert; Build a Programmable Robot; Another CFL Inverter.

October 2004: The Humble "Trannie" Turns 50; SMS Controller, Pt.1; RGB To Component Video Converter; USB Power Injector; Remote Controller For Garage Doors & Gates.

November 2004: 42V Car Electrical Systems; USB-Controlled Power Switch (Errata Dec. 2004); Charger For Deep-Cycle 12V Batteries, Pt.1; Driveway Sentry; SMS Controller, Pt.2; PICAXE IR Remote Control.

December 2004: Build A Windmill Generator, Pt.1; 20W Amplifier Module; Charger For Deep-Cycle 12V Batteries, Pt.2; Solar-Powered Wireless Weather Station; Bidirectional Motor Speed Controller.

January 2005: Windmill Generator, Pt.2; Build A V8 Doorbell; IR Remote Control Checker; 4-Minute Shower Timer; The Prawnlite; Sinom Says Game; VAF DC-7 Generation 4 Kit Speakers.

February 2005: Windmill Generator, Pt.3; USB-Controlled Electrocardiograph; TwinTen Stereo Amplifier; Inductance & Q-Factor Meter, Pt.1; A Yagi Antenna For UHF CB; $2 Battery Charger.

March 2005: Windmill Generator, Pt.4; Sports Scoreboard, Pt.1; Swimming Pool Lap Counter; Inductance & Q-Factor Meter, Pt.2; Shielded Loop Antenna For AM; Cheap UV EPROM Eraser; Sending Picaxe Data Over 477MHz UHF CB; $10 Lathe & Drill Press Tachometer.

April 2005: Install Your Own In-Car Video (Reversing Monitor); Build A MIDI Theremin, Pt.1; Bass Extender For Hifi Systems; Sports Scoreboard, Pt.2; SMS Controller Add-Ons; A $5 Variable Power Supply.

May 2005: Getting Into Wi-Fi, Pt.1; Build A 45-Second Voice Recorder; Wireless Microphone/Audio Link; MIDI Theremin, Pt.2; Sports Scoreboard, Pt.3; Automatic Stopwatch Timer.

June 2005: Wi-Fi, Pt.2; The Mesmeriser LED Clock; Coolmaster Fridge/Freezer Temperature Controller; Alternative Power Regular; PICAXE Colour Recognition System; AVR200 Single Board Computer, Pt.1.

July 2005: Wi-Fi, Pt.3; Remote-Controlled Automatic Lamp Dimmer; Serial Stepper Motor Controller; Salvaging & Using Thermostats; Unwired Modems & External Antennas.

August 2005: Mudlark A205 Valve Stereo Amplifier, Pt.1; Programmable Flexitimer; Carbon Monoxide Alert; Serial LCD Driver; Enhanced Sports Scoreboard; Salvaging Washing Maching Pressure Switches.

September 2005: Build Your Own Seismograph; Bilge Sniffer For Boats; VoIP Analog Phone Adaptor; Mudlark A205 Valve Stereo Amplifier, Pt.2; PICAXE in Schools, Pt.4.

October 2005: A Look At Google Earth; Dead Simple USB Breakout Box; Studio Series Stereo Preamplifier, Pt.1; Video Reading Aid For Vision Impaired People; Simple Alcohol Level Meter; Ceiling Fan Timer.

November 2005: Good Quality Car Sound On The Cheap; Pt.1; PICAXE In Schools, Pt.5; Studio Series Stereo Headphone Amplifier; Build A MIDI Drum Kit, Pt.1; Serial I/O Controller & Analog Sampler.

December 2005: Good Quality Car Sound On The Cheap; Pt.2; Building The Ultimate Jukebox, Pt.1; Universal High-Energy Ignition System, Pt.1; Remote LED Annunciator For Queue Control; Build A MIDI Drum Kit, Pt.2; 433MHz Wireless Data Communication.

January 2006: Pocket TENS Unit For Pain Relief; "Little Jim" AM Radio Transmitter; Universal High-Energy Ignition System, Pt.2; Building The Ultimate Jukebox, Pt.2; MIDI Drum Kit, Pt.3; Picaxe-Based 433MHz Wireless Thermometer; A Human-Powered LED Torch.

