SILICON CHIP

DECEMBER 2006
ISSN 1030-2662
12
9 771030 266001
PRINT POST APPROVED
- PP255003/01272
$8.50* INC GST NZ$9.90 INC GST

We've got all the details:

HOLDEN'S 2321cm TV SCREEN

Flying to a sky near you!

FEATURE: Bringing old cordless tools back to life!
Special battery offer from Jaycar Electronics

CORDLESS DRILL CHARGER CONTROLLER

2ND BATTERY ISOLATOR FOR 4WD, VANS MOTOR HOMES

HEARTBEAT CPR TRAINING BEEPER

Contents

Vol.19, No.12; December 2006 www.siliconchip.com.au

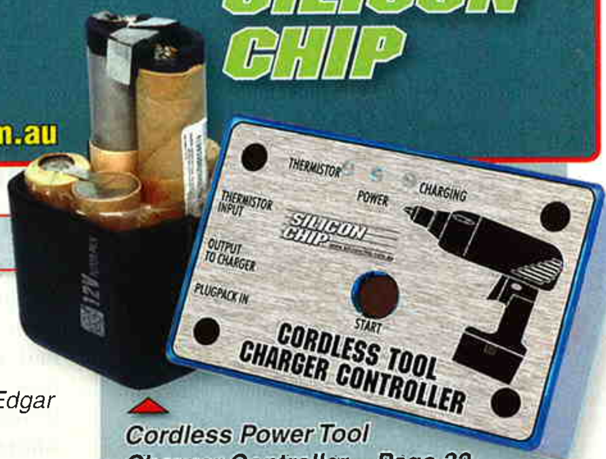
SILICON CHIP

Features

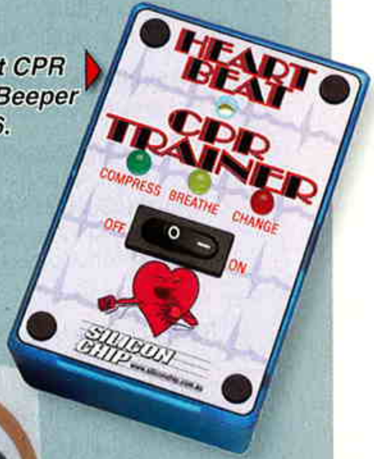
Projects To Build

Special Columns

Departments



Cordless Power Tool Charger Controller – Page 32.



Heartbeat CPR Training Beeper – Page 66.

Calibrate Your Speedo With This Speedo Corrector – Page 72.

12/24V Auxiliary Battery Controller – Page 80.

SILICON CHIP
www.siliconchip.com.au

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

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

Technical Editor
Peter Smith

Technical Staff
John Clarke, B.E.(Elec.)
Ross Tester
Jim Rowe, B.A., B.Sc, VK2ZLO

Reader Services
Ann Jenkinson

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

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

SILICON CHIP is published 12 times a year by Silicon Chip Publications Pty Ltd. ACN 003 205 490. ABN 49 003 205 490 All material copyright ©. No part of this publication may be reproduced without the written consent of the publisher.

Printing: Hannanprint, Noble Park, Victoria.

Distribution: Network Distribution Company.

Subscription rates: $89.50 per year in Australia. For overseas rates, see the subscription page in this issue.

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

ISSN 1030-2662
*Recommended and maximum price only.

Publisher's Letter

Cheap battery drills are very wasteful

For quite a few years now, we have been concerned about the waste of resources concerned with electrical and electronic equipment. It is bad enough that most electronic equipment is now so cheap that it is not worth repairing when it finally does fail. At least if it gives a reasonably long service life, you don't mind so much if it then has to be replaced with a new one rather than being repaired. But I still regard the huge amount of electronics going to the tip each year, all for the want of a simple (albeit uneconomical) repair, as a huge waste. Cars and large appliances such as fridges and washing machines get discarded too but at least most of their metal content does get recycled. But cheap electrical and electronic appliances don't last very long and then they end up on the tip.

Even worse is the situation with cheap battery-powered electric drills. Because their battery life is so short, there must be tens of thousands of these drills being discarded every year. They work for a short time, then the battery ceases holding a charge and out into the bin they go, to be replaced by another drill. In fact, the drill itself is fine but the battery is ruined and you can not get a replacement. This is an unconscionable waste of resources. So in conjunction with Jaycar Electronics, we have done something about it. First, there is the article beginning on 24 about repacking the cells in your drill's battery pack. This is not a cheap exercise and will typically cost a lot more than the price of a new drill – but at least you are starting afresh with good cells.

But given that the chargers for these drills are so rudimentary, that is only half the task. To ensure that your new battery pack has a reasonable life, you need to incorporate a specified thermistor in the battery pack and then build the Drill Charger Controller described in the article beginning on page 32. With over-temperature and time-out functions, this will prevent the cells from being over-charged and they should last many times longer than in normal drills.

In fact, even if the battery pack in your present drill is still OK, I would strongly recommend that you modify it along the lines described and build the Charger Controller. Or if you go out and buy a new battery drill, don't wait for the battery to deteriorate – modify it straight away to ensure a reasonable life. After all, there is no point in spending $30 or so on a new drill if you know that it is going to have a very short life.

The really irresponsible parties in this whole affair are the manufacturers who are churning out this short-lived rubbish and the importers and retailers who ultimately sell it to the public. It is in their interests to keep this wasteful cycle going, isn't it? For the want of a better charger which would only add a few dollars to the price, the retailers are probably selling many more drills than they otherwise would.

Unfortunately, there is a great deal of electronics gear for which there are no simple refinements but there is still a curb that you and I can apply. Every time you are confronted by some cheap (or not so cheap) electronic gadget, ask yourself, "Do I really need this?" The chances are that you don't or you can wait until you have saved enough for a better-made unit. If enough Australians took this approach, we could substantially cut our import bill and ultimately, substantially reduce the torrent of discarded gear going to the tip.

Leo Simpson


INTRODUCING
Swann
MOBILE VIDEO STREAMING
Want to Stream Live Video to Your Mobile Phone?
Mobile Video Kit
Max-i-Swann™ Webcam & Software
• Award-winning webcam & software
Webcam works with:
YAHOO! MESSENGER
msn
skype
AIM
RRP $129
Contents
software
webcam
• Works with most leading 3G & 2G phone brands & providers
• Turns your mobile phone into video controller
• See your family, friends & home for fun or security
Advanced Video Pack
2 Cameras & Software
• Day/night indoor/outdoor cameras
Contents
software
4 port card
2 cameras
RRP $399
Powered by
capture-cam
3G
3
Available from Harvey Norman & selected resellers or go to www.swannsecurity.com
Trademarks are properties of their respective owners. Not all products are available in all stores. All prices include GST. ©Swann ABN 27 006 786 072

MAILBAG

Starting a motor at full load

I wish to comment on the question and answer about a 3-phase motor controller on page 123 of the August 2006 issue. I suspect the lift pump is of the constant delivery type. This means that for each revolution of the pump there will be a fixed volume displaced.

When one of these pumps is started there could be maximum pressure in the discharge pipe. There is probably a non-return valve in the foot valve and another downstream of the pump. If this is the case, the pump motor will have to exert full load or whatever margin is left in the design to start it, accelerate the rotating parts and move the media in the pipe.

Forget about the soft starter for a moment. The soft starter is to protect the supply side, not the motor; ie, if there is too much current drawn on starting, the voltage will drop and cause a lot of dropout problems.

Most people do not understand how induction motors really work. Full load torque is not developed until the motor is almost up to full speed. The starting torque will be considerably less. Even to obtain this reduced torque at starting requires around five or six times FULL LOAD current. A soft starter only reduces the current; it will not help the starting of the drive at all.

If the scenario above is correct, I suggest putting a relief valve in to allow start-up. This is just a valve which returns the water back to the sump. If automatic start is required, the valve would need to be automated.

If the pump is a centrifugal type, there is a fair chance the soft start will be OK. I suggest that your reader observes the ammeter on start-up rather than look at waveforms. The ammeter will probably show average current in spite of the distorted waveform during the start. Also make sure that all the three phase currents are similar.

The starter design might limit the current during the run-up. If it does and the motor does not get up to speed in a reasonable time, say 20s, I would suspect that the current is not great enough to provide sufficient torque to overcome inertia and system resistance. If this is the case, try closing the outlet valve. The motor will have an easier time, as it only has to accelerate the pump. If this fails, an autotransformer will probably solve the problem but they are expensive.

On the subject of re-using equipment from junk, Hoover front-loading washing machines have a nice little speed controller on the spin/wash motor. The motor has a pulse generator feeding back into one of those chips used in switchmode power supplies.

Jeff Jones,
via email.

Teaching about the American moon shots

As a science teacher of some 33 years, I read the October 2006 editorial with great interest. I teach HSC physics and I have followed the development of space exploration since the very first Vostok and Mercury missions. While I have not come across any science teacher who would teach such nonsense, I do encounter students who have been convinced that the moonshots never happened. The power of the media!

When this happens, I bring in books on the subject that basically prove that, if indeed this thing was a hoax, then it must have been the longest and most expensive and elaborate hoax in the history of humankind. I recommend "Apollo: The Epic Journey To The Moon", by David West Reynolds (Tehabi Books Inc, 2002). This is a full-colour history of the equipment and missions.

Once my students see this, they realise that it was real. I also explain that the VAB (Vertical Assembly Building) still exists and is used to refurbish shuttles, while the crawler transporter that was used to move the Saturn V moon rocket to the pad is still used to transport shuttles.

Other notable books are: The Apollo NASA Mission Reports (Apogee Books, http://www.egpublishing.com) and "A Man On The Moon" by Andrew Chaikin (Penguin Books, 1994).

I had the great pleasure of visiting the National Air and Space Museum in Washington DC last year and the sense of awe I got from standing next to the Apollo 11 command module and Dave Scott's (Commander, Apollo 15) moon suit were incredible. I wish I could take my students on such an excursion!

If, as the Editor states, some science teachers are indeed pushing this garbage, then perhaps his last sentence would be justified. Thank you for a great magazine.

George Green,
Physics teacher,
Wollongong NSW.

Plugpacks could be supply option

I note the letter by Ross Herbert in the October 2006 Mailbag section headed "Plugpacks Are Undesirable". I agree with all the issues raised by the writer and the attached comments. May I offer a suggestion on this issue?

If projects were designed with the option of using either a built-in mains power supply or a separate plugpack supply, all of the concerns mentioned should be reasonably met. I expect this would require that projects would need to be designed and tested with a built-in mains supply, while the article would describe the steps needed for incorporating either of the two supply types. I guess the power transformer, fuseholder, on-off switch, mains wiring, and cable anchoring, etc would be the main constructional and safety

PIC Programmer caused computer restart problem

A while ago, I bought a serial PIC programming kit from Dick Smith Electronics and it's been a dream to work with. But after I started to leave it plugged into my computer, my computer started to do a very annoying thing: every time I shut it down, it would restart and it would only stop if I held the power button down. I looked at my power management settings under BIOS and then I saw the setting that was causing the problem. Under Wake Events -> LPT/COM, it was set to LPT/COM, so if there was any event on either the parallel or serial port ports, the computer would start up. I turned off the Wake on LPT/COM and there were no more problems.

What I think happens is that the serial port constantly powers the MAX232 chip and when the computer powers down, the MAX232 chip has a little heart attack and manages to trigger the POWER UP event on my computer via the serial port. I am not sure of a hardware fix but for those with Power Management or similar on their computers, they should insure that Wake on LPT/COM is set to NONE to avoid these problems.

Max Bainrot,
via email.

areas of difference between the two supply types.

Having the two power supply options should also address the legalities and responsibilities relating to safety. This way, inexperienced constructors should build the plugpack version, while experienced constructors would be able to choose the type appropriate to their needs.

In fact, as a majority of projects use DC-output-only supplies, then an option is for the entire rectifier/filter/regulator stage to be made common to both supply types. This does, of course, presume that suitable AC plugpacks would be available; designing for DC plugpacks may add some complexity where ± rails, etc are needed.

Still, the idea is there. Further, there is also the option of using single-chip DC-DC voltage converters.

Graeme Dennes,
via email.

Moon landing conspiracy rebuttals

I could not agree more with your editorial in the October 2006 issue. It might almost be OK if the "fake moon landings" were introduced as a classroom exercise in examining what it means to "know" that an historical event took place. There is a particularly good web site at **www.clavius.org** which has rebuttals to all of the specious claims of the conspiracy theorists.

Note that many of the "doubters" are Americans themselves. One of the most outrageous books written on the subject is "NASA Mooned America" by Ralph Rene, written in 1992 (his "The Last Skeptic of Science" is, if anything, even more ridiculous).

With the rise of the internet this nonsense is spread wider and faster than ever.

Bill Hanna,
Alice Springs, NT.

Hacking your DVD player is not illegal

I am writing in reply to the letter from John Tingle in the October 2006 issue. In his letter, John talks about DVD region codes and how farcical they are. I have to agree with everything John talks about but I want to point out that there is a website devoted purely to finding out how to circumvent the region-encoding that is embedded into most DVD players currently on the retail market.

Before I list the website's address, I have to say that "hacking" your DVD player is not illegal - I was informed of this during a phone conversation with the Trading Standards Office in Brisbane. Have a look around the site and you will see that a large majority of manufacturers actually list the codes for their DVD players and they list them voluntarily, along with the procedures required to change or reset the codes.

I also cannot understand why manufacturers still undertake measures to prevent piracy. As far as I know, every type and method of piracy protection that has been implemented by a manufacturer or supplier has been circumvented. We all know that there are a lot of people who have a lot of time on their hands and that these people like nothing more than a challenge.

Please do not get the wrong impression; I am not a pirate, nor do I agree with piracy. In fact, as a systems analyst, I deal with piracy everyday.

When I am called upon to fix a problem, the culprit is usually a piece of software that has been installed to circumvent system or software security, or it is a piece of pirated software installed by a user.

Most hackers also include some form of malware into their hacks. A large number of Trojan and Zombie infections are caused by "hacked" games being downloaded off the Internet and installed onto the office network or home PC.

To make you DVD player region-free, have a look at:

www.dvdregionhacks.com
www.ottmarliebert.com/blog/2004/11/dvd-player-hack-list.html
www.dvdremotehack.com
www.dvdownunder.com.au/rewww.dvd-views/dvdhacks.htm

You can search these sites to locate your player and take the appropriate action.

As a footnote, I am assured by the various suppliers I have asked that this DOES NOT invalidate the warranty. However, making a mistake during the hacking procedure may render the player inoperative.

Treat these procedures as you would a BIOS update on your PC. If you have any doubts about what you are doing, don't do it. The responsibility for mistakes or a damaged DVD player is entirely your own.

Dave Sargent,
via email.

DVD zoning : the explanation

With reference to the letter from John Tingle in the October 2006 issue, the reason we can buy zone-free DVD players in Australia is due to a unique High Court decision.

All DVD hardware manufacturers were coerced into signing an agreement with the software suppliers (the US-based movie industry) to only sell region coded players in each zone. The reason for the regional coding was to enable the movie industry to restrict DVD sales until after a movie had been released in each market (perhaps also to be able to set prices differently in each market).

Consumer hardware (unlike many computer drives) has always had the facility to be modified to allow all zones. When the movie cartel discovered this practice - they filed suits in each affected zone's countries to have this practice declared illegal.

In Australia, however, the High Court held that zoning was an illegal restriction on every Australian's right to enjoy movies they bought outside Australia. The example cited was people returning from overseas holiday travel with DVDs bought while on their trip, although the argument could as easily be applied to mail order - an "expectation of enjoyment" would be there as well.

Thus although all Zone 4 players are manufactured marked with the zones, the manufacturers are still required to do so. Indeed, elsewhere in Zone 4 they only play that code. In Australia, all players sold today are zone-free and usually the distributor makes the change before shipping units to the retailer.

If you own an early player, it can still be modified to play all zones, usually by something simple, like changing the remote or by just entering a code. Some early players required a wiring change. I have an RCA, my earliest DVD player which required that kind of treatment; it was bought before the ruling. The dealer made the modification for $200 - worth it to me, since I already had an extensive collection of movies from several zones.

It is all perfectly legal.

Bear Stanley,
Atherton, Qld.

Thomas Edison was not a genius

I must take issue with Kevin Poulter's articles on Edison. While they were a good read, to say that he was a genius is just plain wrong. Edison was an ideas man. He got an idea and then, through sheer hard work and experimentation, brought it to fruition.

For true electrical genius, there is only one man to turn to: Nikola Tesla.

Les Glover,
Earlwood, NSW.

Computer TV card problems

With regard to the "Computer TV Card Problems" topic on page 106 of the October 2006 issue, the problems that T. B. has in burning PAL DVDs from captured off-air broadcasts are probably a specific limitation in the software he has tried.

PAL DVDs are encoded at 720 x 576 resolution, so input video files of any other resolution must be resized/resampled to that resolution. The software T. B. has tried must be incapable of performing that video resizing function. I have just tested Nero Vision Express 3 and it is capable of resizing high-definition (high-resolution) video files down to PAL DVD resolution as part of the DVD burning process. My copy came bundled with a Pioneer DVD-RW drive as part of Nero OEM suite 6.

However, note that converting high-definition video content to PAL DVD will result in a significant loss of resolution (detail). If you have a high-definition television, it would be better to write the MPEG2 file to a data DVD for playback by a PC, or perhaps by a device like the Zensonic Z500 High Definition Network DVD Media Player (**www.zensonic.com**). This would retain the high-definition aspect of the video.

Regarding delays between audio and video, I tried many different (unsuccessful) methods to overcome this problem until finding "VideoReDo".

VideoReDo's main task is editing MPEG files which it does without recompressing the video file - this results in fast performance without adding any further compression artifacts. A 14-day free trial is offered at **www.videoredo.com**

Any mention of recording off-air broadcasts should be tempered by a mention of Australian Copyright Law at: **http://en.wikipedia.org/wiki/Australian_copyright_law.**

Andrew Woods,
Centre for Marine Science & Technology,
Curtin University of Technology,
Perth, WA.

Home theatre projector is very satisfying

I would like to thank you for all that information on home-theatre video projectors in the August 2006 issue.

I have been interested in setting up a home-theatre system for some time but was put off by the cost of the projectors. I did not know whether the cheaper ones would be good enough and you can't tell until you set them up. However, a few weeks ago, Officeworks advertised an Acer PH110 for $799.00 and according to your article, it should do a reasonable job. So I bought one.

We did not want a special room for it, so we set it up in such a way that the room looked like a normal lounge-room except when we put the projector on. All we have to do is shift a few vases.

The projector is about four metres from the wall (screen), giving a picture 2.4 metres wide. We sit about 4.5 metres from the screen. The only giveaways are the surround sound speakers and the projector mounted upside down from the ceiling. The cost? Just under $1600. We are both really pleased with the results.

I hope that this will encourage other readers to have a go.

R. A. Groves,
Tin Can Bay, Qld.

Caution needed with reformed electrolytic capacitors

Over many years in industry I have seen sufficient "near misses" with electrolytic capacitors to have gained a healthy respect for their destructive capabilities under fault conditions. All electrolytics lose their anodic film after extended periods of disuse or storage and I agree with Rodney Champness in his article (in the October 2006 issue of SILICON CHIP) that this film can be restored by "reforming" the capacitor by the application of the appropriate voltage via a low constant-current source.

However after an electrolytic is reformed in this way it is not a foregone conclusion that it is safe to use, particularly if it is of the age of most components found in vintage radios. The ESR could still be high enough to cause over-heating when there is significant ripple current in the circuit where the capacitor is fitted and this is where the trouble can start.

As an example, I was asked to overhaul a 1960s guitar amplifier for a young friend who was a fan of "valve sound". The unit was in quite good condition and appeared to work well, with minimal work required on my part. I was cautious about the three multiple electrolytics fitted since they were over 40 years old and even though they reformed OK and had acceptable ESR, etc, I advised the owner that they should be replaced. Since the capacitors were not standard types and had to be ordered, the owner elected to use the amplifier and return it to me when the new components arrived.

A couple of weeks later I received a phone call to say that the amplifier had "blown up". On examination, one of the electrolytics had exploded. Its metal case had shot backwards out of its metal clamp, passed (fortunately) between the output valves, bent flat a projecting 3.5mm bolt and embedded itself in one corner of the case. Meanwhile the capacitor's insides had been evenly distributed over the chassis and the inside the cabinet.

On this occasion, the only human damage was the owner's loss of composure at the time. However if the amplifier had not been in a fully enclosed cabinet or somebody's face had been near the offending component when it exploded, the results could have been much worse.