February 2006: PC-Controlled Burglar Alarm, Pt.1; A Charger For iPods & MP3 Players; Picaxe-Powered Thermostat & Temperature Display; Build A MIDI Drum Kit, Pt.4; Building The Ultimate Jukebox, Pt.3.

March 2006: The Electronic Camera, Pt.1; PC-Controlled Burglar Alarm System, Pt.2; Low-Cost Intercooler Water Spray Controller; AVR ISP SocketBoard; Build A Low-Cost Large Display Anemometer.

April 2006: The Electronic Camera, Pt.2; Studio Series Remote Control Module (For A Stereo Preamplifier); 4-Channel Audio/Video Selector; Universal High-Energy LED Lighting System, Pt.1; Picaxe Goes Wireless, Pt.1 (Using the 2.4GHz XBee Modules).

May 2006: Lead-Acid Battery Zapper ; Universal High-Energy LED Lighting System, Pt.2; Passive Direct Injection (DI) Box For Musicians; Picaxe Goes Wireless, Pt.2; Boost Your XBee's Range Using Simple Antennas; Improving The Sound Of Salvaged Loudspeaker Systems.

June 2006: Pocket A/V Test Pattern Generator; Two-Way SPDIF-to-Toslink Digital Audio Converter; Build A 2.4GHz Wireless A/V Link; A High-Current Battery Charger For Almost Nothing.

July 2006: Mini Theremin Mk.2, Pt.1; Programmable Analog On-Off Controller; Studio Series Stereo Preamplifier; Stop Those Zaps From Double-Insulated Equipment.

August 2006: Picaxe-Based LED Chaser Clock; Magnetic Cartridge Preamplifier; An Ultrasonic Eavesdropper; Mini Theremin Mk.2, Pt.2.

September 2006: Thomas Alva Edison – Genius, Pt.1; Transferring Your LPs To CDs & MP3s; Turn an Old Xbox Into A $200 Multimedia Player; Picaxe Net Server, Pt.1; Build The Galactic Voice; Aquarium Temperature Alarm; S-Video To Composite Video Converter.

October 2006: Thomas Alva Edison – Genius, Pt.2; LED Tachometer With Dual Displays, Pt.1; UHF Prescaler For Frequency Counters; Infrared Remote Control Extender; Picaxe Net Server, Pt.2; Easy-To-Build 12V Digital Timer Module; Build A Super Bicycle Light Alternator.

November 2006: Radar Speed Gun, Pt.1; Build Your Own Compact Bass Reflex Loudspeakers; Programmable Christmas Star; DC Relay Switch; LED Tachometer With Dual Displays, Pt.2; Picaxe Net Server, Pt.3.

December 2006: Bringing A Dead Cordless Drill Back To Life; Cordless Power Tool Charger Controller; Build A Radar Speed Gun, Pt.2; Heartbeat CPR Training Beeper; Super Speedo Corrector; 12/24V Auxiliary Battery Controller; Picaxe Net Server, Pt.3.

January 2007: Versatile Temperature Switch; Intelligent Car Air-Conditioning Controller; Remote Telltale For Garage Doors; Intelligent 12V Charger For SLA & Lead-Acid Batteries.

February 2007: Remote Volume Control & Preamplifier Module, Pt.1; Simple Variable Boost Control For Turbo Cars; Fuel Cut Defeater For The Boost Control; Low-Cost 50MHz Frequency Meter, Mk.2.

March 2007: Programmable Ignition System For Cars, Pt.1; Remote Volume Control & Preamplifier Module, Pt.2; GPS-Based Frequency Reference, Pt.1; Simple Ammeter & Voltmeter.

April 2007: The Proposed Ban On Incandescent Lamps; High-Power Reversible DC Motor Speed Controller; Build A Jacob's Ladder; GPS-Based Frequency Reference, Pt.2; Programmable Ignition System For Cars, Pt.2; Dual PICAXE Infrared Data Communication.

May 2007: 20W Class-A Amplifier Module, Pt.1; Adjustable 1.3-22V Regulated Power Supply; VU/Peak Meter With LCD Bargraphs; Programmable Ignition System For Cars, Pt.3; GPS-Based Frequency Reference Modifications; Throttle Interface For The DC Motor Speed Controller.

June 2007: 20W Class-A Amplifier Module, Pt.2; Knock Detector For The Programmable Ignition; 4-Input Mixer With Tone Controls; Frequency-Activated Switch For Cars; Simple Panel Meters Revisited.

July 2007: How To Cut Your Greenhouse Emissions, Pt.1; 6-Digit Nixie Clock, Pt.1; Tank Water Level Indicator; A PID Temperature Controller; 20W Class-A Stereo Amplifier; Pt.3; Making Panels For Projects.

August 2007: How To Cut Your Greenhouse Emissions, Pt.2; 20W Class-A Stereo Amplifier; Pt.4; Adaptive Turbo Timer; Subwoofer Controller; 6-Digit Nixie Clock, Pt.2.

September 2007: The Art Of Long-Distance WiFi; Fast Charger For NiMH & Nicad Batteries; Simple Data-Logging Weather Station, Pt.1; 20W Class-A Stereo Amplifier; Pt.5.

October 2007: DVD Players – How Good Are They For HiFi Audio?; Electronic Noughts & Crosses Game; PICProbe Logic Probe; Rolling Code Security System, Pt.1; Simple Data-Logging Weather Station, Pt.2; AM Loop Antenna & Amplifier.

November 2007: Your Own Home Recording Studio; PIC-Based Water Tank Level Meter, Pt.1; Playback Adaptor For CD-ROM Drives, Pt.1; Rolling Code Security System, Pt.2; Build A UV Light Box For Making PC Boards.

December 2007: Signature Series Kit Loudspeakers; IR Audio Headphone Link; Enhanced 45s Voice Recorder Module; PIC-Based Water Tank Level Meter; Pt.2; Playback Adaptor For CD-ROM Drives; Pt.2.

January 2008: PIC-Controlled Swimming Pool Alarm; Emergency 12V Lighting Controller; Build The "Aussie-3" Valve AM Radio; The Minispot 455kHz Modulated Oscillator; Water Tank Level Meter, Pt.3 – The Base Station; Improving The Water Tank Level Meter Pressure Sensor.

February 2008: UHF Remote-Controlled Mains Switch; UHF Remote Mains Switch Transmitter; A PIR-Triggered Mains Switch; Shift Indicator & Rev Limiter For Cars; Mini Solar Battery Charger.

March 2008: How To Get Into Digital TV, Pt.1; The I²C Bus – A Quick Primer; 12V-24V High-Current DC Motor Speed Controller, Pt.1; A Digital VFO with LCD Graphics Display; A Low-Cost PC-to-I²C Interface For Debugging; One-Pulse-Per Second Driver For Quartz Clocks.

April 2008: How To Get Into Digital TV, Pt.2; Charge Controller For 12V Lead-Acid Or SLA Batteries; Safe Flash Trigger For Digital Cameras; 12V-24V High-Current DC Motor Speed Controller, Pt.2; Two-Way Stereo Headphone Adaptor.

May 2008: Replacement CDI Module For Small Petrol Motors; High-Accuracy Digital LC Meter; Low-Cost dsPIC/PIC Programmer; High-Current Adjustable Voltage Regulator.

June 2008: DSP Musicolour Light Show, Pt.1; PIC-Based Flexitimer Mk.4; USB Power Injector For External Hard Drives; Balanced/Unbalanced Converter For Audio Signals; A Quick'n'Easy Digital Slide Scanner; Altitude 3500-SS Stereo Valve Amplifier Reviewed.

July 2008: DSP Musicolour Light Show, Pt.2; A PIC-Based Musical Tuning Aid; Balanced Mic Preamp For PCs & MP3 Players; Bridge Adaptor For Stereo Power Amplifiers.

August 2008: Ultra-LD Mk.2 200W Power Amplifier Module, Pt.1; Planet Jupiter Receiver; LED Strobe & Contactless Tachometer, Pt.1; DSP Musicolour Light Show, Pt.3; Printing In The Third Dimension.

September 2008: Railpower Model Train Controller, Pt.1; LED/Lamp Flasher; Ultra-LD Mk.2 200W Power Amplifier Module, Pt.2; DSP Musicolour Light Show, Pt.4; LED Strobe & Contactless Tachometer, Pt.2.