Incidents like this convinced me a long time ago that the only good electrolytic is a new one from a reliable manufacturer! New, unused electrolytics that have been stored for a couple of years can often be re-formed and used safely but any of the old brown, grey or blue Ducons should be retired to the "round bin".

Warwick Woods,
Historical Radio Society (Aust).

Cheap DVD players are amazing value

Back in January 2005, Leo Simpson wrote an editorial on the perils of cheap consumer audio/electronic gear. While he was quite right for the most part, there is a vastly different situation for items such as DVD players.

I have found that, as a rule, the more you pay for a player, the less formats it is likely to play. So, although a Japanese brand-name unit might play DVDs and VCDs quite OK, don't expect it to deal with non-standard things or maybe even burned DVD disks.

The most spectacular example of this sort of thing was a small, unpretentious DVD player I purchased recently from Dick Smith Powerhouse for $38. At this price, one would be content with almost any performance level, so long as it plays the basic things. But amazingly, this one plays virtually anything you put into it. Besides DVD, VCD, SVCD, etc, it also plays virtually any MPEG file, MP3 (well, they all do, don't they?), WMA, DIVX and XVID (AVI format). This capability is not mentioned anywhere in the documentation.

This thing was such good value that I bought three of them, against the day when the optical drive eventually fails, whereupon I will merely place one of the backups into service. I got three of these for less than the cheapest brand-name unit which wouldn't even approach the performance.

Richard Belanger,
Gosford, NSW.

TV takes to . . . THE HOLDEN AIRSHIP

coming to a sky near you!

by Ross Tester

Look! Up in the sky! It's a bird . . . it's a plane . . . it's a, well, what *is* it?

Airships are not exactly new in Australian skies. We recall several over the past couple of decades or so. But they still command a lot of attention whenever they are in view. Perhaps it's because they *are* in view for such a long time, given their sedate progress through the heavens.

Holden's new A-170 Lightship is something else again. It has the "wow" factor! It's not just a large airship – though it is certainly that at 54.3m long, 14m wide and almost 17m tall – that's bigger than a Boeing 767.

The first time you see it, especially from a distance and even more especially at night, you look – and look again. Just what is it? My first time was from perhaps 20km or more away and all I could make out, in the night sky, was this big, red, pulsating "*thing*". It was, most definitely, an Unidentified Flying Object. Was it *finally* those long-expected Martians?

"No one would have believed in the last years of the nineteenth century that this world was being watched..." so starts the HG Wells classic, "War of the Worlds." Well, in a way, we are – being watched, that is: the Holden Lightship is certainly watching as well as being watched. But I digress.

As what I now know as the Holden Lightship got closer that night, the massive 21.3 x 9.1m "TV" screen attached to one side started to come into focus. Wow! What a picture!

In fact it's so big that up too close (say a hundred metres or so) the image becomes too pixellated to make out.

Full motion video

Until now airships and blimps have only been able to screen animation or basic graphic displays.

You've probably seen them in coverage of major sporting events in the USA (eg, the Goodyear Blimp or the Whitman Airship). Their video screens were capable of showing rudimentary computer-generated graphics.

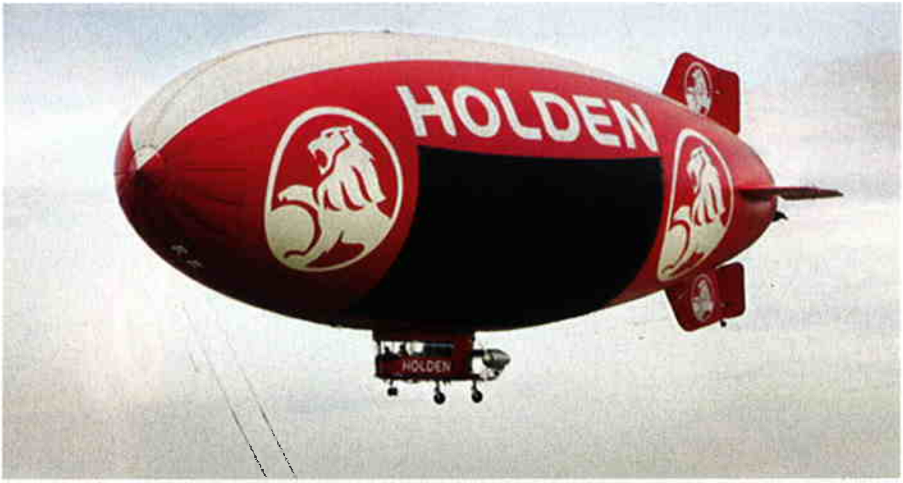
But the Holden Airship is unique: it's the first and only aircraft in the world to use technology that allows full-motion video to be shown on its screen. And Australians are the first audience in the world see it.

Not even Holden's parent company in the USA, GM, can claim a lightship like this (although that will probably change given the amazing popularity and acceptance of the down-under subsidiary's baby!)

It can, in fact, show a computer graphic, a recorded video, live video from its on-board cameras (very handy at a major event!). It can even show programming picked up "off air" from its own TV receivers.

The screen

The video screen, on the port (left) side of the envelope and measuring 914 inches (diagonal) in the old



In this daytime photo you can clearly see the port (left) and starboard nose ropes which the ground crew must secure when the Lightship comes in to "land".

money, contains a massive 396,600 ultrabright LEDs in R-G-B clusters.

This screen has been in development since 1998 and the Holden Lightship was only certified to fly earlier this year. The company which developed the screen has considerable experience in the field, with several large screeens around the world including the one in Times Square, New York.

But their biggest challenge – and the difference between those types of screens and one which can fly on any aircraft, has been keeping the weight down to an acceptable level. Even so, it weighs in at around 450kg.

The precise construction of the screen is, according to GM, "a closely guarded secret", as is the proprietary software developed to drive it. However, we do know that the screen is specifically designed to be viewed from ground level.

The screen developers believe they are about three years ahead of the opposition. They're already assembling a second Lightship, hoping to have it ready to fly early in the new year.

There is a difference between the night and day screens – during the night, it's full colour but by day, the choices are only red on a black background. Development is proceeding on a full colour system for daylight viewing, which is hoped will be ready about the middle of next year.

So at the moment, for example, in daylight it can "only" display a Holden logo or animation while flying over a city – or an event!

And that's why certain parties have been getting at least a little miffed by the Holden Lightship flying over major sporting events. You simply can't help look up and see those Holden logos or adverts, when other (opposition) companies have paid big money for exclusivity at a sporting ground.

It's called ambush marketing and so far, at least in the Holden Airship case, no-one has found a satisfactory way to counter it because air space is free!

Incidentally, we've seen claims that the screen on the Holden Lightship is the largest video screen in the world. But we imagine Mitsubishi with their 109 x 12m Diamond Vision screen at Hong Kong racecourse might just dispute that a little (at least according to the folks from Guinness!). It is the largest *flying* video screen though. . .

The airship

There have also been all sorts of rumours around, especially on the 'net, about the Holden Lightship: one that keeps popping up by those "in the know" is "it's just the Whitman's Airship repainted". It's not.

Funny, but the Whitman's Airship is a completely different model (the smaller A-60+) and has never had a full motion video screen attached (it's not big enough).

The Holden Lightship is brand new, American Blimp model A-170, built and modified specifically for the purpose. What might be confusing the issue is the Holden Lightship's US registration – N156LG. As it was built in the US, it flies under the US (FAA) aircraft register.

Designed originally for advertising and thus kept simple for reliability, A-170s have almost 200,000 flight hours. Many of these hours have been flown with various types of broadcast cameras and data downlinks, covering events for media or security. The camera mounting is made to handle a gyro-stabilised camera for the rock-solid images we are used to seeing on TV.

This type of airship has also been adapted as a communications and sensor platform for a multitude of other missions.

T he A-170 has a maximum speed of 84km/h and a cruising speed of 74km/h – provided by twin 180 BHP Lycoming IO-360-B1G6 motors with constant-speed, variable-pitch, reversible propellers.

At cruising speed, it uses around 91 litres of Avgas per hour, giving it about 7.5 hours or about 400km, of endurance. The aircraft can climb at 425m/minute and descend at 485m/minute.

200A alternators attached to each engine give the ship its electrical

The Holden Lightship moored at its base at Camden Airport, southwest of Sydney. A crew of 19 – 14 of them on the ground – is required to handle the aircraft. (Photo by Peter Murphy)

power. These power everything on board except the two internal 1kW floodlights which give the Holden Lightship its red glow at night – a small APU (auxiliary power unit) is attached to the rear of the gondola for these.

While the on-board crew is limited to five (pilot plus four others) it takes 19 overall crew to handle the aircraft.

The envelope

The Holden Lightship is a dirigible or blimp – that is, there is no metal frame inside the outer skin to keep it rigid. Only the pressure of the gas inside the UV-protected skin keeps its shape.

Four fins with rudder and control surfaces are attached at the back, while at the front, a nose-dish is used to moor the airship when on the ground.

It was built by ILC Dover in the US, the same company which manufactures space suits for NASA. Fabrication was in clean-room conditions, to eliminate the possibility of dust contamination, especially in the seams. This could allow helium to escape, lowering the lift of the aircaft.

The ballonet (the gas container inside the outer skin) contains approximately five million litres of helium, giving a maximum lift of a little over 5.5 tonnes.

Remember that this has to lift everything: the envelope, the gondola, the motors, those on board with their equipment and of course, that near half-tonne of video screen.

From a fully-collapsed package about the size of a car, the envelope takes about eight hours to fill.

While it is coloured a translucent red, the Holden logos are white. But more than that, they are perforated with small (12mm) holes so that the light inside the envelope can shine through, making them appear brighter than what they otherwise would be.

The gondola

There's not a great deal of cabin space inside the 8m x 3.3m x 6.2m gondola, which hangs from the envelope via 16 external cables. It's made from welded steel tubing and covered with a combination of aluminium and fabric. The cabin is just 5.5m x 2m x 1.5m.

The gondola is divided into five main compartments:

1. Flight Deck, which houses the avionics panel, flight controls, pilot station, seating for one passenger and can be configured to accommodate various equipment required for special missions. The instruments and layout are typical for a twin engine IFR-approved aircraft, with added instruments for airship pressure management. Access to the ballonet and the ballonet view-window are located on the Flight Deck.

This photo, in flight over Sydney Harbour, shows one of the two 180 BHP Lycoming motors attached to the rear of the gondola. They chew through 91 litres of Avgas each hour! (Photo by Peter Murphy).

2. Personnel/Passenger Compartment (cabin), accessible through a main entry door located aft of the Flight Deck on the port side of the gondola. A bench seat, providing seating for three, is located against the aft bulkhead. An emergency exit is located directly aft of the co-pilot/pax seat on the starboard side of the gondola.

3. Electrical Bay, which contains the equipment to monitor, regulate and distribute the electrical power.

4. Equipment Compartment – contains the air plenum chamber and the 673 litre fuel tank, which feeds the two power plants mounted on outriggers at the aft end of the gondola.

5. The Ballast Compartment, located beneath the rear bench seat located in the personnel compartment. The Ballast Compartment is accessible from four outer crew access doors located on the port and starboard side of the gondola and forward of the outriggers.

The rear bench seat can be raised for access from within the personnel compartment. In addition to ballast, this compartment also houses the ship's batteries and electrical power distribution system. SC

Passenger's-eye view of the "flight deck" of the Holden Lightship. The gondola has a large amount of glass, giving breathtaking views of the scenery as it passes below. (Photo by Peter Murphy)

Powerful enough to detect interest.

Wade Barker

Navy Electronic Technician

When a piece of equipment fails it certainly is challenging, because there's a requirement to get it up and running in the shortest amount of time possible.

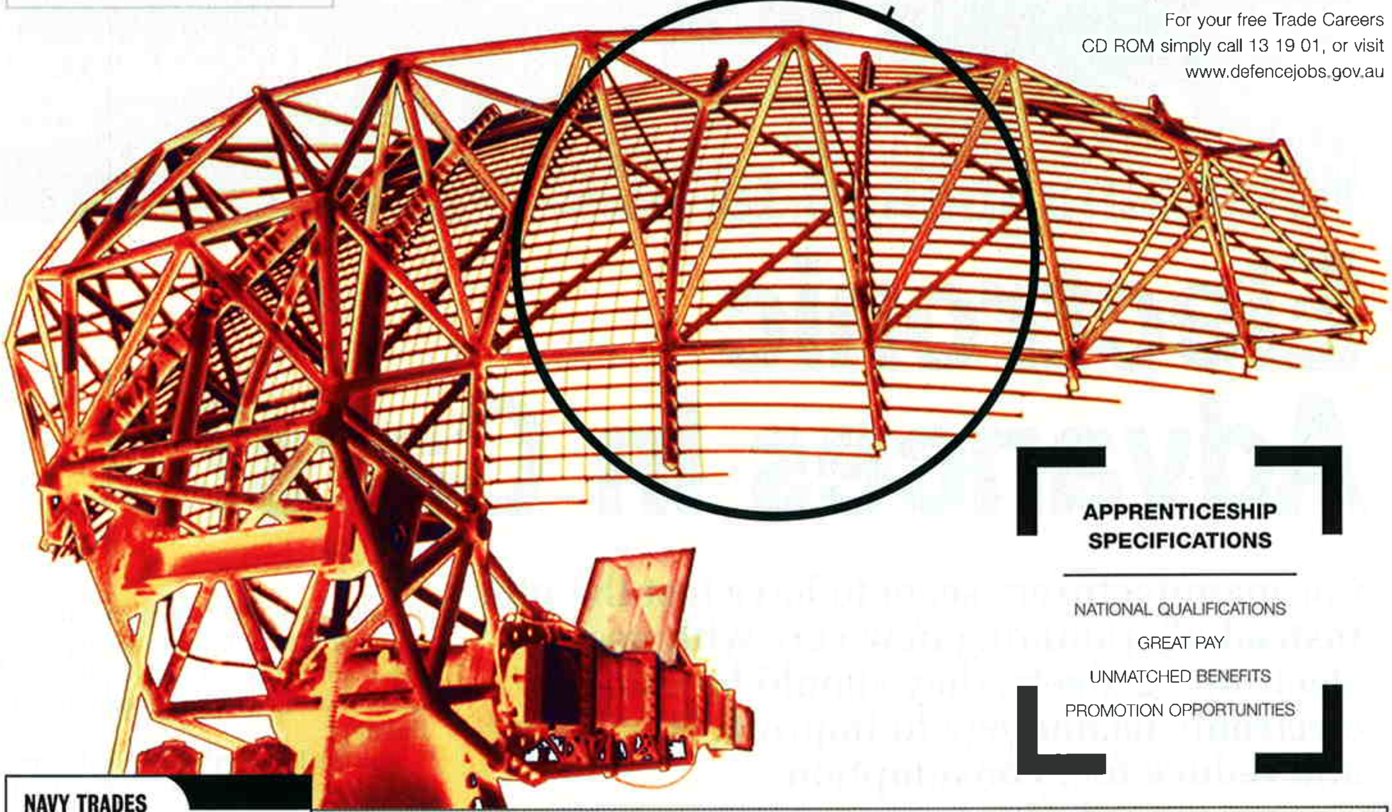
Start on $25,400p.a. and earn over $55,800 p.a. after training, when at sea.

The Navy's fleet of ANZAC Frigates are equipped with the latest very long-range surveillance radar.

The power output of the ANZAC's search radar equates to over 300 microwave ovens.

FREE TRADE CAREERS CD ROM THE COMPLETE GUIDE

For your free Trade Careers CD ROM simply call 13 19 01, or visit www.defencejobs.gov.au



APPRENTICESHIP SPECIFICATIONS

NATIONAL QUALIFICATIONS
GREAT PAY
UNMATCHED BENEFITS
PROMOTION OPPORTUNITIES

NAVY TRADES

- Electronics Technician
- Marine Technician (Mechanical or Electrical)
- Aviation Technician - Aircraft
- Aviation Technician - Avionics

If you're good with all things electronic, the Navy opens up an exciting world of apprenticeship training unlike anything you'll find anywhere else. As an Electronics Technician, you'll be trained on sophisticated equipment including radar and sonar, communications and combat computers, as well as missiles and weapons systems. For more information on other Navy and Electronics trade careers, and to order your free CD ROM, call 13 19 01 or visit www.defencejobs.gov.au

You'll be paid a great wage while you train with a guaranteed job when you finish. Starting on $25,400p.a., you'll earn over $46,500p.a. after training. You'll also receive a $9,300p.a. seagoing allowance.

You'll enjoy all sorts of benefits like free medical and dental, subsidised meals and accommodation.

11

NAVY TRADE APPRENTICESHIPS

Call 13 19 01 or visit www.defencejobs.gov.au

About the only significant electronic development in cars of the last decade is the widespread fitting of stability control. Like ABS, this system can prevent many crashes. In fact, German statistics show that cars fitted with electronic stability control are involved in fewer accidents.

by JULIAN EDGAR

What's happened to Electronic Advances In Cars?

Car manufacturers seem to have lost the plot. Instead of cramming new cars with useless electronic gadgets, they should be using electronic technology to improve efficiency and reduce fuel consumption.

IT'S A SNOW-JOB: we're being sold purported advances in car technology that achieve little real benefit. In fact, instead of being better off, we're paying in cash and fuel consumption for a plethora of unwanted and unneeded gadgets: in-car entertainment, climate control, electric seat adjustment with memory, active steering, electric handbrakes, parking proximity sensors and auto-dimming rear vision mirrors. They're being foisted on us to disguise the fundamental lack of design progress being made in cars and we are paying for these "advances" in higher fuel consumption.

How so? Well, how much do you reckon a seat that contains no less than six electric motors weighs – some quite hefty in size? Or a sound system that includes a CD stacker, eight speakers (including a subwoofer) and two amplifiers? It's not even possible to physically pick up the wiring loom of a modern car – it's too heavy. And how much do all these gizmos cost to develop?

You can be sure that if this stuff was taken out and the resources devoted to better engineering the basics of the car, you'd be paying less and going further on the same tank of fuel.

Yes, there have been significant electronic breakthroughs in car design. Trouble is, all but one happened about a decade ago.

Engine management

It's well over 15 years since we first saw "family-priced" cars with electronic engine management. Along with its ability to reduce exhaust emissions, improve starting, power and economy, and allow the widespread introduction of other technologies like turbo-charging, engine management was a genuine breakthrough.

But contrast that with electronic throttle control. These days nearly all cars are sold with a throttle that's run by an electric motor. You put your foot down and a pair of potentiometers relays signals to an ECU that checks them for compatibility with one another and then decides how much throttle it will actually give you. The latter depends on engine temperature, the torque output of the engine at those revs – a whole bunch of internally-mapped stuff. Gee-whiz indeed!

But so what? Apart from integrating more smoothly with the cruise control and allowing the system to close the throttle on you, what's the huge benefit? In fact, many people complain that the throttle response of these systems is dull – one of the original aspects that engine management helped improve over points and carbies! And the engineers who design and then map the electronic system spend literally years on the project, including time on esoteric aspects like anti-surge control that stops incompetent drivers kangaroo-hopping.

Where is the progress in current cars? This 12-year old Falcon engine has direct-fire ignition, a dual-length changeover inlet manifold, knock sensing and full engine management. Under the bonnet of a current Falcon you'll find a lot more power but in terms of electronic and mechanical advances, just variable camshaft timing and electronic throttle control. The pace of improvement in engine electronics is slowing to a near standstill.

What if they spent that time and money developing active aerodynamics instead, using just the same sort of actuators and control logic to reduce the drag of a car by 25-30% at highway speeds? Or what about infinitely variable intake manifolds, rather than the archaic two-step long/short runner changeover that's now common? So forget kangaroo hopping: how about better fuel economy?

Or take engine knock sensing. The ability to run ignition timing as advanced as possible for the conditions of fuel octane, intake air temperature

Honda Insight: A Brilliant Concept

Although a complete sales flop in Australia, the 2001 Honda Insight is yet to be bettered in terms of design. It addressed nearly every concern expressed in this article. The aluminium-bodied hybrid used a lean-burn, 1-litre, 3-cylinder petrol engine featuring variable valve timing and developing 56kW at 5600 RPM. Peak torque was developed at just 1500 RPM.

A 10kW electric motor – which also doubled as a generator and starter – was sandwiched between the engine and the conventional 5-speed manual transmission and a 144V NiMH battery pack was fitted. The drag coefficient was just 0.25 and the total mass only 827kg. Twin airbags and ABS were standard.