October 2008: USB Clock With LCD Readout, Pt.1; Digital RF Level & Power Meter; Multi-Purpose Timer; Railpower Model Train Controller, Pt.2; Picaxe-08M 433Mhz Data Transceiver.

November 2008: 12V Speed Controller/Lamp Dimmer; USB Clock With LCD Readout, Pt.2; Wideband Air-Fuel Mixture Display Unit; IrDA Interface Board For The DSP Musicolour; The AirNav RadarBox.

December 2008: Versatile Car Scrolling Display, Pt.1; Test The salt Content Of Your Swimming Pool; Build A Brownout Detector; Simple Voltage Switch For Car Sensors.

January 2009: Dual Booting With Two Hard Disk Drives; USB-Sensing Mains Power Switch; Remote Mains Relay Mk.2; AM Broadcast Band Loop Antenna; Car Scrolling Display, Pt.2; 433MHz UHF Remote Switch.

February 2009: Digital Radio Is Coming, Pt.1; Tempmaster Electronic Thermostat Mk.2; 10A Universal Motor Speed Controller Mk.2; Programmable Time Delay Flash Trigger; Car Scrolling Display, Pt.3.

March 2009: Reviving Old Laptops With Puppy Linux; Digital Radio Is Coming, Pt.2; A GPS-Synchronised Clock; Theremin Mk.2; Build A Digital Audio Millivoltmeter; Learning about Picaxe Microcontrollers.

April 2009: Digital Radio Is Coming, Pt.3; Wireless Networking With Ubuntu & Puppy Linux; Remote-Controlled Lamp Dimmer; School Zone Speed Alert; USB Printer Share Switch; Microcurrent DMM Adaptor.

May 2009: A 6-Digit GPS-Locked Clock, Pt.1; 230VAC 10A Full-Wave Motor Speed Controller; Precision 10V DC Reference For Checking DMMs; UHF Remote 2-Channel 230VAC Power Switch; Input Attenuator For The Digital Audio Millivoltmeter; Drawing Circuits In Protel Autotrax.

PLEASE NOTE: issues not listed have sold out. All listed issues are in stock. We can supply photostat copies of articles from sold-out issues for $A9.50 each within Australia or $A13.00 each overseas (prices include p&p). When supplying photostat articles or back copies, we automatically supply any relevant notes & errata at no extra charge. A complete index to all articles published to date can be downloaded free from our web site: **www.siliconchip.com.au**

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Copper strip for inverter transformer

I want to build the 600W DC-DC Converter (SILICON CHIP, October & November 1996). The primary of the transformer is made from 0.315mm copper strip. There is also a strap made from 0.6mm copper strip.

Could you please advise me if there is a company that supplies sheet copper in small quantities, as used by hobbyists? (Z. F., via fax).

• The copper strip can be obtained from any model shop that has supplies for model aircraft, model cars, etc. They usually have a stand with various copper, brass and aluminium cross-sections.

Shadows on VU display module

I have just completed a second digital VU meter (SILICON CHIP, May 2007) with the display module connected to the PC board via 40mm lengths of rainbow cable to facilitate fitting to a 2005 Studio preamp 1U rack-mounting case. All voltages are present and conductivity has been established between the 14 solder connections on the display unit and their points of origin on the PC board.

There are many dark shadows (almost 50% of the area), making the peak only indicators not to easy to see. Has anyone else experienced this? (D. G., via email).

• Our guess is that the shadows are caused by the added lead length between the LCD module and PC board and the stray coupling between the leads. Try separating the strands of the ribbon cable. Some terminating resistors of say 1kΩ between the ENable (pin 6) of the module and ground and the RS (pin 4) and ground may help. Or you may also need the resistors at the data lines (D7, D6, D5 & D4).

The shadows might be minimised by adjusting the contrast control, VR3. Alternatively, you could build it as described in the original instructions. If that fixes the fault, you know where the trouble lies.

Programmable ignition question

I have been looking at buying a kit for the Programmable Ignition System published in the March, April & May 2007 issues. I want to use it on a Holden 186 and have a Bosch dizzy from a later model motor for it. It has a reluctor pickup which triggers an inbuilt ignitor. Can the ignition be used to trigger the existing ignitor unit? (D. M., via email).