For the on-line magazine "AutoSpeed", I drove an Insight on an interstate trip of 3500 kilometres, completed in just four days. Driven normally at the open-road speed limits, the car turned in an average of 3.6 litres/100km, the best real world economy of any car ever sold in Australia. The official highway figure was an astonishing 2.8 litres/100km! The sprint to 100km/h took about 12 seconds.

And the negatives? A retail price of nearly $50,000 and poor packaging that saw most of the load area of this two seater taken up by a battery/electronics box.

Remember Those Big Old "Yank Tanks"?

It's not very many years ago that we all used to laugh at sixties "Yank Tanks". They were enormous vehicles, vastly overweight, with simple suspensions and huge V8 engines to drive their bloated forms.

In fact, to take one example, let's briefly look at the pictured 1963-65 Buick Riviera. Despite having only two doors, the Riviera was no less than 5.3 metres long and weighed 1800kg. Its huge pushrod V8 engine could be optioned up to just less than seven litres with a peak power (measured in SAE units) of 253kW. Standard transmission was a Dual-Path Turbine Drive automatic. It was a huge, heavy, over-powered barge which probably drank fuel at the rate of 25 litres/100km.

Today, many of us are driving cars that, philosophically at least, are not much different. Take the SS Commodore. It's 4.9 metres long, just 40cm shorter than the Riviera, and it weighs 1650kg or just 8% less than the sixties Buick. And the motor is now six litres and 260kW, although its fuel consuption is considerably better than the old Buick's.

So huge, heavy cars with enormous V8 engines aren't something from an American car museum – they're here now and available at your local dealer.

We laughed at cars like the Buick because they were much larger than was necessary, therefore had far greater weight than was needed and as a result, used huge thirsty engines to push along that weight. So are today's big V8-engined cars any different in basic concept?

and engine load is of great benefit – it provides optimal power and economy. Trouble is, that technology was available in family cars well over a decade ago. The same goes for "direct fire" ignition, where troublesome distributors and ignition leads made way for multiple coils. Even ABS – a worthwhile gain to be sure – was being sold on Australian family cars over 10 years ago.

In fact, about the only really worthwhile breakthrough I can see in the last decade is the fitting of electronic stability control, which has the potential to prevent many accidents. In fact, German statistics show it is doing just that.

The hoopla

You'd never believe from watching the ads and listening to the salesmen that every new model is anything but a grand exposition of cutting-edge technology. Sure, since the 1950s in the USA (when annual styling updates were introduced), car manufacturers have been selling cars on the latest-is-best philosophy. But now it's electronics that is underpinning much of the hype.

"Have you seen our twin DVD screens, sir?"

"Do you realise this car has auto windscreen wipers, madam?"

"This auto transmission now has six ratios and Adaptive Logic Control". (No sir, I don't know why it needs that many gears when in fact this year the engine is larger and has an even broader torque curve than before.)

"Madam, this seat has three memories – and oh no madam, it's not just the seat! When you press the button it also adjusts the external mirrors and the position of the steering wheel to your preferred settings."

"That's right, sir, the steering column now has two electric motors in it".

"Have you seen the rear window blind, madam? It rises and falls at the touch of a console button. And you know what? It automatically drops down when you are reversing!"

This parade of smoke and mirrors disguises the fact that the rate of progress in the fundamentals of car design – fuel economy, packaging and performance – has over the last decade been disgraceful. Fact: my 1994 EF Falcon 5-speed manual gets better real world fuel economy than a current Falcon. Fact: it also matches the current car in acceleration to 100km/h. Fact: most SUV-type vehicles have incredibly bad interior packaging that sees 15 and 20 and 30-year old cars look amazingly spacious. (Just sit in a 1960s Austin 1800 or look in the load area of a 1980s Holden Camira wagon.)

Yes, in an accident I'd prefer to be in a current car – even though that same old EF Falcon has a driver's airbag and ABS.

Toyota Prius

So what about that touted technological masterpiece, the Toyota Prius? Well, the best that can be said is that at least Toyota tried.

The gizmos being packed into today's cars disguise the lack of real progress being made in economy, packaging and performance. From 10-way power electric seats to multi-screen DVD players, dual climate control, electric handbrakes and auto-dimming rear-vision mirrors, it seems that electronics is now being used in complex gadgets designed primarily to just entertain and amuse.

The car is aerodynamic, it has power (and bottom-end torque) appropriate to the real world and it is space-efficient. But the shortcoming screams to anyone with even only half an ear on the automotive world: batteries. The NiMH battery pack is heavy (the Prius, for its external size, is one of the heaviest cars on the road) and requires such a huge amount of energy to produce that it's doubtful whether the energy saving in fuel over the life of the car outweighs the production energy input. And in energy/kg terms, it has almost no capacity and is certain to have a life shorter than the rest of the car.

In fact, it could be argued that the Prius could be an even better car without the heavy battery pack and instead with bodywork made from aluminium and powered by a very small turbocharged engine – say a 3-cylinder of the type first widely used in Japanese Kei class cars of 10-15 years ago.

Diesels

Diesels have been much in the news recently and the specific power and torque outputs of passenger car diesels have rocketed. They also achieve significantly better fuel consumption than petrol engines – although the major upsizing of diesels now being fitted to passenger cars is rapidly eroding that advantage.

But since these more efficient diesels run electronic control, doesn't that shoot down my argument in flames? No! Most of the technological breakthroughs in diesel fuel systems have been purely mechanical, especially the engine-driven fuel pumps designed to develop very high fuel pressures. Apart from a high voltage system used to operate the high-pressure fuel injectors, the electronic architecture of the system is very much like a late eighties petrol management system. And anyway, trucks have had electronically controlled diesels for 20 years or more.

Missed opportunities

So where should the electronic and mechanical advances have taken us?

For starters, it's bizarre that engine management systems are still running pretty well the same air/fuel ratios that they always have. If you burn less fuel, you get better fuel consumption – but cars still use a 14.7:1 air/fuel ratio (at least the madness of high-load 12:1 and 11:1 air/fuel ratios has just about ceased in new cars). Running leaner air/fuel ratios has emissions as well as economy significance – the output of oxides of nitrogen skyrockets. So, how

At highway speeds, most of the fuel is used to push the car through the air. But after the rapid developments in the late eighties, aerodynamic development has now stalled. Drag coefficients have barely changed in 10 years, let alone developments like actively-controlled aerodynamics which has the potential to dramatically drop open road fuel consumption.

to solve the problem of high oxides of nitrogen emissions when running lean air/fuel ratios? That seems like a good research project for the engineers – perhaps for those engineers currently working on the software control of the next model's 10-way power seat design.

Aerodynamics has stalled. At highway speeds most of the petrol that your car burns is used to push the car through the air.

In the late eighties, manufacturers (finally) recognised this and moved to "slippery-shaped" cars. Aerodynamic drag coefficients dropped in just a few years from mid 0.4 figures to mid and low 0.3 coefficients. But since then there has been almost no change.

In fact, most manufacturers now don't even bother stating the drag coefficients of their new cars – let alone the total drag found by multiplying the coefficient by the frontal area. And the bizarre thing is that the poor internal packaging mentioned earlier is not the result of sacrifices made to produce low-drag cars – cars (like SUVs) with the poorest drag figures often have the poorest packaging!

The number of production models with electronically-controlled moveable aerodynamic surfaces can be counted on the fingers of one hand, yet such an approach has the potential to substantially drop open road fuel consumption without any around-town disadvantage.

The advances in electronics are also not being employed with any kind of engineering rigour. LEDs consume less electrical power, have faster light-up times and effectively never fail. You'd expect then to see LEDs being used on – at least – all rear lights and indicators (as in fact they are on most new trucks). But on cars, that's the exception not the rule. Instead, manufacturers have moved to using coloured LEDs for instrument panel and foot-well illumination because then they can talk about the "cool blue" lighting!

Solar cells? They've improved in efficiency at the same time as costs have decreased. So why don't many cars in our sunny land use solar cells to keep the battery topped up and the internal fan ventilating the cabin when the car is parked? Mazda once sold a car with this feature on the local market but otherwise there's been no sign of such lateral thinking.

Alternative fuels? Almost zero progress, with LPG system technology lagging decades behind petrol fuel injection. In Brazil, 30% of new cars are able to run on either petrol or alcohol, with the alcohol made primarily from locally-grown sugar cane. In those cars, the engine management system is programmed to adapt itself to the appropriate fuel – whether that's petrol, alcohol or any mixture in between. In Europe, half of all new cars are diesels.

And if a DVD screen is obligatory, why not use it for the rear vision and not just when reversing – ie, to completely replace the mirrors and rear window? In addition to reducing the solar radiation into the cabin input (and at night, that of following cars' headlights), the drag-inducing exterior rear vision mirrors could be dispensed with and the rear of the car far better tailored for low drag. (Many don't realise that the shape of the back of the car is more important than the front in reducing aerodynamic drag.)

Losing the plot

However, the problem is far more fundamental than not applying some obvious technologies: simply, car manufacturers have lost the plot.

They pack in more and more trivial and irrelevant equipment, making cars heavier. Even a small car these days has a mass of 1250kg or more. To cope with the increased weight, they fit larger brakes, heavier suspension and wider tyres. The wider tyres increase rolling resistance and accelerating the heavier mass requires more fuel, so producing more pollutants and to a large extent decreasing the effectiveness of tighter emissions standards.

To be market competitive, apparently the next model is always required to have even more equipment and more power, so the cycle continues.

It seems no manufacturer ever steps back and lays out the criteria for the functionality of a car, ignoring what others are doing and simply trying to achieve the best outcome.

The mind boggles at the thought of what innovative and original car designers like Ferdinand Porsche and Alec Issigonis would now be able to do with the exotic materials, CAD/CAM design techniques, well-instrumented wind tunnels and the electronic control systems available to today's designers.

One thing's for sure: they wouldn't be designing 1.8-tonne cars with the worst interior packaging in automotive history, hugely powerful and equally thirsty, and loaded to the gunwales with complex electronic gadgetry designed primarily to just entertain and amuse. **SC**

2006 SILICON CHIP

Excellence in Education Technology Awards

$10000 PRIZE POOL!

AND THE WINNERS ARE . . .

In the 2006 Silicon Chip Excellence in Education Technology Awards a prize pool of $10,000 was offered. The judging panel decided that the prize pool would be split up equally between the two divisions, secondary schools/colleges and university/TAFE colleges.

Schools/Colleges Division

In this division, electronics laboratory and test equipment with a value not less than $3000, and a plaque, would be awarded to the school sponsoring the winning individual entrant in the final year assignment category. The two individual divisions offered $1000 cash prizes plus plaques to the winners.

The judges further thought that the initial wording of one of the schools division prizes – "Best school project involving electronics technology" – could have a different meaning to students/ teachers, as school projects are more often than not an individual's own projects within the curriculum. For this reason, all entries received were judged according to the first category: Best final year assignment of an individual student involving electronics technology.

As it happened, both the individual winners came from the one school – Mater Maria College in Sydney, obviously reflecting the enthusiasm and dedication of those involved in the electronics curriculum of the school, especially their electronics teacher, Dave Kennedy. It is therefore not surprising that the judges also awarded the major schools prize to **Mater Maria College**.

There were in fact numerous entries from students at this school. However, most were "more of the same" – perhaps typical of boys of this age group, almost all had built high power stereo amplifiers; some adding speakers, parametric equalisers and so on.

However, there were two entries which the judges considered showed that a lot more thought had gone in, with significantly more research and project development than what amounts to building a project from a kit. It was these two entries which were chosen as the two school's division winners, receiving $1000 cash prize and a plaque:

(a) **Lauren Capel**, who first of all found, then restored a 1950s Mullard MBS1112 Valve Radio, with the help of members of the Historical Radio Society of Australia. Unfortunately the radio had suffered further damage in the post so that had to be repaired as well. She then brought that radio into the 21st century by adding a mains power supply and an MP3 player feeding an AM micro transmitter so she could listen to her MP3s on the radio.

(b) **Matt McDonald**, who built a state-of-the-art home security system, with RFID arming and disarming and an SMS controller which sends a text message to his mobile phone when the alarm is activated. The SMS controller also had a pre-programmed set of instructions which enabled Matt to remotely control various alarm functions. Matt imported the alarm panel kit from Britain to meet his requirements.

University/TAFE College Division

This division also offered three categories –

(a) Best project from a student as part completion of a degree, diploma or certificate in electronics or a related field (eg, mechatronics)

(b) Best research project from a post-graduate student working in an area of applied electronics

(c) An award to the university faculty or school sponsoring the best research project.

Entries were received in division (a) but no post-graduate research projects were received and no university-sponsored projects. The judging panel therefore decided to award two $2500 cash prizes in division (a). The two winners of this division (in no particular order!) were:

Luke Robinson, of Monash University (Vic), with his micro-hydro-electric power generation system, Single Phase Self-Excited Induction Generator with Voltage and Frequency Regulation. This controller regulates the output voltage by switching capacitors connected to the generator and regulates frequency by phase controlling a load to vary the "slip" of the machine. It maintains regulation at 49.9Hz, +/-0.3Hz and 219V, +/-1V, for loads up to 500W.

Carlos Galli, of Sydney Institute of Technology, with his single cylinder engine management system. This project grew from a requirement in the syllabus of the Advanced Diploma of Electrical Engineering and introduced microcontroller management to a "somewhat ancient" 75cc 4-stroke lawnmower engine. Many components for the engine had to be fabricated as replacements.

Thank you to all the students (and their lecturers/teachers) who entered. We hope to feature some of the winning entries next year in Silicon Chip and also to bring the **Silicon Chip Excellence in Education Technology Awards** back in 2007.

BENCHMARK

Dec 2006

BELOW COST!

Limit 2 per customer

Trade not supplied.

16-Piece Servicing Tool Kit

Wide range of servicing tools in a handy zippered carry case. It contains: pearl catch, IC extractor, wire cutters, driver handle, 1/4" hex driver, PLCC extractor, 3/16" hex driver, component tube, long nose pliers, insulated tweezers, IC inserter (14 and 16 pin), double-ended Torx bit, (T-10 & T-15), large flat head screwdriver – 75 x 5mm, small flat head screwdriver – 75 x 3mm, large No. 1 Phillips head screwdriver.

T 4843

$9.99

SAVE $20

Aluminium LP Storage Case

Keep your LP records secure in this solidly built, lockable aluminium storage and transport case with polished circle patterns and carry handle. Ideal for DJs or serious collectors, it holds up to 50 LPs and comes with two keys for added peace of mind. Size 355mm (H) x 340mm (W) x 240mm (D). **T 4855**

$29.99

SAVE $20

Benchtop Power Supply Kit

Features a variable output of 2.5 to 18V, a switchable current limiting (30mA and 1.2 amps), selectable voltage and current metering and an output load switch. Includes components, hardware, PCB, panel meter, case and front panel. **K 3202**

$48.87

SAVE $50

LIMITED STOCK

Retail stores only

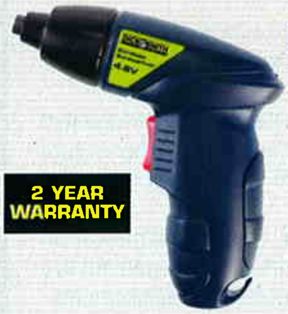
Electrocardiograph Kit

Watch your heart beat with this easy to build project that lets you take your own electrocardiograph (ECG) and displays it on a PC (via USB). You can read, display, save to disk and print the electrical waveform generated by your heart. Includes all components, hardware, PCB, a specially manufactured case that has been fully drilled, powder coated and screen printed as well as a set of ECG pads to get you started.

K 3704

$49

SAVE $90



2 YEAR WARRANTY

DICK SMITH ELECTRONICS

4.8V Rechargeable Cordless Screwdriver

Great for jobs around your home or office. Durable metal gearbox with extra-strong moulded body, forward/reverse control, 3-4hr mains charger, accessory bits and instructions. 2 year warranty. **T 4844**

$19.99

2 YEAR WARRANTY

digitor

18V Rechargeable Cordless Drill

Powerful 18V cordless drill with 17 torque settings, variable speed, 10mm keyless chuck, AC adaptor, NiCad battery pack, 4-6hr charging cradle with auto cut-off, plus carry case. 2 Year warranty. **T 4868**

$29.99

Look what's HOT!

HOT CHRISTMAS OFFER!

DICK SMITH ELECTRONICS

10MHz Single Channel Oscilloscope
At last an economical and easily transportable Oscilloscope with bandwidth of up to 10MHz and sensitivity of 5mV/DIV to 5V/DIV. Easy to operate, it is an ideal scientific and engineering instrument for a wide range of uses including hobby and education. Supplied with a 1:1 and 10:1 switchable CRO probe and detailed instruction manual.
Q 1803

$98
SAVE $30

24V Cordless Drill and Bit Set Pack

SAVE $20 on individual items

DICK SMITH ELECTRONICS

24V Heavy Duty Cordless Hammer Drill
Two speed gearbox and smooth electronic speed control, large 13mm keyless chuck, 17 torque settings, carry case, 1hr fast charger.

101-Piece Bit Set with Carry Case
Ideal for the handyman or electronics enthusiast. An enormous collection of screwdriver bits, including Torx, Pozidrive, Tri-wing style security bits and a driver handle, all stored in a rugged carry case.
T 4870T

$69.98

NEW

Push Bike Tyre Valve Light
In-built light sensor. Incl. batteries. P 8700

DUE LATE DECEMBER

$12.98 pair

NEW

Push Bike Tyre Valve Light
In-built light sensor. Incl. batteries. P 8704

DUE LATE DECEMBER

$14.98 pair

NEW

Push Bike 7 Colour Tyre Light
In-built light sensor. Incl. batteries. P 8705

DUE LATE DECEMBER

$14.98 pair

Promotion from 29/11/06 to 26/12/06

DICK SMITH ELECTRONICS
know-how to make it easy

Kit clearance time

Up to 60% OFF DICK SMITH ELECTRONICS KITS

LEGO MINDSTORMS

NXT Robot System

Comes with a 32 bit microprocessor, a large matrix display, seven input-output ports, Bluetooth and USB communication link, easy-to-use software (PC and Mac) and building instructions for four amazing robots. K 1487

$378

The NXT is the brain of a MINDSTORMS® robot.

It's an intelligent, computer-controlled LEGO® brick that lets a MINDSTORMS robot come alive and perform different operations. Use the touch Sensor to make your robot pick up things: the robotic arm lets the robot know whether or not there is something in its arm to grab. Pressing the Touch Sensor you can make your robot walk, talk, close a door, or turn on your TV.

Software.

It's easy to get started building and programming with LEGO NXT as the LEGO MINDSTORMS NXT Software comes with building and programming instructions for 4 cool models that you can build and program to do what you want.

The Sound Sensor makes your robot hear!

The sensitivity of the sensor is adapted to the sensitivity of the human ear. In other words, these are the sounds that your ears are able to hear. Test the robot on sound levels and see them displayed on-screen.

The Robot can sense things!

Make a burglar alarm robot: when an intruder turns on the light in your room the robot can react to defend your property. You can also use the Light Sensor to make a line-following robot or a robot that can sort things by colour.

Suitable for ages 6 and above.

GEOMAG

Dynamic Master

Magnetic construction kit where you can build fantastic top spinners and change the shape for a different effect. Suitable for ages 6 and above. K 1165

$19.98

PLAY STRATEGY– 2 Player Game LABYRINTH– 4 Player Game

GEOMAG

45-Piece Magnetic Board Game

Consists of metallic magnetised rods and nickel plated ball bearings. The only brand to have an internal metallic bar that directly joins the two end magnets. K 1167

$34.98

Magnetic 123-piece decko panel construction kit

GEOMAG

123-Piece Magnetic Construction Kit

Ideal learning aid in geometry, maths and chemistry. Consists of metallic magnetised rods and nickel plated ball bearings. Has an internal metallic bar that directly joins the two end magnets. K 1169

$59.98

Loads of handy

64-Piece Super-Hard Bit Set
This Bit Set is ideal for those heavy-duty applications where a stronger bit is required. These mirror chrome finished 6.3mm Hex-ended bits are made from super-hard S2-grade steel alloy, making them ideal for those heavier jobs. They're supplied with a very high quality combination locking and magnetic bit holder for easier connection to the chuck of your cordless drill, and all the parts are stored in a handy plastic carry case. T 6345

NEW

$38.90

digitor

Automotive Multimeter Kit
Multimeter and automotive tester in one. Measure RPM and DWELL angle plus temperature, frequency, voltage, current and resistance. Incl. inductive pick-up, temperature probe, rubber holster and test leads. Q 1585

$59.86

SAVE $20

Dual "O" ring seals for better suction

Heavy Duty Solder Sucker
Solidly built plastic housing, easy to open for waste solder removal. T 2574

$6.99

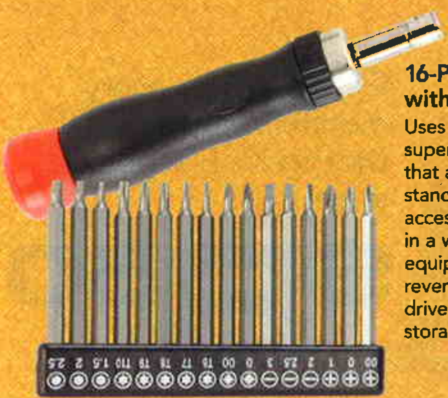
SAVE $8

iroda.