• There are two possibilities with your existing system. There is either a separate reluctor and separate ignition coil driver (ignitor) or the ignition coil driver is all in the same housing as the reluctor.

If you have separate units, more than likely the output from the programmable ignition can be used to trigger the existing ignition module (ignitor). The output may require inverting (a way to do this is described in the articles) if the module fires on a negative-going signal rather than a positive-going signal.

For a combined reluctor and ignitor, set up the programmable ignition for points and use the ignitor output as the trigger input for the programmable ignition. The ignition coil driver that was designed as part of the programmable ignition would then be required to drive the coil.

How to connect digital TV to multiple sets

With the increase in digital channels, etc, would it be possible to compose a detailed article on ways that some of the older sets people have in their bedroom, kitchen, etc could be connected to the digital signal? Perhaps some of your very smart contributors could develop a kit that could carry the signal via the antenna cable.

I know you touched on the subject a couple of months ago but a simple detailed explanation would certainly help non-technical people like me. (D. L., via email).

• Many people are in your situation, with perhaps four or more analog sets, wanting to access the programs from a single set-top box (STB). The real problem is that no matter what scheme is used, RF or cable, you will only be able to watch one program at a time, on all sets. So if you have two or more people in the home who want to watch different programs simultaneously, you will need more than one set-top box or a DVR, or a digital TV set with its own tuner.

As far as getting the set-top box program to the other analog sets is concerned, the best way appears to be a UHF transmitter/receiver set-up.

What Determines CD Sound Quality?

As a long-term SILICON CHIP reader I would like to ask some advice. As CD players use minimal analog stages, does the resultant audio quality depend on these only?

There is such a myriad of (lesser quality) program sources (MP3, DVD, etc), so does it matter? Could a computer CD drive extract as good quality audio as say a dedicated name-brand CD player, eg, Denon, Marantz, etc? (R. R., McCrae, Vic).

• The main determinant of sound quality in a CD player (or a DVD player) is the quality of the DAC (digital-to-analog converter). These vary enormously from brand to brand and from one PC or laptop to another.

A quality dedicated CD player from Denon, Onkyo, Yamaha or other top brand-name will give far better sound quality than any PC or laptop CD/DVD drive.

Modern Electronic Gear Often Runs Hot

I value your opinion regarding how hot components should operate and some ways to achieve lower temperatures to give products a life span somewhat longer than the usual 12-months warranty.

In summer, my living room temperature often reaches 33°C which results in my appliances (TV, VCR, CD player, monitor, etc) becoming uncomfortably hot to the touch. The top of my set-top box reaches 45°C and the CPU heatsink runs at 58°C. Most of the electrolytic capacitors in it are rated at 105°C but a few are only rated at 85°C and I know a chain is only as strong as its weakest link.

I once abandoned a TV repair when I found that almost every electrolytic capacitor (72 in all) had corrosion holes which I believe are caused by high temperatures.

My friends have a computer games console which has been stood on end to operate, as in the horizontal position it becomes very hot, and elsewhere a computer freezes on hot days.

In the past, I have improved the cooling by removing the outer casings and drilling hundreds of 5mm holes through them. But clearly this increases the danger of shock when the appliance has power.

I have considered winding a few turns around the switchmode transformer to provide power for a fan. However, I am unsure of the diodes and filtering needed by the circuit to control the fan speed, and any possible overload on the switchmode circuit.

I have been using a contact type thermometer to check temperatures, and have been thinking of purchasing a Non-Contact Dual Laser Thermometer which I hope will quickly detect hot capacitors, transistors etc. Is this a good choice? (A. F., Chinderah, NSW).

• In an ideal world, most components would run cool to the touch and only a few key power supply and output stage components would run hot. These days that is just wishful thinking and a lot of gear runs very warm or hot. There is not much you can do about it except to make sure that ventilation around the appliance is not restricted and that it is not exposed to direct sunlight.

Do not even think about winding turns around switchmode transformers. They run at very high frequencies (not 50Hz) and any such "mods" are likely to prejudice reliability.

You can certainly use a non-contact thermometer to check operating conditions for components but even if you discover hot components, unless a fault has occurred, it is likely that the circuit (whatever it might be) is operating as intended. Nor can you dive in and make circuit changes willy-nilly because that will void any warranty and possibly lead to other problems. There is no simple solution.