PRO-70K Solerpro Kit
Cordless, simple and safe butane powered operation. Quick ignition, tank holds fuel for 120mins of operation. Includes soldering, hot knife, heat blower and blow torch tips plus solder and cleaning sponge. T 1105

$49.98

SAVE $20



16-Piece Slim Bit Set with Ratchet Handle
Uses 16pcs 45mm long super-hard S2 grade bits that are thinner than standard bits, allowing access to recessed screws in a wider range of equipment. Includes a reversible direction ratchet driver handle and bit storage holder. T 6333

$9.80

SAVE $7

BONUS Gaffer Tape
N 1395
valued at $4.98

DSE

Waterproof Gaffer Tape
All purpose waterproof 48mm x 20m tape, secures wires/cables, sound and lighting equipment. N 1395P

$4.98

ideas for all!

SUPER CHRISTMAS SPECIALS!

eneloop
Ready to use Rechargeable battery
by SANYO

Battery Charger with Batteries

Includes 4 x AA Eneloop slow self-discharge, high capacity NiMH ready-to-use rechargeable batteries. **S 4415**

$29.99
HOT PRICE

Wireless Weather Station

Make tracking the weather easy and fun with the electronic barometric weather forecast. Features perpetual calendar. Accurate readings with loads of useful features. 1 x CR2032 (S 3221) battery and 2 x AAA batteries required. **D 3971**

$79.96
SAVE $10

Stadium

240V Easy Etch Engraver

Protect and identify your property! Quickly and easily mark tools, stereo equipment and household valuables with a permanent identification or serial number. Complete with AC plug pack and long cord.
T 4753

$19.99
SAVE $10

DICK SMITH ELECTRONICS

Temperature Controlled Soldering Station

A solidly built soldering station with a slim 48W soldering pencil, 1.6mm long-life plated tip and cleaning sponge. Adjustable 150°C-450°C temperature range with front panel metering.
T 2200

$69.99
SAVE $30

Available in-store or through our

Direct Sales Division

Phone: 1300 366 644 (Local call charge)
Fax: (02) 9642 9155
Mail: DICK SMITH ELECTRONICS
Direct Sales Reply Paid 500, PO Box 500,
Regents Park DC NSW 2143
(No stamp required)

Personal Visor Magnifier

Selectable 1.8x, 2.3x and 4.8x magnification, adjustable headband and integral illuminating lights (batteries required). **T 4598**

$19.99
SAVE $10

Promotion from 29/11/06 to 26/12/06

DICK SMITH ELECTRONICS
know-how to make it easy

Do you have cordless drills or other battery-powered tools lying unloved and unused because their batteries have failed? Don't do the usual and buy another one because they're so cheap: think of the planet and resurrect the ones you have! And then build our new power tool charger to <u>really</u> care for your batteries!

Bringing a dead cordless drill back to life

by Ross Tester

A while ago, a builder mate of mine put together a steel-frame house. These are somewhat like a huge Meccano set, with all of the mostly-prefabricated steel frames bolted together. To screw the bolts onto the nuts, he used a cordless drill.

Well, that's not strictly true. He used lots of cordless drills. When I called in to see him he had about half a dozen cordless drills lying on the scrap heap. When I asked him what they were doing there, he said "One has stripped gears, the rest have dead batteries."

"It's a lot quicker, easier and cheaper for me just to buy another drill," he said.

That made me think about my own collection of cordless drills. At last count, I had in my "junk box" (and in my case it's just that) about eight of the things. Or at least they would be cordless drills, if they still had batteries to power them. As it is, they're just about worthless – but I haven't the heart to throw them out!

My junk collection, for want of a better word, dates back the best part of 20 years – ever since the first electric drills, free of the shackles of a power cord, came onto the market.

Every year or two since, I have added another one. And before you think that has been a bit (a lot?) frivolous, I have to say that only a couple of those purchases have been by choice – perhaps to get a more powerful model or one with more features. In one case it was an absolute bargain during a stocktake at a hardware store that I couldn't walk past – like about 90% off normal price!

The rest have been by necessity. Their battery packs have failed – either failed to charge properly (a sure sign is when you only get a few holes drilled out of a charge!) or have been damaged by overcharging. Perhaps the former were caused by the latter. I'll tell you how I know they were overcharged shortly.

I would have preferred to buy a just new battery instead of a new drill.

The problem was, and remains, that if you can *find* a suitable battery pack (not at all easy!) invariably they are significantly dearer than buying a new drill, complete with new battery and probably a case and goodly selection of drill and driver bits into the bargain.

Look , we are not talking expensive drills here. All my drills are imports, mostly from China. The dearest one would have cost me about $100 – and that was a hammer drill as well. The cheapest (and most recent) was the princely sum of $18.88 – with carry case, charger, six drill bits, six sockets and socket converter.

Of course, you can pay a lot more for a cordless drill. Some of the models intended for "industrial" or tradesmen use can easily set you back several hundred dollars. A sparkie mate of mine has one with so much grunt it almost turns the building if you hang on tight! But he paid more than five hundred dollars for it.

The big advantage of these "industrial" models is that they are not only great performers, their battery packs are usually very high quality and most importantly, they usually include a smart (and often very fast) charger which will not allow the battery to overcharge.

But we're not talking about those exotic models here: we're talking about the everyday models that the average handyman – and some not so handy – would buy from their local hardware chain or department store. The prices would range from sub-$20 to, perhaps, $100 or so if you bought a kit with all the works.

As a general rule, the higher the voltage, the more expensive the drill. These days, you can find cordless drills anywhere from 4.8V (toys!) through to 24V (and more). Most common, though, are those in the 12-18V range.

Replacing dead batteries

When I looked at all those dead drills, it seemed to me that it was a terrible waste of money to keep buying complete new ones just to get new batteries. Surely there was a better way to go?

Sub-C (4/5) Nicad cells, the size predominantly found in cordless drills, are easily obtainable, so some time ago I looked at the idea of repacking the batteries with new cells. (You may recall an article in SILICON CHIP about ten years ago where I described doing just that for a mobile phone).

I disassembled a couple of drill batteries and found that while they were packed in like sardines, replacing them in like manner was certainly not beyond the scope of the average person (eg, me!).

Then I priced the replacement cells. Uh-oh!

In a 12V battery there are 10 such cells (10 x 1.2V) – and even in bulk (10+) they were going to cost about eight dollars each. That's eighty bucks just for batteries. Back then, a new cordless drill sold for about a third to half of that – they're even cheaper now!

Chalk and cheese

So I gave that idea away and kept buying drills – that is, until I had the opportunity to talk to Jaycar's Gary Johnston.

He told me that he had been looking at the same idea. What he found was that the Nicad cells used in the cheap imported drills were just that – cheap. And nasty. Even if treated in the best possible way, with charge monitoring and so on, it was highly likely they would fail quite quickly.

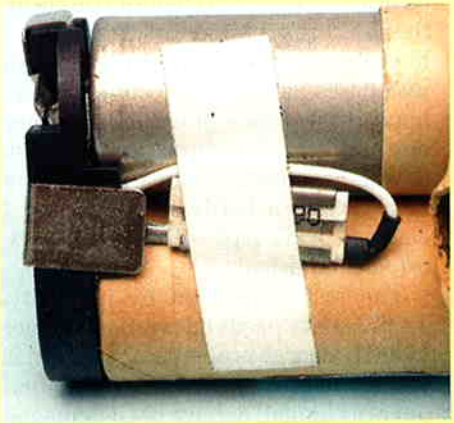
He maintained that with better cells, even if more expensive, you would not only get your drill back but you would

Here's a collection of sub-C NiCad cells from Jaycar – the same ones we used to repack our cordless drill batteries. These are a higher quality cell than you will find in most cordless drills these days and should last much longer – especially if looked after properly and charged with our new cordless drill battery charger, described elsewhere in this issue.

Here's why you can easily cook cordless drill batteries . . .

Here's a typical battery and charger stand from a typical "cheapie" cordless drill, in this case a 12V "XU1" model from Bunnings Hardware. It was purchased for the princely sum of $18.88 (ever seen a battery for anything like that?).

The positive and negative connections to the battery are clearly visible in recesses at the top of the battery – they're even marked with polarity. But you can also clearly see some form of "sense" connector/terminal (the little metal tab facing the camera).



Opening up this battery revealed (presumably) a thermistor connected to this terminal. Note that the insulation has been removed from this cell to allow intimate contact (ignore the fact that in this case the thermistor has been assembled not touching the cell!). However . . .

have one which would perform better (ie, give more power) and would last a lot longer on each charge.

And so that started me thinking about the subject again. But we are getting a little ahead of ourselves.

Cheap and nasty!

Elsewhere in this feature we have shown some photographs of a typical low-cost cordless drill. We're not singling out this particular drill for any reason – it was one of several similar models we could have shown.

As you can see from the photographs and the captions, the battery itself contains a thermistor to (theoretically!) limit charging when the batteries get too hot. But the charger itself contains no terminal to connect to this sensor nor any circuitry to affect charging. Not only that, but the thermistor doesn't even make intimate contact with the cell it is supposed to. Duh!

Worse is the fact that the charging circuitry consists of just one significant component: a resistor.

Even the LEDs which show the charging state (ie, charging and charged) are not at all smart: the manufacturers rely on the fact that red and green LEDs light at different voltages and will therefore (hopefully?) come on at somewhere around the right battery charge point.

12V drill packs from two different drills. The one on the right can be repacked but the one on the left is severely distorted by heat (from overcharging) and no longer fits into either the drill or the charger. Note how the vertical section leans to the left and its edges are wavy, not straight.

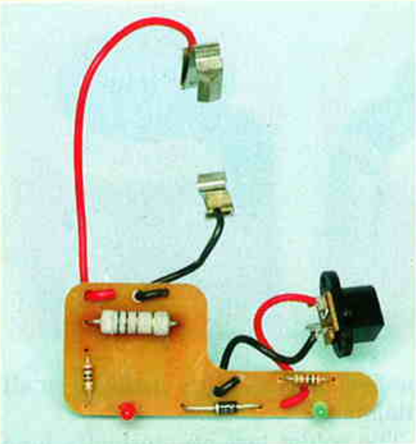
Charge rate and time

While the single resistor will limit the charging current to a "safe" level (and we'll look at charging in more detail shortly), it does absolutely nothing to prevent overcharging due to time.

Most cheap cordless drills have batteries designed to take the standard C10 charge rate – that is, the charging current is 1/10th the rated battery current – so a typical 1.8Ah battery should suffer no damage if it is charged at about 180mA.

Mainly because the current decreases as the battery charges and its voltage rises, the normal charging time is not 10 hours as you might expect but is

. . . looking inside the charger, you can clearly see the positive and negative charging terminal connectors, identified on the top of the well with "+" and "–" symbols. But there is no other connector for the sense circuitry – even though there is clearly a provision for it in the moulding (top of pic, bottom of well).



Here's the evidence! The charger's PC board essentially contains just one significant component – a current-limiting resistor! The red (charging) and green (charged) LEDs sort-of monitor the voltage and the diode makes sure a reverse-polarity plugpack won't cause damage. No wonder with chargers as simple as this that so many batteries are cooked!

increased to about 12-14 hours.

And, as they say in the classics, there's the rub: more batteries (I'll admit it, mine included) are ruined by being left on charge for far too long than wear out through use.

It's easy to see how: you use the drill until it starts to lose its power, then pull the battery and place it in the charger. You mean to take it out next morning before you go to work – but forget. In fact, it might be a couple of days before you remember – and all this time current has been forced into a now very-much-overcharged battery.

Batteries overheat when overcharged (they also overheat when charged too fast). Heat is the biggest enemy of rechargeable batteries. Apart from the fact that overheating can – and does – kill the cells themselves in various ways, it can also cause deformation of the plastic battery case.

One of my cordless drill battery cases is actually deformed so badly due to heat that it won't even fit into the drill any more!

So you may end up with a double whammy: dead cells AND a battery which won't fit the drill even if you replace the cells with new ones.

It's therefore important not to overcharge these batteries – and that brings us to the nub of this article: a cordless drill (or any other low-cost tool) battery charger.

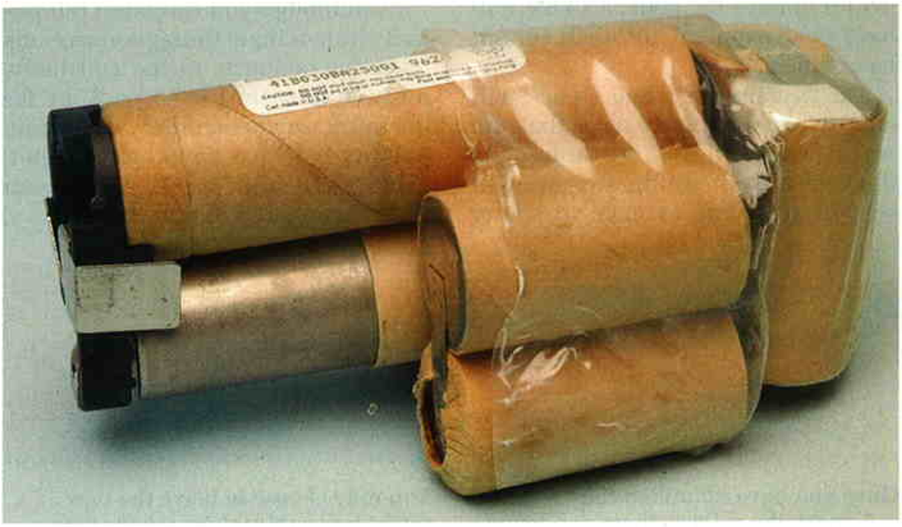
Before we get there, though, we are going to look at repacking your dead cordless drill battery with new cells. After all, you want something worth charging!

Dissassembly

Fortunately, most battery packs are assembled with Phillips screws, so you shouldn't have too much difficulty there. You might come across some with tamper-proof screws, in which case you'll need a suitable tamper-proof screwdriver to tamper with them! Jaycar have a number of sets of these screwdrivers and/or bits for cordless drills.

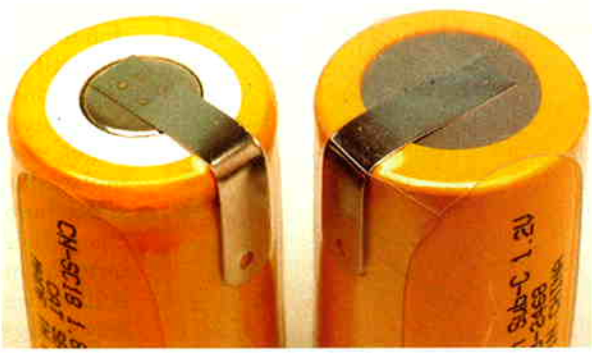
Very occasionally, you might come across a battery which is welded rather than screwed together. If you refer to the article I mentioned earlier on repacking the mobile phone battery (SILICON CHIP, April 1996), you'll see how to get around this wee problem. Basically, it involves gently squeezing the longest edge of the case in a vyse and tapping it until the weld cracks, then prising the joint open.

Once you have removed the screws



Yet another dead cordless drill battery, shown with the case opened at left and the cell pack removed (above). Note the way the cells are stacked to allow them to fit into the case and the use of wide sticky tape to hold them together. To repack the battery, you need to copy the old arrangement exactly.

These cells have long solder tags. There are no polarity markings on the cells and polarity is important! It's safest to identify the polarity with a multimeter. As it happens, the cell on the left has its "+" to the top, the cell on the right its "–" to the top. There is also an indent around the top of the cell at the "+" end.



(and stored them where you can find them again later), pull apart the battery pack carefully, noting where any loose bits (eg, catches, springs, etc) fly out from.

Now gently remove the battery pack in one piece, taking careful note of how the cells are assembled. You are going to have to copy this arrangement exactly with the new cells, otherwise it will probably not fit back together again. Also make a note of the number of cells. It is not unknown for a "12V" cordless drill to contain nine or even eight cells.

Nevertheless, the rule is that what comes out must be replaced exactly. Unless you are very unlucky, the manufacturers would have used "sub-C" cells (which, incidentally are 4/5th the size of a C cell). And that's what you need to buy – the same number as were used originally.

For those who are mathematically challenged, a 7.2V drill should have six cells. A "9V" drill will probably have seven (though it may have eight and possibly be labelled 9.6V). A 12V drill will have ten cells, a 14.4V will have twelve and an 18V drill should have fifteen.

The cells in the original pack will almost certainly have tags that are welded together. Most hobbyists don't have spot welding equipment so you are going to have to solder the new ones and this creates a small dilemma.

The solder tags are normally long enough to reach the edge of the battery (indeed, the Jaycar cells we used were even longer), giving you enough space to solder the tags together.

However, this then gives you exposed metal which you must be very careful not to short circuit.

These Nicad and NiMH cells, when charged, are capable of delivering enormous currents into a short circuit – perhaps 100A or more – for a short time, which can easily cause a fire. So be careful to insulate any exposed metalwork.

Also when soldering be careful that you don't melt through any plastic insulation and allow a "+" tag to touch the "–" case. It's a common reason for cell failure.

Cell polarity

On many cells, there is no polarity marking as such. The very last thing you want to do is solder in a cell back-to-front.

Even though you can often tell polarity by looking at the tag connections (negative connects to the cell body, positive to an insulated pad), by far the safest way to definitely determine polarity is with a digital multimeter. New Nicad and NiMH cells, even those supplied flat from the factory, should have some residual charge.

Remember the old adage: "measure twice, cut once". In our case, measure polarity twice, solder once!

Assembly and soldering

When you have worked out how the new cells are to go together (using the old pack as a template) make up the new pack, soldering the tags as you go. Trim the tags back to the minimum required for a good solder joint (there's less danger of a short that way).

Most packs have cells arranged in both the horizontal and vertical planes; again, you need to arrange your new pack the same way.

It's probable that you will need some tape to hold the cells together. Many factory packs used very wide sticky tape because it *is* wide and is also very thin (much thinner than insulation tape or gaffer tape).

If we were making up a battery pack from scratch, we would normally think about using heatshrink tubing. But even that may be too thick to allow the pack to go back into the holder.

The thermistor

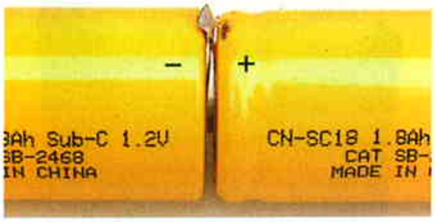
With one proviso, if there is a thermistor in the original battery pack, it should be included in the new one. The proviso is that if you intend to build the Power Tool Charger Controller described later in this issue, you need to install the thermistor designed to go with that charger.

First, we'll look at simply replacing the existing thermistor. Have a good look at how it is mounted and connected. Most batteries have the insulated covering on one cell removed so that the thermistor can make intimate contact – see the photos of the battery pack earlier in this article.

Duplicate the original and remove the insulation from the cell in the same position. Be careful that you don't al-

Once you have identified the "+" and "–", mark the cells so there can be no mistakes. The cells which make up sticks are simply butted together (as tightly as you can) and held securely while you solder the tags.

You may choose to leave the tags intact and solder them where they touch (use a well-tinned iron, clean the tags and make the solder joint quickly – you don't want to heat the cells or melt the insulation) . . .



. . . but to minimise the risk of short circuits, our preference is to trim the tags so that as little metal is exposed as possible – just enough to ensure a reliable solder connection. You still may need to insulate the metal.

The battery conectors on the original pack, which must be transferred to your new pack (see photo below). Once again, there are no polarity markings on the battery connectors, so check and check again. A reversed connection to the drill won't hurt but a reverse connection to the charger most certainly will!

low anything to short to it!

When the new cell pack is completed, check that it still fits inside the case the original pack came from. If necessary, adjust the cell positions so that it does.

The new charger thermistor

One of the features of our new Power Tool Charger is that it closely monitors battery temperature.