This should also have a remote control extender so that you can use a remote control to change the program selection of your STB while watching the program on an analog set in another room.

There are several such UHF transmitter/receivers available. Jaycar currently have their Cat. AR-1836 available at $76.95 and this is also available with an extra receiver (Cat. AR-1837 $44.95), so you could run two analog sets with this set-up plus another TV next to the STB itself.

Mind you, if your analog sets do not have audio/video inputs, you would then need an RF modulator to take the A/V signals from the UHF receiver and feed them to the analog TV's antenna input; ie, it all gets a bit involved. Jaycar have an RF modulator: Cat. LM-3872 (mono $18.95) or LM-3873 (stereo $24.95).

Yes, it is possible to have a coax cable or Cat5 cable routing the A/V signals around the house. In fact, we published an A/V to twisted pair (Cat5) transmitter/receiver in the October 1996 issue. Alternatively, you could use a component video to Cat5 balun, such as Jaycar's Cat.QC-3683.

However, if you consider the cost of a UHF or cable set-up, you might find that it is cheaper to buy more STBs which can be fed from the antenna points you presently may have for your analog TVs.

Ultimately, there is no need to panic. It looks as though the ultimate switch-off for analog TV signals may be a few years away yet, depending on where you live. By that time, one or more of your analog sets may have died and been replaced. Digital TVs, DVRs and STBs continue to get cheaper.

Temperature controller for a reptile tank

I am looking for something to control the temperature in a reptile tank. Would the Coolmaster Fridge/Freezer Temperature Controller do the job? If not, is there any other kit that will do the job? (B. C., Rutherford, NSW).

• The Tempmaster Mk.2 (SILICON CHIP, February 2009) or the earlier Coolmaster (June 2005) would be suitable to control the temperature in a reptile tank.

If you require a higher temperature setting than 19°C (we suspect this would be necessary), then the 3.3kΩ resistor in series with trimpot VR1 can be increased to 3.9kΩ to allow a higher voltage (temperature) adjustment to 3.1V or 40°C.

Cheap pump controller

My mother and I have three mobile air-conditioners in our house and I need to modify the "Cheap Pump Controller" in the Circuit Notebook of August 2005, page 72, for emptying the condensate through a thin PVC hose out the window for each unit.

I will be using a small windscreen washer pump instead of an aquarium pump, due to the size, shape and outlet of the water reservoir.

The circuit needs to be modified to use a 12V relay, since the 12V pump requires up to 1.5A but on the other side of relay the 555 timer might find that current too much for it to handle. Can I therefore use one 12V power supply to power both the punp controller circuitry and the 12V pump motor via the relay?

In order to protect each circuit from reversing currents, do I install four

Controller For Electric Vehicles

Having read your Publisher's Letter in the January 2009 edition of SILICON CHIP, I agree that in the present economic climate we are unlikely to see mass-produced electric vehicles in Australia in the foreseeable future. Even those vehicles touted as imminent are likely to be out of realistic financial viability for the majority of Australians when compared to the flood of relatively cheap imports, both petrol and diesel.

Here lies the challenge! I, for one, would love to do my own conversion and already have a suitable donor vehicle, old enough (read "classic") to be very lightweight and not complicated by such hindrances as ADRs, power brakes and steering, requirements to have heating, and even seat belts (although I firmly believe in these as an essential and currently fitted after-market accessory).

What is lacking and not apparently available commercially in Australia is a suitable DIY motor controller. How about it? Your engineering staff have produced a plethora of add-on goodies aimed at the go-faster, turbo-powered, fuel-injected petrol consumers. Can you please now come up with a versatile, affordable project for an efficient electric motor controller incorporating regenerative braking? A great follow-up article would be a mains-powered battery charger, designed for overnight charging of an electric vehicle battery pack.

What can you come up with to satisfy the purists amongst your readers, those who want to give it a go to help cut emissions without waiting for the industry moguls to catch up? (J. B., Beetaloo Valley, SA).

• There is little chance that we will ever do such a project, unless we had a sponsor with very deep pockets.

The largest DC speed controller we have ever produced is rated at about 1kW at 24V DC (SILICON CHIP, March & April 2008). By contrast, the speed controller for a typical EV conversion will require a battery pack of 120V or more and might have a peak rating of 50kW or more, ie, current of more than 400A. Producing such a design which was reliable and safe would be a major engineering project requiring a very big investment.