It does this via a thermistor fitted in similar manner to the original thermistor; the difference is that both its connections are brought out to a 3.5mm socket with a suitable lead connecting the thermistor to the charger.

Mount the thermistor on the cell without insulation (it can be glued on with a drop of super glue) and find a suitable place to mount the 3.5mm socket.

In most batteries, space is at a premium but as the cells are round, there should be some gaps somewhere big enough to house the socket.

Make sure you don't mount the socket where it fouls either the charger or the power tool when the battery is inserted.

If there is simply NO space to mount the socket, it may be necessary to bring the leads out through a hole in the battery case to an external 3.5mm socket. But this really would be the worst-case scenario because there would be a real danger of catching the leads or socket as you work!

Battery connections

You are going to need the connections from the original battery, along with any hardware which holds them in place. So they will have to be carefully removed.

Before doing this, make sure that you know which one is the positive terminal and which is negative (use your multimeter; hopefully there will be some charge in the old pack to help you).

If the cells are so dead that there isn't enough charge to measure, examine the charger to work out how the pack went into it – this will allow you to determine polarity. Again, use your multimeter if there are no markings on the charger terminals.

Here's our finished battery, complete with terminals, ready to be placed back into the case. We haven't as yet fitted the thermistor or its socket (that is done at final assembly), although we have removed the insulation on one cell to accommodate it. This particular battery is 12V (10 cells x 1.2V)

Higher rated cells – or perhaps NiMHs?

The cells we used in our reconstruction were pretty much the same as the dead'uns which came out – 1.8Ah nickel cadmiums.

We did that deliberately, if for no other reason than wanting to maintain the "originality" of the cordless tool as much as possible and use the supplied charger. This would keep the charging times and currents pretty much identical.

But could we – should we – have taken the opportunity to put higher rated cells in to get more usable life? And what about using nickel-metal-hydride (NiMH) cells instead of nicads?

To answer the first part, yes, we could have upgraded to higher capacity nicads – but as hinted at above, this would probably have altered charging times.

Remember that the charger supplied with most cheap cordless tools has little more than a current-limiting resistor, which would almost certainly prevent the charger delivering the higher charging current required.

As far as NiMH cells go, they're becoming even more readily available than nicads and they don't develop the dreaded "memory effect" that nicads do. More to the point, they are now available in much higher capacities: 2500, 3000 and even 3500mAh are common (we've actually seen 4000mAh sub-C NiMH cells advertised on the 'net, although that could be a marketer taking a bit of licence). And prices have dropped, too.

However, most of the information we have seen claims that nicads are better than NiMH for short term, high current drains such as cordless tools. To counter that, we've also seen high-capacity NiMH cells with a 36A short-term rating, which are claimed to be "ideal for cordless drills etc".

So it's up to you which way to go. Remember that if you do elect to increase the battery capacity, you'll have to adjust charging times to compensate, especially using the original charger.

Remember that the charger "+" terminal connects to the battery "+" terminal.

To avoid any possibility of mistake, we normally mark the battery terminals with a "+" and "-" and mark the terminals of our new pack the same way.

Once again, on an original battery the terminals are normally welded to the cells; by far the easiest way to remove them is to cut the cell tags with a pair of fine snips or even scissors as close as possible to the top of the cells.

Sometimes the weld is not particularly strong and you can remove the terminals with a pair of pliers. Even if the metal tears (and it often will) this can be repaired during soldering.

When completed, you should have a cell pack that is as near a duplicate of the original as possible.

Reassemble it back into the original battery case, making sure the terminals emerge in the right places. Virtually all battery cases have a keyway to stop you putting the battery in back to front but you must ensure that the battery pack is in the right way in the case. On a drill, reversed connection normally wouldn't be too much of a problem (simply flip the reversing switch!). But on a charger, it would be disastrous.

Speaking of chargers . . .

Of course, you could use the existing charger with the new battery pack. But with all the problems we talked about before, do you really want to risk damaging the new pack?

Elsewhere in this issue, we present a microcontroller-powered charger specifically intended for cordless drills and similar battery-powered devices.

John Clarke has designed a beauty: it simply plugs "in line" between your existing plugpack charger and the charging cradle (it basically ignores any built-in charging circuitry) but will monitor temperatures and charging voltage to prevent over-charge – and even turn itself off if the other methods fail.

Your new battery pack will last dramatically longer than the old one did and give you much better performance into the bargain.

Even if you haven't repacked your battery cells (perhaps you even have a brand new drill?), we commend this new charger to you.

It will keep the battery in tip-top condition and save you the problem (and expense) of having to repack the cells in the future!

Just remember that you'll have to replace the thermistor and fit a 3.5mm socket. SC

Special Offer from JAYCAR ELECTRONICS

Exclusively for SILICON CHIP readers, Jaycar Electronics have a special offer on a pack of ten sub-c 1.8Ah Nicads, as we have used in this article.

The pack of ten (for 12V) would normally sell for $79.50 but for December and January, all Jaycar Electronics stores and their online Techstore will have the ten-pack for just $62.50 – as long as you tell them you saw the offer in SILICON CHIP!

CORDLESS POWER CHARGER CONTRO

Protect your investment and extend the life of your power tool rechargeable batteries. Add this Power Tool Charger Controller and never cook a Nicad again!

Well, we've seen how simple it is to resuscitate the batteries in your "cordless" power tools elsewhere in this issue. Now it's time to ensure you don't kill them all over again.

While those battery-powered tools have many virtues, we are not so enthusiastic about their battery charging systems.

As we discussed, most low-cost power tools include a very basic charger: a plugpack to supply power and a resistor to limit the current flow into the battery pack. There is nothing to prevent overcharging: no timer to switch off charging when the time has elapsed and no full-charge detection.

At best, this type of basic charger will shorten the battery pack life so that it will require replacing after only relatively few charges. At worst, the basic charger can cause destruction of the battery pack the very first time it is used!

Destruction of the battery pack can happen if the charger is left on for too long after the battery pack has reached full charge. And it is all too easy to forget to switch the charger off at the required time. The result is serious overcharging

You cannot even rely on the fact that charging requires a certain time period and the charger can be switched off after that because the time period required to reach full charge depends on the state of charge for the battery pack at the start of charging.

Overcharging can destroy the battery pack because of the characteristics of the cells that make up the battery pack, which are usually Nicad (Nickel Cadmium (NiCd)) or NiMH (Nickel Metal Hydride) chemistry. The two types tend to have fairly similar characteristics and overcharging will severely shorten the life of both.

One of the main differences between the two as far as users are concerned is that Nicads can develop a "memory", where if they are only partially discharged then charged again, eventually they will "remember" this as their entire charge/discharge limit and therefore significantly reduce the amount of power available. NiMH batteries do not have this characteristic. However, Nicads are more suited to the heavy discharge currents of power tools and are usually supplied instead of NiMH.

FEATURES

- *Charging timeout*
- *Minimum and maximum temperature monitoring*
- *dT/dt charged detection*
- *Over and under temperature detection*
- *Power, charging and thermistor out indication LEDs*
- *Adjustable timeout limit*
- *Adjustable dT/dt setting*
- *Optional and adjustable top-up and trickle charging*
- *Start switch*
- *Charging resumes after blackout*

To see what happens when a battery charges take a look at Fig.1. This shows the typical voltage, temperature and internal pressure rise with charge. Once charging goes past the 100% charge point (also known as the end-point) the temperature and internal pressure rapidly rise and the voltage initially rises and then falls.

Continual overcharging will damage the cells due to the elevated temperature. This accelerates chemical reactions that contribute to the ageing process. In extreme cases during overcharging, the internal pressure can cause the cells to open their safety vents to release the pressure. The vents should re-close after the pressure is released but sometimes the cells are deformed by the heat and permanent damage occurs.

What should happen?

A well-designed charger will not allow overcharging; in fact it will switch off the main charge when the cells reach their end point.

Some chargers will just include a timer to switch off charge after a certain period has elapsed. This is not ideal for the reasons already mentioned and the timer should really only be included as a fail-safe device; a backup to stop charging should the "detection of full charge" fail.

Full charge of the battery pack can

TOOL
OLLER

by John Clarke

be determined in one of two ways. One way is to monitor the voltage across the battery pack and detect the point where the voltage begins to rapidly rise and then fall.

This form of end point detection is called dV/dt, or the change in voltage with respect to time. In practice, this voltage change can be difficult to detect, especially with NiMH cells which do not show a marked voltage change at full charge.

The second (and more reliable) method is to detect the temperature rise of one or two cells within the battery pack. When charging, the incoming electrical power is converted into stored energy via chemical reactions within each cell. These reactions are reversible – when an electrical load is connected they deliver electrical power.

While charging at normal rates, the cells do not rise much in temperature because most of the incoming power is converted into useful stored energy. However, once the cells become fully charged, no more useful chemical reactions can occur.

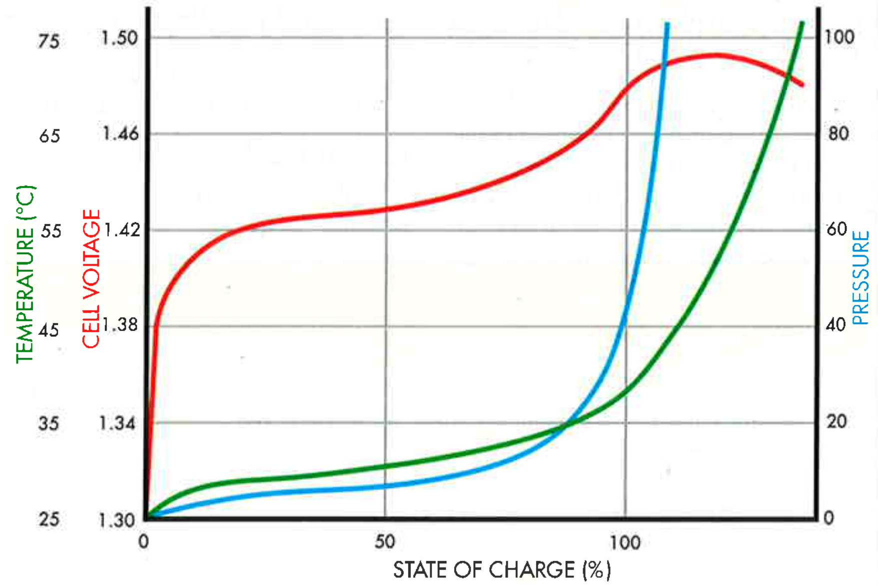


Fig. 1: typical charging curves for Nicad batteries, as supplied in the majority of cordless power tools. Cell temperature (green) and voltage (red) are most often used to detect the "end point" or 100% charge.

But if the charger stays connected, power is still being forced in and this energy is converted to heat. Therefore the cells rise quickly in temperature. Detection of this change at the charging end point is called dT/dt or the change in temperature over time. The temperature rise is in the order of 2°C per minute.

At the end point (where the cells are fully charged), charging is normally switched off to prevent the cells overcharging. Some chargers include a top-up charge after the endpoint to deliver a lower current to the cells to ensure they are fully charged. After top up, the cells are trickle-charged to maintain their full charge.

The trickle charge can be maintained indefinitely because the cells are safely able to dissipate the small amount of heat generated.

Our charger controller

The Silicon Chip Power Tool Charger Controller uses the tool's existing plugpack and battery charging unit/base. It simply connects in series between the two and therefore can control the charging process.

Note that because the Charger Controller does not connect directly to the battery pack, it cannot measure the battery voltage. Instead it utilises

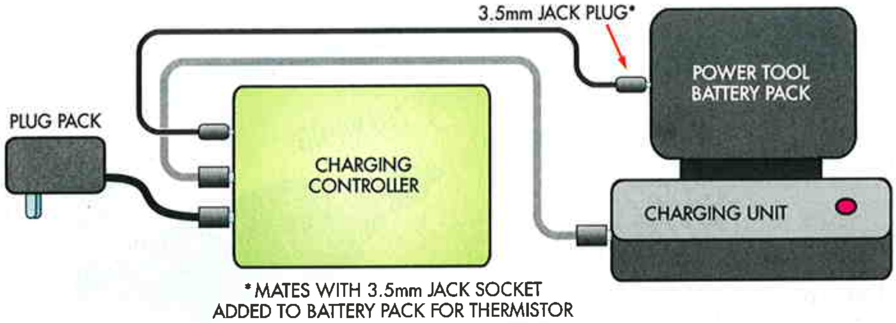


Fig.2: the SILICON CHIP Charging Controller simply connects in series between the original plugpack and power tool charging base, effective ignoring any original "charger" circuit. A separate thermistor connection is also required, with the thermistor mounted on one of the new battery cells.

dT/dt detection to stop charging at the end point.

For this temperature measurement, the charger controller requires that a small NTC thermistor be installed within the power tool battery pack, with the two leads brought out to a 3.5mm jack socket.

We discussed fitting this thermistor in the earlier article on repacking cells. As a backup we have included a timer that will switch off charging after a preset period should the thermistor end point detection fail.

More safeguards

Further safeguards to protect the cells are also included. Charging is initiated with the start switch (S1). However, charging will not start if the NTC thermistor is disconnected or if there is an over-temperature or under-temperature detection. The over-temperature setting is at 70°C while the under temperature setting is at 0°C.

If the NTC thermistor is connected and the cell temperature is within the 0°-70°C range, then charging will start. Charging will halt should the temperature fall below 0°C or if the thermistor is disconnected.

Charging will resume when the temperature range is correct or the NTC thermistor is re-connected. However, if the temperature goes over 70°C, full charging will cease and will not automatically resume.

If a blackout occurs during charging, charging will resume with return of power. The timeout period will also resume from where charging was interrupted.

Charging will cease at the point where the dT/dt value is exceeded or if the timeout period expires. Pressing the start switch will resume charging from the start of the timeout period. You can also stop the charging process at any time by pressing the start switch.

Reduced charge

In its simplest form, the Charger Controller includes just the features mentioned above.

But you can also enable top-up and trickle charging if you wish. The top-up feature provides a reduced charge (typically at 400mA) for an hour to ensure full charge is reached after the main charge cycle. The trickle charge (at typically 100mA) continues after the top up to maintain battery charge.

As mentioned earlier, trickle charging does not generate a lot of heat so the battery can be left on trickle charge, ready for use at a moment's notice. There's nothing worse than picking up a drill to find that the battery has self-discharged (which they can do!).

Adjustments

Both the timeout period and dT/dt values are adjustable. Timeout can be set up to 25 hours while dT/dt can be selected between 0.5°C rise per minute to 5°C per minute. The trickle charge rate must be adjusted if the top-up and trickle charge option is selected. More details concerning the adjustments are included later in the setting-up section.

Indication

Three LEDs indicate the status of the charger controller: power, thermistor and charging.

The power LED is lit whenever power is applied to the charger controller. The NTC thermistor LED lights whenever the thermistor is disconnected. When connected, the LED will be off unless there is an over-temperature or under-temperature condition. In these cases, the NTC thermistor LED flashes at a 1Hz rate when it measures over temperature and at a 0.5Hz (once every 2 seconds) rate when it measures under temperature.

The charging LED is continuously lit during the main charging cycle and switches off when charging is complete. If top-up and trickle charging is selected, the charging LED will flash at a 1Hz rate during top up charge and will flash at a 0.5Hz (once every two seconds) rate during trickle charge. When the thermistor LED is lit or flashing, the charging LED will be off.

How it works

The circuit for the Power Tool Charger Controller (Fig.3) is based

Specifications

Maximum Current	5A
Timeout adjustment	From 0-5 hours, corresponding to 0-5V from VR1 at TP1. 0-25 hours with x5 link installed (LK1)
dT/dt adjustment	From 0.5°C-5°C rise/minute, corresponding to 0.5V to 5V from VR2 at TP2.
Top up and Trickle Charge	Available when LK2 is installed
Trickle Charge adjustment.	From 100% to 1/50th of main charge current corresponding to 0-5V from VR3 at TP3. 100% to 1/250th with x5 link installed (LK3)
Top up charge	4 x trickle setting for 1 hour
Topup and trickle switching rate	30Hz.
Over temperature cutout	70°C
Under temperature detection	0°C
Current consumption	20-26mA depending on status LEDs

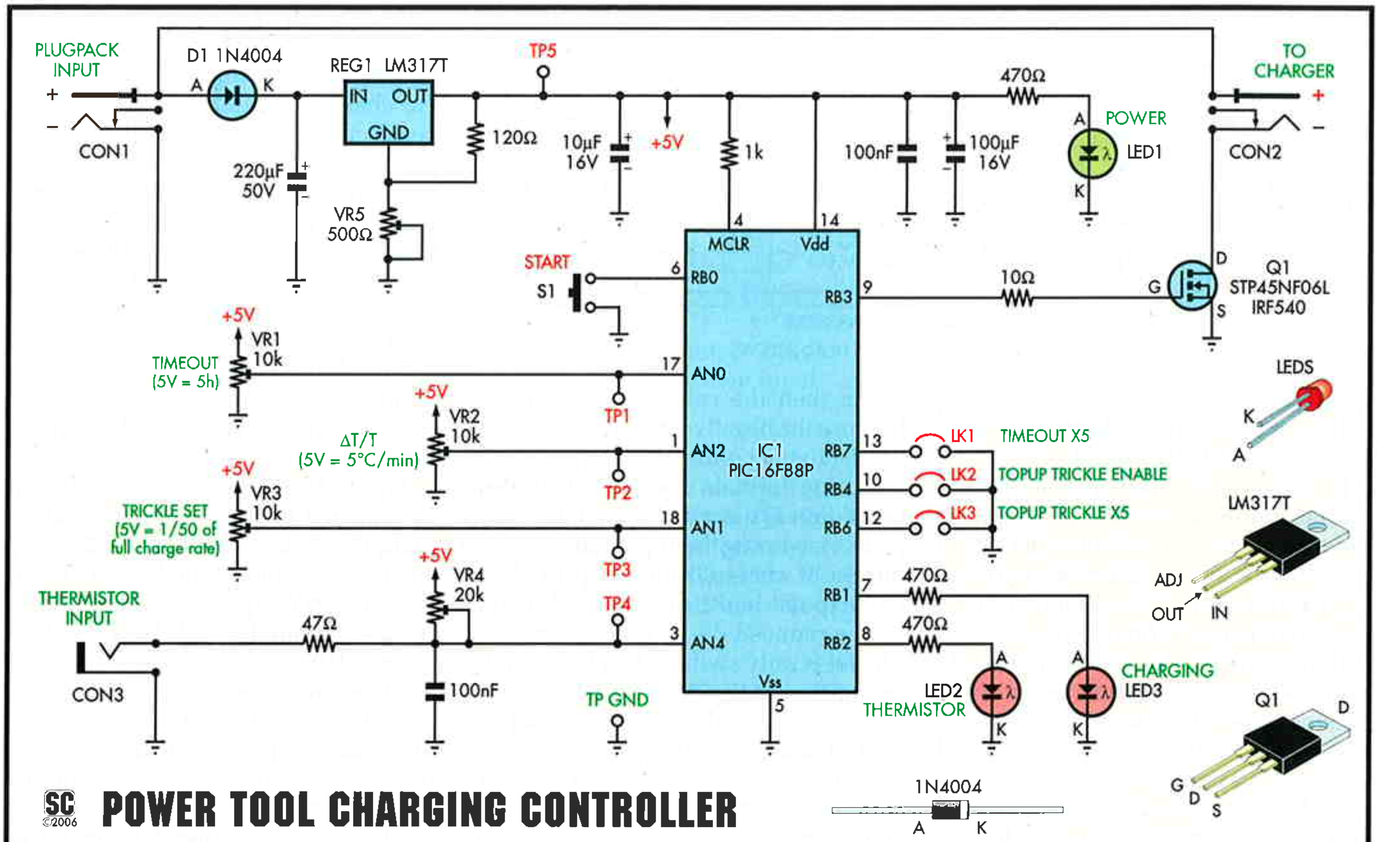


Fig.3: the PIC microcontroller analyses the charge state of the battery, turning the charger on and off by means of Mosfet Q1. Various parameters can be set by means of the links and trimpots.

around a PIC16F88 microcontroller. This performs all the logical decisions required to control the charging and runs a software program specifically for this charger controller application. Apart from the PIC, there is not really much else to the circuit.