The major car manufacturers could be expected to devote millions of dollars to a reliable speed controller for an electric vehicle. We are not in that league.

We also have serious concerns about the safety and reliability of many amateur EV conversions. Adding a heavy (hundreds of kg) battery pack to an old vehicle is a major engineering exercise. Not only must the battery pack be very securely anchored (and ventilated) but it also should not prejudice the handling and braking of the vehicle.

Nor should it prejudice the crashworthiness of the vehicle or present additional risk in the event of a crash. The thought of several hundred kilograms of battery loose and flying forward inside the cabin in the event of a crash is quite stark! It could easily be fatal for the driver and passengers.

The EV conversion featured in this month's issue is the first that we have seen that meets these criteria.

1N4004 diodes (cathode to positive supply, anode to negative supply)? Also, to prevent electrolytic effects decaying the water level probes, can I install 10µF DC blocking capacitors on the ground probe or on all probes? (W. F., via email).

• The circuit should work without modification. Just change the relay to a heavy duty one such as the Jaycar SY-4042. You can use the same 12V supply to power both the circuit and the pump.

Using 10µF capacitors in series with the probes as you propose would prevent circuit operation.

Mesmeriser clock problem

I am having a problem with the time keeping of my Mesmeriser LED Clock (SILICON CHIP, June 2005). When it was first built it was fine for 18 months. Then it was put away (batteries out) for 3/4 months during renovations and when it was put back into service, it gained about one hour per day.

On checking the circuitry, I found the 100Hz reference signal applied to the base of the BC547 was varying dramatically, eg, 99.96Hz (measured with a Fluke 8060A multimeter) for the first 35 seconds, 125Hz for the next 10 seconds and 152Hz for the last 15 seconds (times varied slightly but are within five seconds). This was also measured between pin 4 and pin 20 of the microcontroller with the same results. The 12V AC plugpack is a 50Hz ±0.5Hz. On the cathode side of the 1N4007 (D1) there was 0Hz.

I plugged into different power circuits through house, turned off lights and electronic devices and removed compact fluorescent globes to check interference/stray harmonics to no avail. I got a loan of a Critec electronic faxguard interference/surge protector which also didn't help. I tried a long extension cord which didn't help.

I have replaced the bridge rectifier, the 68kΩ resistor and the BC547 transistor, none of which have helped. I have fitted a 4.7kΩ resistor between the anode of D1 (1N4007) and the earth end of the 3.3kΩ resistor which has made a difference – it still gains but on a random basis; it kept good time for two hours and then gained five minutes and then good time again – weird!

I am wondering whether a 100Hz oscillator feeding a signal to the BC547 should be inserted into the clock? I would need guidance with this; should the pin 4 reference signal be removed and let the thing time off the onboard 8MHz crystal? Hoping you can enlighten me with this frustrating problem. (M. C., via email).

• As you say, your problem is really weird. You have replaced all the obvious suspect components, however, you might be on the right track in increasing the loading on the bridge rectifier with your addition of a 4.7kΩ resistor. The rectified waveform from a bridge rectifier can certainly be "wonky" if there is insufficient loading. Perhaps you should try reducing it to 1kΩ.

Another thing to consider is that the 68kΩ resistor to Q7's base may be too large if the 12VAC supply is on the low side. Try reducing this resistor to 47kΩ.

You can certainly remove the reference signal from pin 4 and just run the clock from the 8MHz crystal but the long-term time-keeping won't be as good.

As a final thought, is there any leakage on the board from BD682 transistors Q1 & Q5 to the base of Q7? This might have developed when the clock was in storage.

IF transformers in Aussie Three

I have partly completed construction of the Aussie Three valve radio from the January 2008 issue. The information supplied with my IF/OSC coil packs (Jaycar-LF1050) says that the yellow coils are first IFT and the blacks are third IFT. However, the circuit on page 63 of the January 2008 issue shows "black" for first IFT and "yellow" for second IFT.

Your advice would be appreciated. (T. G., via email).