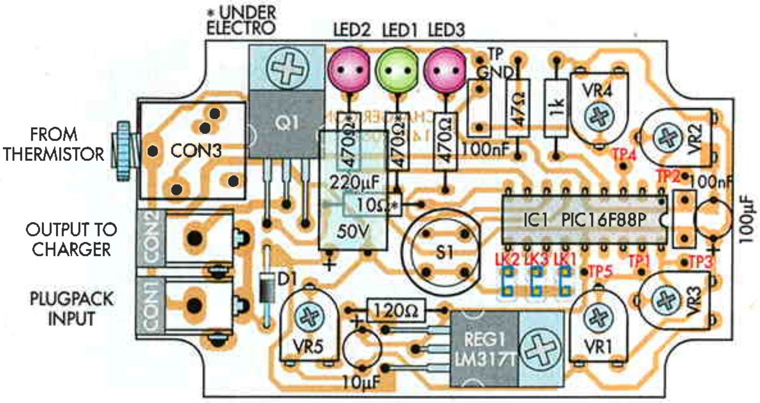
When the thermistor is plugged in to its socket, it forms a voltage divider in conjunction with trimpot VR4 across the 5V supply. VR4 is set so that the voltage across the thermistor is 2.5V at 25°C. The voltage across the thermistor is monitored by the PIC's AN4 input (pin 3) via a 47Ω stopper resistor and 100nF filter capacitor. These are included to remove any RF signals and noise that could be present due to the thermistor being connected remotely from the circuit.

The voltage at the AN4 input is converted into a digital value by the software and this is compared against the over- and under-temperature values and for dT/dt changes.

VR1, VR2 and VR3 set the timeout, dT/dt and trickle charge current respectively. They each comprise a 10kΩ trimpot connected across the 5V supply. The wiper of each trimpot connects to one of the PIC's AN0, AN2 or AN1 inputs. The voltages are converted to a digital value within IC1 so that the settings can be processed in software.

Note that the trimpots can be monitored via test points (TP1, TP2 and TP3) using a multimeter.

For example, setting VR1 to give 4V at TP1 will set the timeout to four hours. The timeout value can be multiplied by a factor of five if the jumper link (LK1) is inserted. With LK1 out,



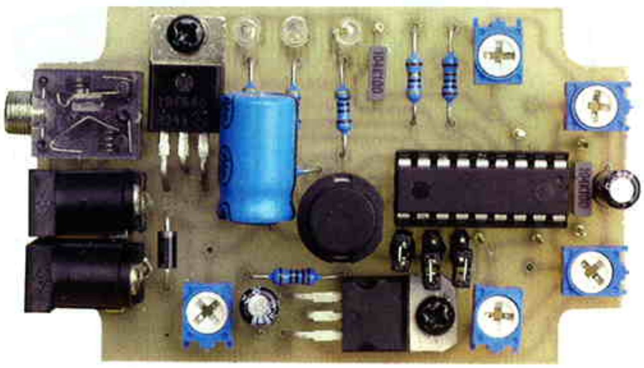
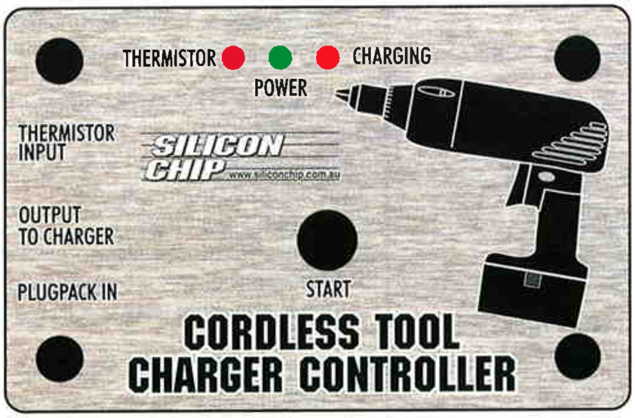
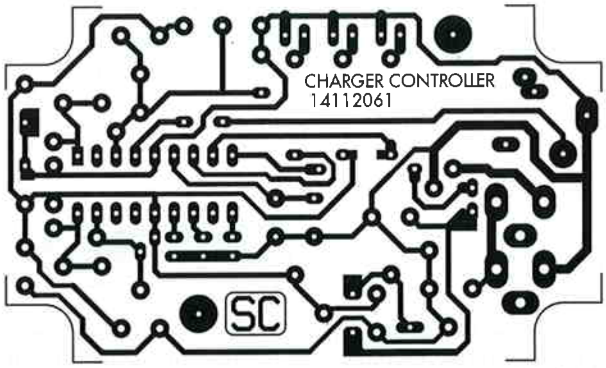


Fig.4: with the exception of the thermistor (which must be installed in the battery pack) everything fits onto one small PC board. The photo at right is reproduced same size to match the component overlay at left.





Figs. 7&8: same-size artwork for the front panel label (which glues to the case lid) and the PC board.

easy measurement of these trimpot settings.

The timeout is easily set from between 0 and 25 hours. In its simplest arrangement the voltage at TP1 gives the timeout in hours. So, for example, if VR1 is set provide 5V at the TP1 point then the timeout is five hours.

If you need longer than this time period, then you can install LK1. This acts as a x5 multiplier. So for example, with LK1 installed and with VR1 set so that TP1 is 5V, the timeout will be 25 hours.

Similarly, if TP1 is 1.2V then the timeout will be six hours (5 x 1.2). Most chargers for the battery power tool will state the required charge time.

Temperature rise detection (dT/dt) can be adjusted from between 0.5°C per minute rise to 5°C per minute. This is adjusted using VR2 and measuring at TP2. The negative connection of your multimeter connects to TP GND. There is a direct correlation between the voltage and the setting.

So, for example, a setting of 2.5V at TP2 will set the dT/dt value to 2.5°C per minute rise. Initially set VR2 so that the voltage at TP2 is 2.5V.

Option

Top-up and trickle charge is enabled by installing link LK2. If this option is selected you will need to set the trickle charge rate. The top-up charge is fixed at 4 times the trickle charge and the trickle charge is set using VR3 and link LK3. If LK3 is not installed, then VR3 allows the trickle charge to be set from unity to 1/50 of the main charge current.

With link LK3 installed, the ratio is multiplied by a factor of 5. The trickle charge requirement is calculated by dividing the amp hour rating of the cells by 20. If the cells are 2400mAh then the trickle current should be 120mA.

To set VR3 you need to know the charge current of your charger. This is usually quoted on the charger. It can also be measured with a multimeter connected in line between the plugpack and charger when the battery pack is charging. VR3 (and link LK3) provide the division ratio required to reduce the charge current down to the trickle value.

For example, if the main charge current is 3A and we want a 120mA charge, the division required is 3/0.12 or 25. So VR3 should be set to 2.5V. If a ratio of more than 50 is required, link LK3 can be installed to allow the value to be increased by 5 to a maximum of 250.

Connection

As shown in Fig.2, the Power Tool Charger Controller simply connects in-line between the charger's plugpack and the Charger. The plugpack supplied with the cordless tool can connect directly into the Power Tool Charger Controller.

A separate lead connects between the Power Tool Charger Controller and the original charger. You will need to make up this lead using a length of 2-way wire (figure-8 wire) and two DC plugs. Similarly you will need a 3.5mm jack plug to 3.5mm jack plug lead for the thermistor connection. Fig.6 shows how to do this for the 3.5mm jack lead. The wiring is similar for the DC socket lead.

As explained in the earlier article, the power tool must have a battery pack that has the thermistor installed and a 3.5mm jack socket added to the battery pack for connection to the Power Tool Charger Controller.

Note that some battery packs have a thermistor already installed. This should be replaced because it may not have the same resistance characteristics as the one we specify.

It may also connect the negative side of the battery pack to one side of the NTC thermistor. Our circuit requires an isolated thermistor connection to avoid bypassing the Mosfet.

Setting up

Depending on settings, the charger may stop before full charge or it may tend to overcharge the batteries.

Undercharge will be evident if the charging period appears to be too short and the power tool does not run for the usual period before charging is required. In this case, turn VR2 more clockwise to increase the dT/dt value. Alternatively, if the battery pack appears to get hot after full charge has been reached, turn VR2 back anticlockwise for a lower dT/dt value. SC

Resistor Colour Codes

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	3	470Ω	yellow violet brown brown	yellow violet black black brown
❑	1	120Ω	brown red brown brown	brown red black black brown
❑	1	47Ω	yellow violet black brown	yellow violet black gold brown
❑	1	10Ω	brown black black brown	brown black black gold brown

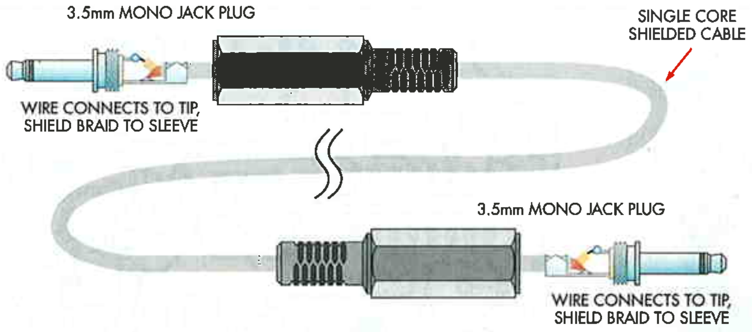


Fig.6: the lead for the thermistor mates with the 3.5mm socket fitted to the battery pack (which connects to the thermistor itself) and the 3.5mm input socket.

output voltage. These factors can be trimmed out with VR5 to set the output to precisely 5.00V.

Construction

The Power Tool Charger Controller is assembled onto a PC board coded 14112061 and measuring 78 x 46mm. It is housed in a small plastic case measuring 83 x 54 x 31mm.

Begin construction by checking the PC board for any defects such as shorted tracks, breaks in the copper and incorrect hole sizes. Holes for the DC socket and 3.5mm jack socket will need to be larger than the 0.9mm holes required for the other components.

Insert the resistors first, taking care to place each in its correct place. Use the resistor colour code table as a guide to finding each value. You can also use a digital multimeter to check each resistor before inserting it into the PC board. Solder each lead and cut the leads short against the underside of the PC board.

Now solder in the diode and IC socket, taking care to orient them with the correct polarity. The capacitors can go in next. Note that the electrolytic types must be oriented with the polarity shown and the large 220μF capacitor needs to mount on its side as shown in the photograph to allow room to fit into the box.

LEDs 1-3 mount so that the top of the LED is 17mm above the surface of the PC board. Take care to orient them with the anode (longer lead) towards the left of the PC board. LED1 is green while LED2 and LED3 are red.

Switch S1 each must mount with its flat side towards IC1. When placing the trimpots, make sure the correct values are in each position. The link headers can also be installed for LK1, LK2 and LK3.

REG1 and Q1 are installed so that they lie flat on the PC board with their leads bent over to insert into the appropriate holes. During installation in the box, they are secured to the PC board with an M3 screw. Finally, install the DC sockets and the 3.5mm jack socket.

Installing in a box

The PC board is installed into the small translucent plastic case.

Before you can insert the PC board into the box, drill out the hole for the 3.5mm jack socket. Mark and drill out this hole and clip the PC board into the integral side pillars of the box. Mark out the positions for the screw holes in the base of the case for the Q1 and REG1 mounting supports. Drill these holes at 3mm in diameter and countersink the holes at the underside of the box.

Install the two 10mm tapped standoffs and the 1mm spacers as shown in Fig.5 and secure the PC board in place. Mark out the positions for the DC socket holes in the side of the box and for the three LED holes and for switch S1 in the box lid. Drill these holes out. The switch surface is slightly below the panel lid so its hole will need to be large enough for your finger to reach in and push.

Setup

Initially leave IC1 out of its socket. Apply power to the plugpack input DC socket (positive to the centre of the plug). The power LED should light. Connect a multimeter between TP5 and TP GND and adjust VR5 for a reading of 5.0V. Check that there is 5V between pin 14 and pin 5 of IC1's socket. If this is correct, switch off power and insert IC1.

Adjustments

The trimpot is adjusted so that the voltage between TP4 and TP GND is 2.5V when the thermistor is at 25°C. Alternatively set it for 2.8V at 30°C or 2.2V at 20°C.

Both the timeout and dT/dt values are adjustable and these are changed using trimpots VR1 and VR2. Test points have been included to allow

Parts List – Power Tool Charger Controller

1 PC board, 78 x 46mm, coded 14112061
1 plastic utility box, 83 x 54 x 31mm
1 momentary pushbutton PC mounting switch (S1)
1 3.5mm PC-mount stereo socket
1 3.5mm panel mount mono socket (installed within power tool for the NTC thermistor)
2 3.5mm mono line jack plugs
2 2.5mm DC line plugs
2 2.5mm DC sockets, PC mounting
1 18-pin IC socket
1 3-way DIL header
3 jumper shunts
1 NTC thermistor (10kΩ @ 25°C) Jaycar RN-3440 or equivalent (installed in battery pack)
2 10mm M3 tapped brass spacers
2 5mm M3 countersunk screws
2 M3 screws
2 1mm spacers (washers)
1 1m length of single-core shielded cable
1 1m light-duty figure-8 cable

Semiconductors
1 PIC16F88P microcontroller (IC1) programmed with CHRGCONT.ASM
1 STP45NF06L logic-level Mosfet (Q1) (or IRF540 – see text)
1 LM317T adjustable 3-terminal regulator (REG1)
2 3mm red LEDs (LED1 & LED2)
1 3mm green LED (LED3)
1 1N4004 1A diode (D1)

Capacitors
1 220μF 50V PC electrolytic
1 100μF 16V PC electrolytic
1 10μF 16V PC electrolytic
2 100nF MKT polyester (0.1μF) (code 104 or 100n)

Resistors (0.25W, 1%)

1 1kΩ	3 470Ω	1 120Ω
1 47Ω	1 10Ω	

1 500Ω horizontal trimpot (VR5)
3 10kΩ horizontal trimpots (VR1-VR3)
1 20kΩ horizontal trimpot (VR4)

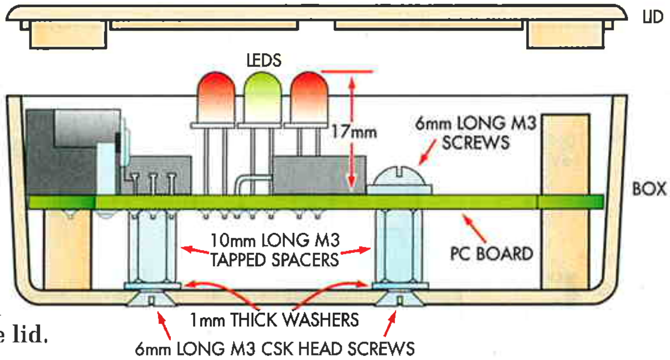


Fig. 5: the PC board sits 11mm up from the bottom of the case with the tops of the LEDs 17mm above the board so they just poke through the lid. The "start" pushbutton switch (not shown here) is below the lid surface, accessed through a hole in the lid.

pin 13 is pulled to 5V via an internal pullup resistor within IC1 With LK1 in, pin 13 is tied to ground.

Links LK2 and LK3 work in a similar manner, with LK2 enabling the top-up and trickle charge when inserted. LK3 increases the top-up and trickle current setting by a factor of 5 when inserted.

Switch S1 is a normally-open push-button type. When open, input RB0 is pulled high via an internal pullup resistor. When the switch is pressed, RB0 is taken to 0V and the charge timing begins its cycle. The software code provides switch debouncing, mainly to prevent a false initiation of the charge cycle. When RB0 is taken low, there is a short delay before the port is checked again. If it is still low, then the software waits for a further delay and rechecks. If it is still low the software assumes that the switch has been pressed. If RB0 is at 5V after any of the delay periods, it is assumed that the switch was not pressed.

Outputs RB1 and RB2 drive the charging and thermistor LEDs respectively via 470Ω resistors. The Power LED is driven directly from the 5V supply via its 470Ω resistor.

Mosfet Q1 is driven from IC1 output RB3 via a 10Ω gate resistor. When Q1 is on, then the cells can be charged because the negative side of the charger is effectively connected to ground.

During the main charge, RB3 is taken to 5V and Q1 is always switched on. However, during the Top up and Trickle modes of charge, RB3 can provide a PWM (pulse width modulation) signal with a reduced duty cycle, so that the Mosfet is only switched on for a small proportion of the time, therefore average current is also reduced. RB3 is pulsed at about 30Hz.

The specified STP45NF06L Mosfet is a logic-level device that is fully switched on with a 5V gate voltage (standard Mosfets require around 10V of gate voltage in order to fully switch on).

An IRF540 can also be used because it switches on fully for gate voltages over 4.5V.

Power for the circuit is taken directly from the original plugpack supply for the charger via diode D1. This provides reverse polarity protection for the following capacitor and regulator. Note that this diode will not protect against reverse charging of the battery – therefore the original charger (ie, supplied with the cordless tool) should be used.

As per the labelling, the charger plugpack output should be connected to the plugpack input socket and the "to charger" output socket should be connected to the charger. In this way power for the Charger Controller is taken from the plugpack. If the connections are reversed, the Charger Controller will still operate but the battery will be discharged over time because it will be supplying power to the Charger Controller.

An LM317T is used to supply a regulated 5V supply. This was chosen in preference to a standard 5V regulator for two reasons.

Firstly, this adjustable regulator can be adjusted to supply a precise 5V to make the settings of VR2 and VR3 more accurate. Secondly, the LM317T can accept a 45V input (when the output is 5V) compared to 35V for a standard 5V regulator.

The extra voltage that the input can accept may be needed for an 18V battery pack. A high voltage is also specified for the 220μF capacitor at the IN terminal of REG1.

REG1 is an adjustable regulator that has a nominal 1.25V between the out and adjust pins. If a 120Ω resistor is placed between these pins then there will be a current flow of about 10.42mA. This current flows in VR5 and will raise the output voltage to 5V when set at 360Ω. This is because 10.42mA x 360Ω = 3.74V. When we add this voltage to our original 1.25V between the out and adjust terminals we get 5V.

Note that the tolerance of the regulator output to adjust pin voltage is between 1.2V and 1.3V. As well, a nominal 50μA current flows out of the adjust pin and this can affect the

Here's a view of the Charging Controller before the lid/panel was screwed on.

From the left, thermistor 3.5mm jack socket and the DC sockets for output to charger base and plugpack input.

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.

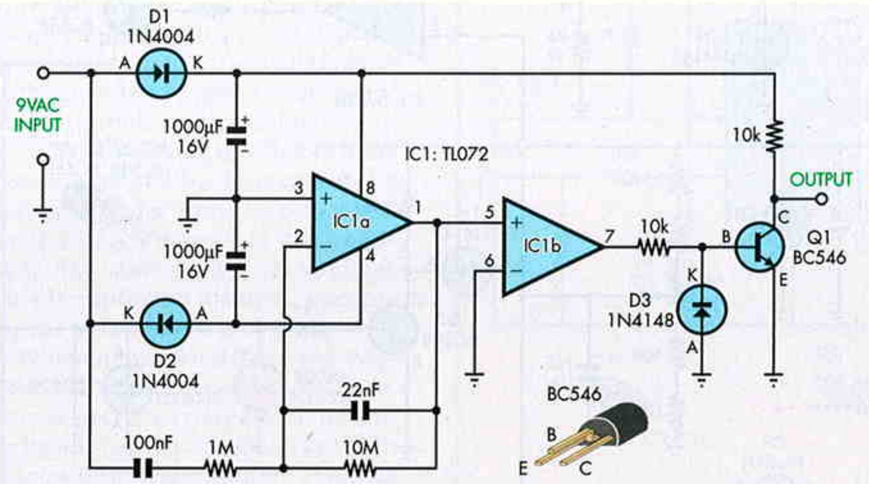


Fig.1: an integrator based on op amp IC1a forms the heart of the circuit.

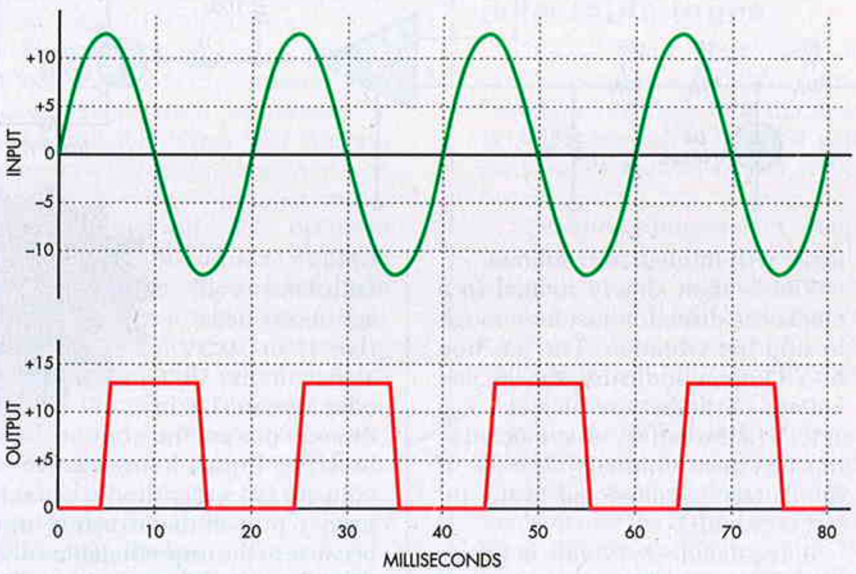
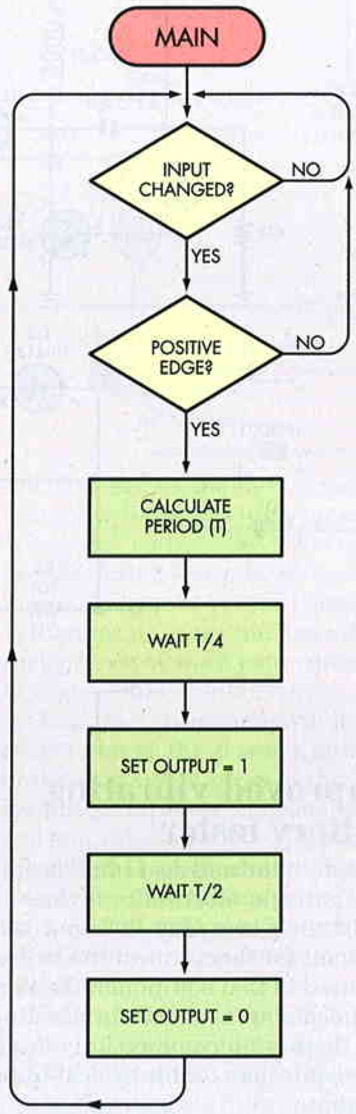


Fig.2: this diagram shows the input (green) and output (red) waveforms.



Mains zero-crossing recovery

This circuit (Fig.1) is a response to a request from K. R. in Mailbag, May 2006, who asked how a PIC microcontroller could be used to detect the zero crossing points on a 50/60Hz mains signal that is badly distorted at zero crossings.

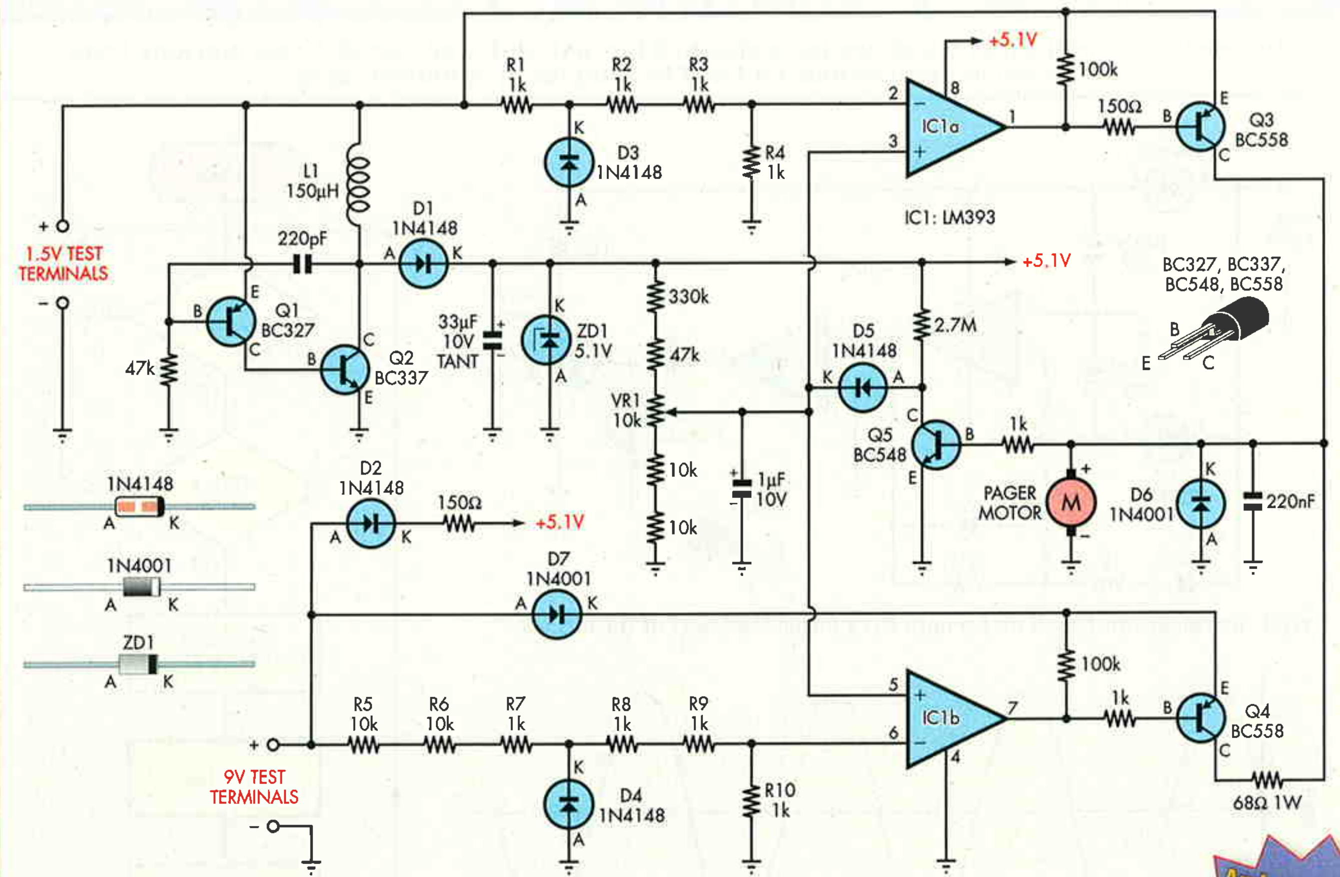
The input signal is derived from a 9VAC adaptor, which also supplies power to the circuit. Op amp IC1a and associated components form an integrator that also operates as a low-pass filter, greatly reducing the effects of high-frequency noise.

IC1b and Q1 square up the waveform so that the output can be fed to a microcontroller if desired. The output lags the input by 90° (reversing the input connections to IC1b reverses the phase). The microcontroller could be programmed to introduce a delay to produce zero phase synchronisation, as outlined in the accompanying flow chart.

Alternatively, a 0/180° phase output can be achieved with a 4046 (not shown) operated in XOR phase-locked loop mode. The 4046 oscillator may need to be adjusted to give a precise zero-phase lock, if this is a critical requirement.

Note that IC1a's input is AC-coupled via a 100nF capacitor to negate the effects of input leakage currents. This has a minor effect on output phase and in most cases can be omitted.

Herman Nacinovich, Gulgong, NSW. ($40)



Improved vibrating battery tester

Many blind and deaf-blind people use portable electronic devices to assist their everyday lives but it is difficult for them to test the batteries used in that equipment. Talking voltmeters are available for the blind but there is no commercially available equivalent usable by deaf-blind persons.

This device enables blind, deaf-blind and sighted people to test batteries. It will test AAA, AA, C and D cells, as well as 9V "transistor" batteries. All rechargeable and non-rechargeable cell types are supported. The circuit needs no calibration and is cheaper to build than my design in Circuit Notebook in September 2002.

To use the tester, turn potentiometer VR1 fully counter-clockwise and then connect the battery to be tested to the appropriate set of test terminals. If the battery has any usable charge, the pager motor in the tester will immediately vibrate.

VR1 is then slowly rotated in a clockwise direction just far enough to stop the vibration. The position of VR1 then indicates the loaded voltage of the battery on a scale of 1-1.5V (if the battery is connected to the 1.5V test terminals) or 6-9V (if the battery is connected to the 9V test terminals).

A regulated +5.1V rail is generated from the battery under test with the aid of zener diode ZD1. For 9V tests, a 150Ω resistor limits the zener current, while diode D2 protects the circuit from reverse polarity battery connection. For 1.5V tests, a blocking oscillator formed by Q1, Q2 and L1 steps up the battery voltage before it is applied to the regulator. This configuration works reliably with inputs down to below 0.9V. The output of the oscillator is rectified by D1 and smoothed by the 33μF capacitor.

The circuit has to survive reverse connection of the battery under test. This creates a problem, because the LM393 cannot withstand a voltage more negative than -0.3V at its inputs. Diodes D1 and D2 indirectly protect the non-inverting inputs from negative voltages but series diodes cannot be used to protect the inverting inputs because of the unpredictable voltage drop they introduce.

Andrew Partridge is this month's winner of a Peak Atlas Test Instrument

The solution used is to shunt negative voltages at the 1.5V test terminals with diode D3 in conjunction a 1kΩ resistor (R1). D3 limits the voltage at its cathode to about -0.7V, while resistors R2-R4 divide this by three to give no less than -0.23V at the inverting input (pin 2) of IC1a.

When the battery is connected the right way around, D3 is reverse-biased and R1-R4 form a voltage divider that applies a quarter of the battery voltage to IC1a's inverting input. Similarly, D4 and R5-R10 protect the inverting input (pin 6) of IC1b from reverse-connected batteries at the 9V test terminals. However, in this case only 1/24th of the battery voltage appears at IC1b's inverting input.

Battery voltages in the range 1-1.5V at the 1.5V test terminals will therefore produce 0.25-0.375V at the inverting input of IC1a, while battery voltages in the range 6-9V at the 9V test terminals will produce 0.25-0.375V at the inverting input of IC1b. Potentiometer VR1 forms part of a voltage divider used to generate a comparison voltage that is variable over the same 0.25-0.375V range. This is applied to the non-inverting inputs of both IC1a and IC1b.

When the sampled battery voltage exceeds this comparison voltage, the respective comparator output swings low, switching on Q3/Q4 to energise the pager motor. The 68Ω resistor in the collector circuit of Q4 ensures that higher battery voltages do not overdrive the motor.

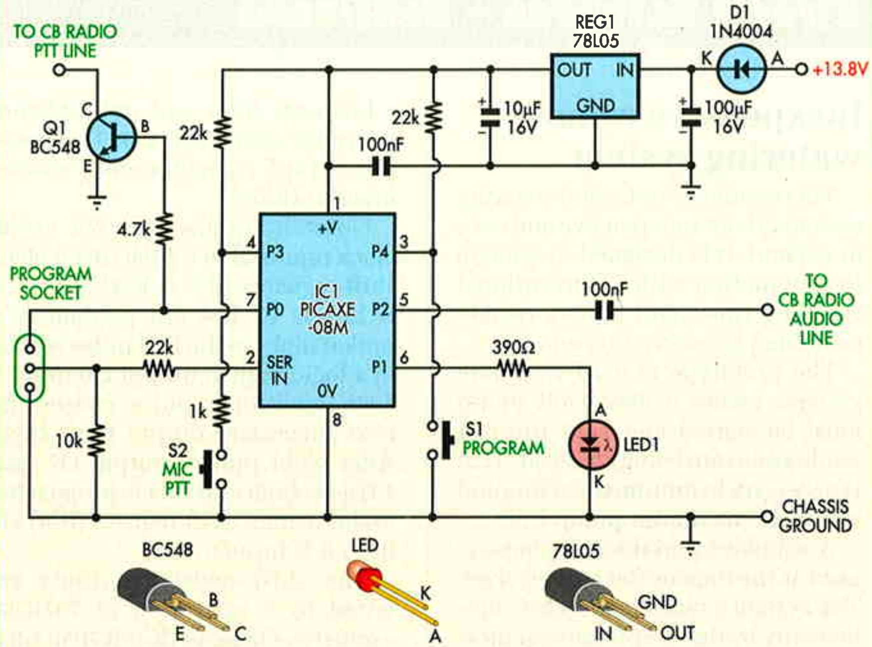
When testing an earlier version of this circuit with batteries that have high internal impedance, it was found that when VR1 was advanced to the indicating point, the pager motor slowed down rather than switched off. This occurred due to a rebound in battery voltage at motor switch-off, which in turn caused the circuit to immediately switch the motor back on again. To counteract this effect, a small amount of positive feedback is applied around the comparators when the motor switches off. The feedback is disabled while the motor is running so that the indicating point of VR1 is not affected.

This works as follows: when the motor is running, Q5 is conducting and D5 is reverse biased, so the comparison voltage at the non-inverting inputs of the comparators is not affected. If the motor stops running, Q5 switches off and the 2.7MΩ resistor pulls the comparison voltage higher via D5 to ensure that the resulting battery voltage rebound does not restart the motor.

Finally, diode D7 prevents reverse breakdown of Q4 in case of reverse battery connection at the 9V terminals. There is no need for a similar diode in the 1.5V part of the circuit because 1.5V is well below the reverse breakdown voltage of Q3. The prototype used "Magtrix" magnetic connectors on short flexible leads as the 1.5V test terminals. These allow the connection of AAA, AA, C and D cells but are arranged so that they cannot be brought closely together enough to connect 9V types. Unfortunately, magnetic connectors cannot be used for the 9V test terminals because some brands of 9V batteries have non-magnetic terminals. A conventional 9V battery snap can be used instead.

For blind people, the knob on VR1 should be pointer-shaped (eg, DSE P-7102) so that the degree of rotation can be easily assessed by touch.

Andrew Partridge,
Kuranda, Qld.



CB radio beeper with selectable tones

This CB radio "roger beep" circuit features 10 selectable tones, is based on a PICAXE-08M micro and is simple enough to be constructed on a small section of prototyping board.

The microphone's PTT switch must be wired to *input3* (P3) of the PICAXE micro. When the switch is closed, the BASIC program immediately sets *output0* (P0) high, switching on transistor Q1 and keying the transmitter.

When the PTT switch is released, the PICAXE program plays the currently selected tune, which is injected into the radio's audio input via a 100nF coupling capacitor. The transistor is then switched off to release the radio's PTT input and terminate the transmission.

When powered up, no tune is selected and so the radio operates normally. To select a tune, press the "program" switch (S1). This lights the LED for 1.5 seconds, after which the switch can be pressed between 1-10 times to select the tune. After each press, you must pause until the LED goes out (about 0.5s).

Once the program switch has been pressed the desired number of times, a single press of the PTT switch completes the sequence and the selected tone will play. If the switch is pressed more than 10 times, the LED flashes to indicate an error. The LED also functions as a transmit indicator during normal operation.

Unfortunately, the PICAXE program (ROGER_BEEP.BAS) is too large to be reproduced here but it can be downloaded from the SILICON CHIP website.

K.Howell,
Renmark, S.A. ($40)

Inexpensive remote watering system

This remotely controlled watering system is both inexpensive and easy to expand. It is designed to operate in conjunction with a conventional watering timer and allows remote switching between nine zones.

The prototype is used in a bore system, where a deep-well pump must be started and kept running while zones are being changed. This is necessary to minimise cycling and results in maximum pump life.

A standard portable telephone is used as the transmitter and receiver. The system's range is therefore limited only by the telephone specifications. The prototype uses an Audioline model CDL1A, set to pulse-dial mode via a switch in the side.

Selecting zones from the telephone keypad couldn't be simpler. For the first nine zones, each key number (1-9) corresponds directly to a zone number. If additional zones were added to the basic circuit, "0" would represents zone 10, while further zones are "dialled-in" by simple addition. For example, to select station 15, you'd press "0" and then "5".

Looking now at the circuit, the telephone base station is wired to one input of a hex Schmitt-trigger inverter (IC5a), which functions as a low-pass filter and pulse shaper in conjunction with two 1kΩ resistors, a 10μF capacitor and a second inverter (IC5c).

Glitch-free pulses are fed to the clock inputs of two 74HC164 8-stage shift registers (IC3 & IC4). The A & B inputs of IC4 are permanently pulled high, so the first pulse results in a logic high at output O0 (pin 3). Each additional pulse causes the next successive output to go high. After eight pulses, output O7 (pin 13) goes high and this is propagated to the second shift register (IC4) via its A & B inputs.

The shift register outputs are wired to a collection of 74HC86 exclusive-OR gates (IC6-IC8) in such a way that only one of the 74HC86 outputs can be high at a time. For example, after three clock pulses, outputs O0-O3 of IC4 are high, which results in IC7c's output going high. The exclusive-OR gates feed a pair of ULN2001A Darlington drivers (IC9 & IC10), which in turn drive relays to switch power to the water solenoids.

If a wrong key is pressed at the remote end and 10 pulses arrive at the shift register inputs, output O1 of IC3 will go high, triggering both 555 timers (IC1 & IC2) via inverter IC5e. The 555s are configured as monostables, so their outputs immediately swing high.

IC2 resets the shift registers, returning all outputs to their initial (low) state. The reset signal is held for about three seconds, which ensures that any number of additional pulses (within reason) above the maximum of nine will be ignored.

In the meantime, IC1 energises one of the water solenoids via diode D2 and the zone #1 driver circuit. This solenoid is held on for about 20 seconds, giving sufficient time for the number to be redialled after the 3-second redial "hold-off" period. This solenoid "hold-on" period is important as it prevents overheating of the pump motor that might otherwise occur without continuous water flow.

The circuit operates from +5V, which is generated by a conventional bridge rectifier (BR1), filter and regulator arrangement. 24VAC for the water solenoids is obtained from the water system timer transformer and is external to this circuit.

Editor's note: for the "sorry, wrong number" feature to be effective, some form of operator feedback would be required if all of the sprinklers are not visible. Perhaps a siren could also be driven by IC1's output to alert the operator that a valid sector number must be dialled within 20 seconds!

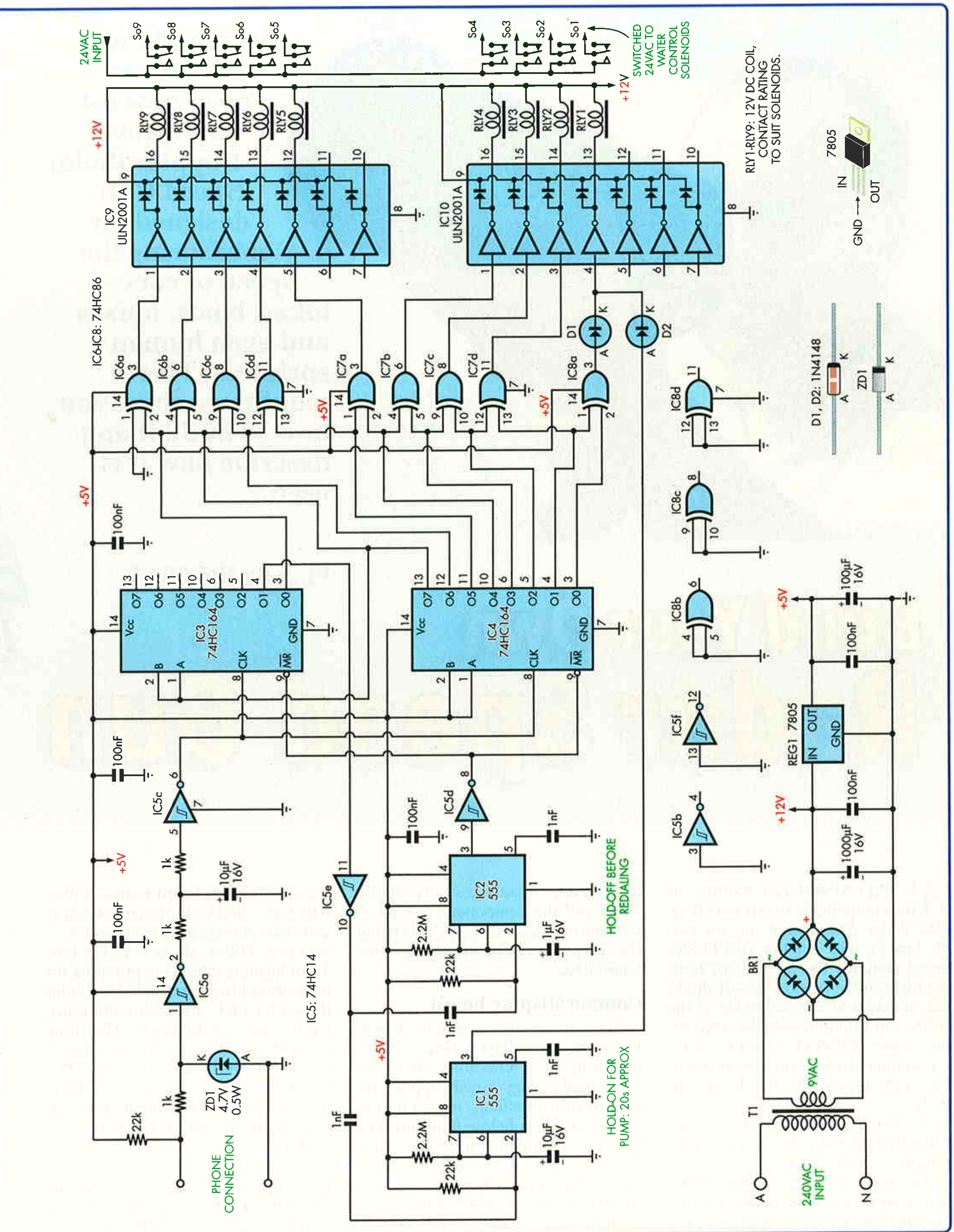
Francis Egan,
Kew, Vic. ($60)

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 silicon@siliconchip.com.au or post it to PO Box 139, Collaroy, NSW 2097.