• The designations 1st, 2nd and 3rd IF transformers refer to the difference in the coils between the second winding and the tapping ratios. For the Aussie Three, the black slug coil is more suited to the 1st IF stage, with the yellow best for the second.

Follow the published circuit rather than the designations shown on the IF coil pack.

Pulser for fuel injector cleaning

I recently purchased an ultrasonic cleaner from Jaycar. A fuel injection specialist advised me that to properly clean injectors they should be pulsed while in the ultrasonic cleaner. I was advised by one of the Jaycar sales people that the Peak Hold Injector Adaptor was suitable for this. Is this so or is there something more suitable available to do this job? Will the Peak Hold Injector Adaptor have to be modified for this role?

The injectors are from a 1985 Cordia Turbo which has done 150,000km. The maximum duty cycle for the injectors for this model is only 50%. (C. C., via email).

• The peak hold injector adaptor is not suitable for driving injectors. This project converts the peak hold signal that drives some injectors into a stable square wave signal that's suitable for measuring the injector duty cycle.

To drive the injectors, use the Motor Speed Control published in November 2008 (Jaycar Cat. KC-5382). Set the drive duty cycle to less than 50%.

AM transmitter to suit old car radio

I read the article in SILICON CHIP about building this little AM transmitter which has a range of just a few metres. The thing is, it runs on 12V. Is it possible to create a version that can run on 6V instead?

I own a Buick Roadmaster from 1948 with an original Sonomatic tube radio but there are no stations to tune in. It would be so nice to be able to drive about and listen to some golden oldies on the original radio. An MP3 player and this AM transmitter in the glove compartment would be a blessing.

Maybe it's possible to make a device/adaptor to slave in the output from the AM transmitter directly to the antenna input on the car radio. (P. E., Linkoping, Sweden).

• We assume you are referring to the "Little Jim" AM Transmitter from the January 2006 issue of SILICON CHIP.

You should be able to run the circuit from 6V if you change REG1 from a 7812 12V regulator to a zener diode regulator circuit. Remove REG1 and connect a 10Ω 0.5W resistor between the IN and OUT terminal positions on the PC board that were originally for REG1. Then connect a 6.2V 1W zener diode (1N4735) between the OUT position and the GND position for the original REG1 (the diode's anode connects to GND, while the cathode connects to the OUT terminal).

You can couple the antenna signal directly to the radio's antenna. SC

Notes & Errata

Temperature Probe For Hot Water System, March 2009: the text for this Circuit Notebook item on page 76 has the instructions for calibrating VR1 & VR2 transposed.

230VAC 10A Full-Wave Motor Speed Controller, May 2009: the two 5W resistors shown on the parts overlay (Fig.10, page 42) as 4.7Ω should both be 4.7kΩ. The photograph, parts list and circuit show these correctly as 4.7kΩ.

In addition, pin 13 for IC2f on the circuit (Fig.9, page 40) should be labelled as pin 15.

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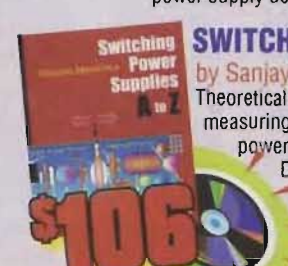

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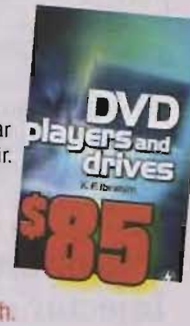

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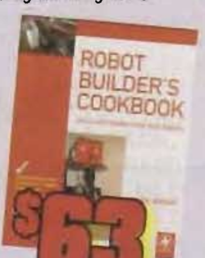

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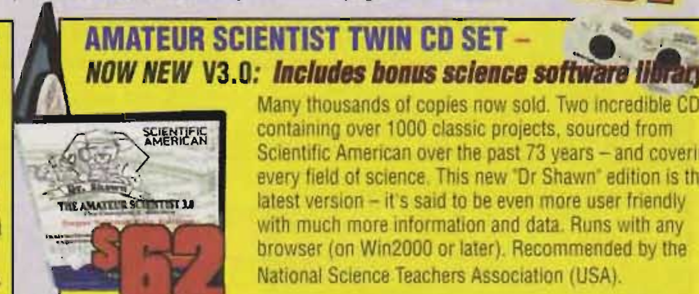

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