24VAC INPUT
SWITCHED 24VAC TO WATER CONTROL SOLENOIDS
RLY1-RLY9: 12V DC COIL, CONTACT RATING TO SUIT SOLENOIDS.
IC9 ULN2001A
IC10 ULN2001A
IC6-IC8: 74HC86
IC3 74HC164
IC4 74HC164
IC5: 74HC14
IC1 555
IC2 555
HOLD-OFF BEFORE REDIALING
HOLD-ON FOR PUMP: 20s APPROX
PHONE CONNECTION
ZD1 4.7V 0.5W
D1, D2: 1N4148
REG1 7805
9VAC
240VAC INPUT

Last month, we unveiled our new low-cost microwave Doppler Radar Speed Gun, designed for measuring the speed of cars, bikes, boats, horses and even human sprinters. This month, we show you how to build it and describe how it is used.

Pt.2: By JIM ROWE

Build Your Own Radar Speed Gun

AS EXPLAINED last month, all the components in our new Doppler Radar Speed Gun are on two PC boards. The smaller DOPPLER1 board contains the microwave head circuitry and fits inside a small shield box attached to the underside of the coffee-can antenna barrel. By contrast, the larger DOPPLER2 board carries the counter/display unit circuitry and fits inside a standard UB1 plastic utility box.

The two units are linked by a single cable that's fitted with a Type A USB plug at each end.

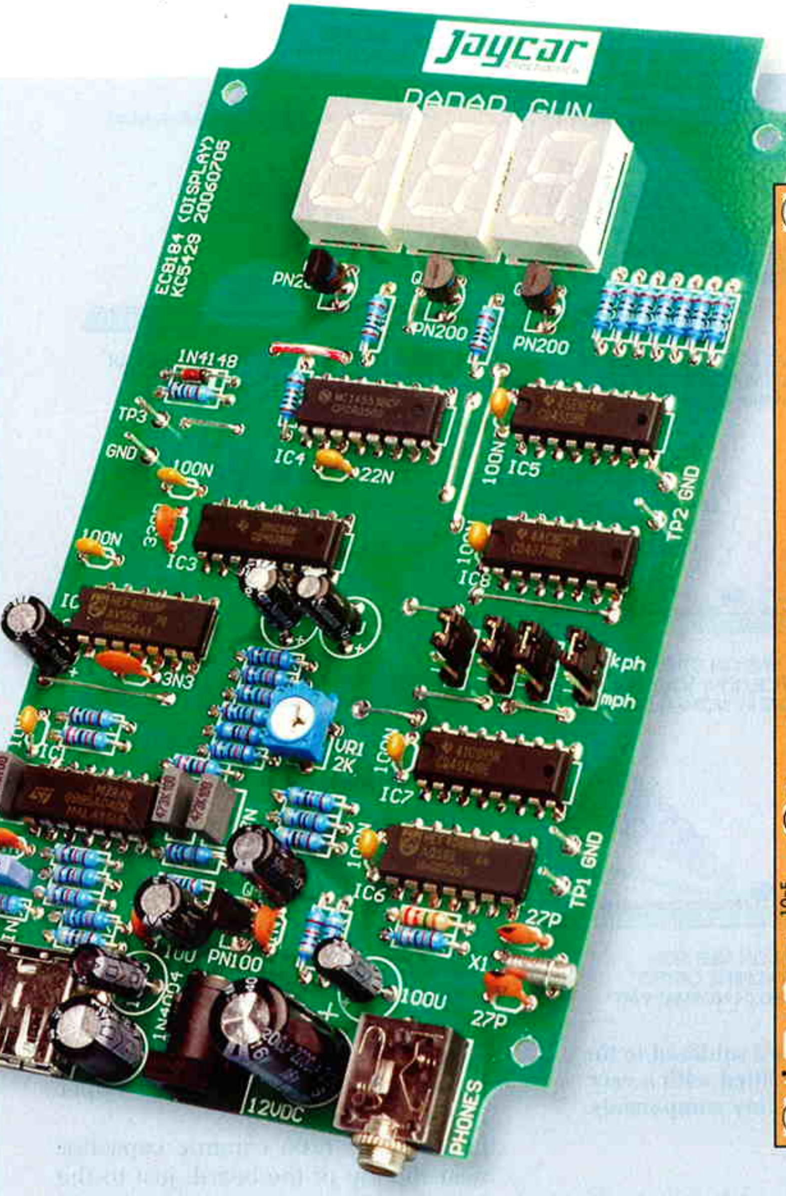
Although the larger DOPPLER2 board has more components on it than the smaller board, it's a little easier to assemble because it's only single-sided and the components are all of the familiar "leaded" type. This being the case, we're going to assemble this board first.

Counter/display board

Fig.5 shows the assembly details for the counter/display board. Begin by fitting the 12 wire links. These can all be made using tinned copper wire or resistor lead offcuts, except for the one located just below transistor Q3. This link should be made from a short length of insulated hookup wire, because it runs quite close to a lead from the 1kΩ resistor just below it.

Once all the links are in place, fit the six 1mm PC board terminal pins which are used for the three test points and their accompanying ground connections. Follow these with the four 3-pin headers which are provided for reprogramming the timebase divider links LK1-LK4, just below the right-hand centre of the board. The three connectors along the bottom edge of the board can then go in – ie, CON1 (the USB Type A connector), CON2 (the mini stereo headphone jack) and CON3 (the concentric DC input connector).

Now fit the IC sockets, taking care to orientate each one with its "notch" end towards the left, as shown on the overlay diagram. This will help ensure



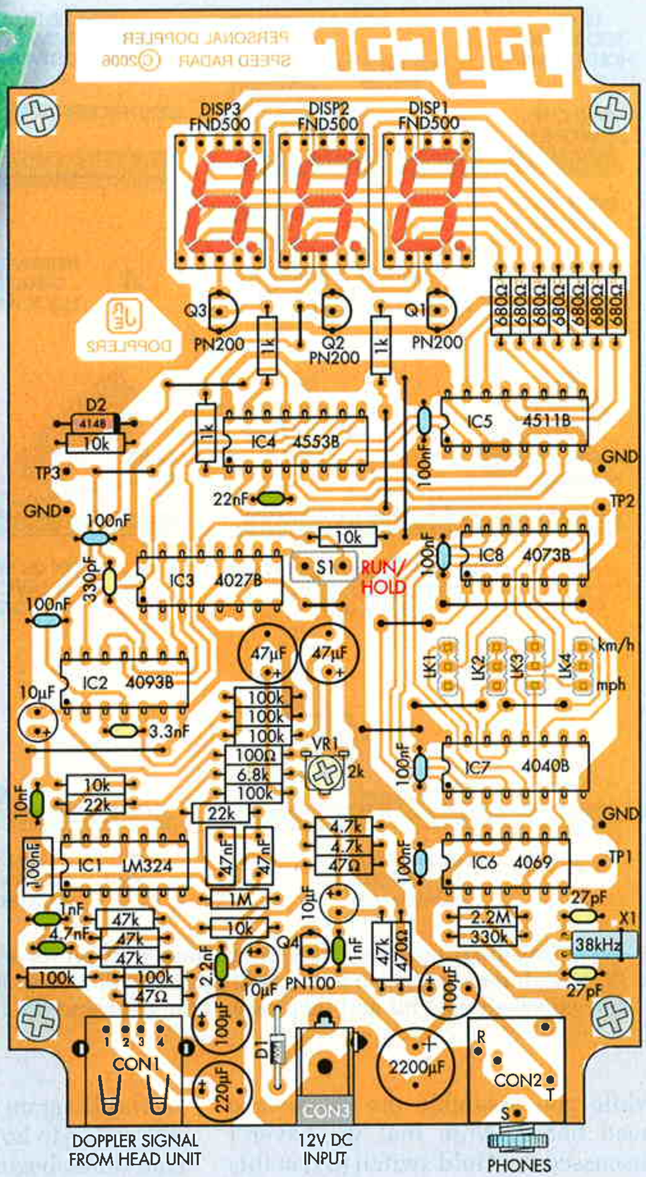


Fig.5 (right): install the parts on the counter/display board as shown here. Above is the completed prototype, which has since been modified to include the Hold/Run switch facility.

that you later fit the ICs the correct way around.

The resistors can go in next, followed by trimpot VR1. Be sure to fit the correct value resistor in each location. Table 1 shows the resistor colour codes but we also recommend that you check them using a digital multimeter, as some of the colours can be difficult to decipher.

The small ceramic, monolithic and metallised polyester capacitors can now all be mounted. These capacitors are all non-polarised, so they can be fitted either way around. Follow them with the electrolytics which are of course polarised, so take care to fit them with the correct orientation.

That done, fit the 38kHz crystal (X1). As shown on Fig.5, this mounts on its side, with both leads bent downwards about 2mm from the case so that they pass through the holes in the PC board. Solder its leads to the pads underneath, then fit a small U-shaped piece of tinned copper over the crystal's case to secure it in position (the ends of the wire "U-loop" are soldered to matching pads on the the board).

Now for the semiconductors. Begin with the two diodes, taking care to install them with the correct orientation. Also, be sure to use the 1N4004 power diode for D1 and the smaller 1N4148 diode for D2.

Follow these with three 7-segment LED displays. These must all be orientated with their decimal point LEDs (which we don't use here) at lower right. The four transistors can then go in – the PN100 device goes in the Q4 position (near the bottom of the board), while the three PN200 devices go in the Q1-Q3 positions below the displays.

Finally, plug the eight ICs into their sockets, taking care to ground both yourself and the PC board earth before handling them. This is necessary because most of the ICs are CMOS devices and are vulnerable to damage from electrostatic discharge.

Your counter/display board is now finished and can be placed aside

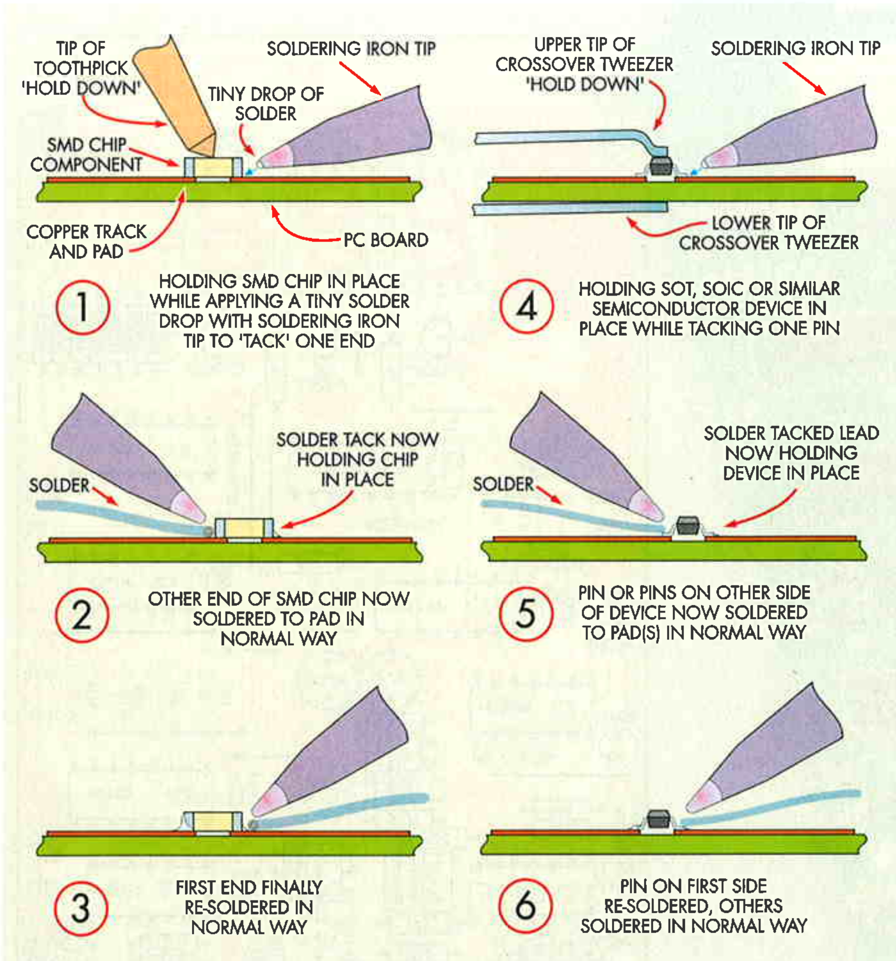


Fig.6: this diagram shows how the various SMD parts are soldered to the PC board. Be sure to use a temperature-controlled iron fitted with a very fine chisel-shaped bit and take care not to overheat the tiny components.

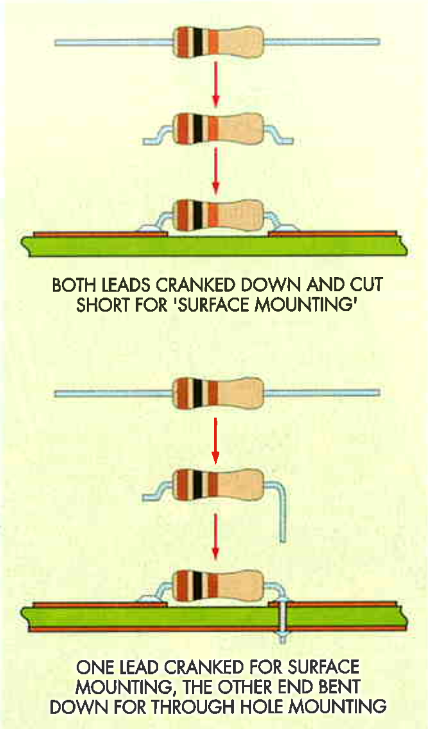


Fig.7: the leaded resistors are soldered to the PC board as shown here.

while you assemble the microwave head board. Note that we haven't discussed the Hold switch (S1) at this stage, because it mounts on the box lid and is only connected to the display board later.

Microwave head board

This second board is considerably smaller than the first but is more challenging because about half of the components on it are small surface-mount devices. It's also double sided but this shouldn't cause you any problems because the board supplied in the kits will have plated-through holes and solder masking on both sides.

Only one component mounts on the underside of the board – the Type A USB socket. Everything else mounts on the top of the board, because virtually all of the underside copper is used as an earthed ground plane and shield.

Before you begin fitting any components to this board, examine the overlay diagram of Fig.8 to familiarise yourself as to how it all goes together. That done, begin the assembly by fitting the surface-mount (SMD) parts.

To do this, you'll need a soldering iron with a very fine chisel-shaped tip, which you need to keep particularly clean. Ideally, it should also be a temperature-controlled iron, so it doesn't get too hot and damage the tiny components. In addition, you'll need a small pair of crossover tweezers to handle the SMD parts and a wooden toothpick to hold each part down while you solder it in position.

You'll also find an illuminated magnifier a big help – especially if it's on the end of a spring-loaded arm, so you can place it in just the right position above the PC board.

By the way, manually soldering SMD parts in place isn't all that difficult if you tackle them carefully and one at a time. Fig.6 shows how to solder both passive and active SMD parts to a PC board.

You should fit the SMD parts to the head-end board in the following order:

(1) the 100Ω 0805 resistor at upper right;
(2) the 1nF 1206 ceramic capacitor near the top of the board, just to the left of centre;
(3) the five 10nF 1206 ceramic capacitors;
(4) oscillator transistor Q1 (this must be orientated with its "fatter" collector lead at upper right);
(5) mixer diode D1, orientated with its "two-lead" side towards the antenna microstrip line on its right;
(6) the ERA2-SM microwave amplifier chip (IC1), orientated with its locating dot and diagonal-cut end (pin 1) towards the bottom of the board;
(7) RFC1, the UHF choke, which is the largest of all the SMD devices (orientated with its pin 1 identification dot at lower right).

That completes the trickiest part of the board assembly and you should now be ready to fit the rest of the parts.

Begin this second phase by fitting the USB connector, which mounts on the underside of the board. It's fitted in the normal way by carefully pushing

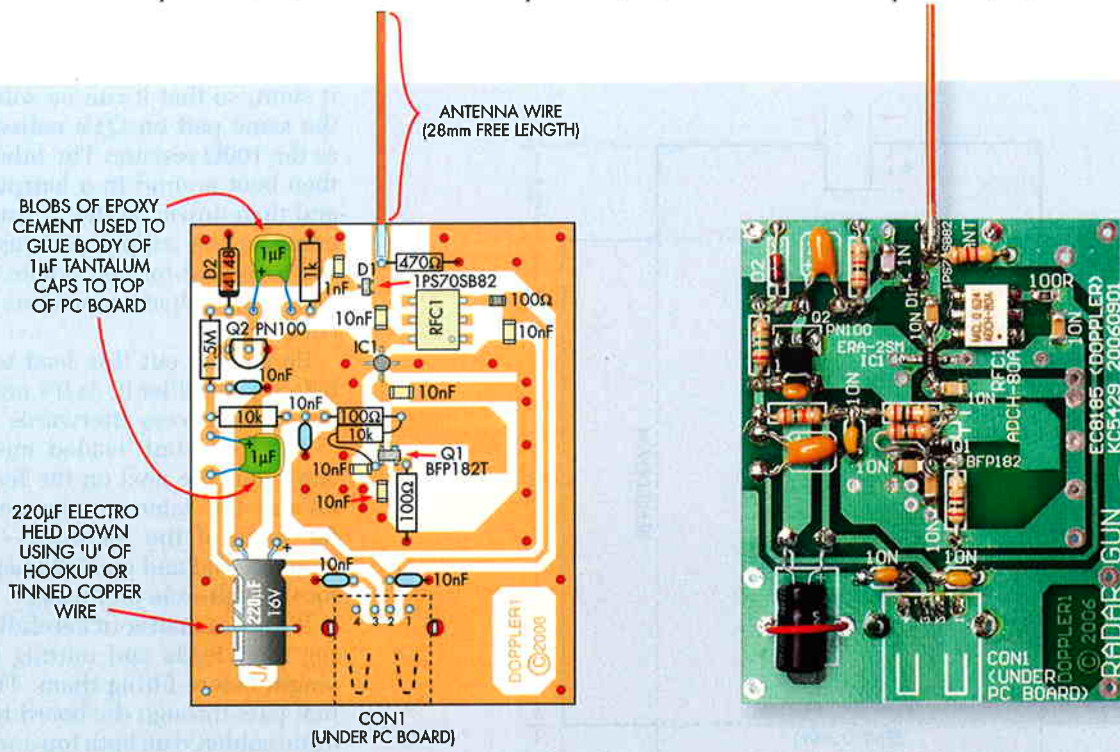


Fig.8: the microwave head board carries quite a few surface mount devices (SMDs) and these should be mounted first, as described in the text. The USB connector mounts on the underside of the board.

all its connection leads and mounting clips through the matching board holes, then soldering them to the pads on the top of the board.

Next, fit the leaded resistors but note that most of these are mounted in a slightly unorthodox way – either with both end leads cranked down and cut short for "surface mounting" or with only one lead dressed this way and the other bent down in the usual way to pass through a board hole.

Fig.7 shows how the leads are prepared and the resistor fitted to the PC board in each case.

Start with the resistors that are fitted with one end passing down through the board hole. These are: (1) the 100Ω resistor which connects the emitter of Q1 to ground; (2) the 1kΩ load resistor for mixer diode D1; and (3) the 470Ω DC return resistor between the antenna microstrip line and ground.

In all three cases, it's the lead at the "earthy" end of the resistor which passes down through the board hole. These leads are then soldered to the copper pads on both sides of the board. In contrast the "cranked down" leads at the other ends of these resistors are soldered only to the pad on the top layer.

The remaining "leaded" resistors can now be installed. Three of these have both leads cranked down as at the top of Fig.7 – ie, the 10kΩ collector load resistor for Q2, the 1.5MΩ bias resistor for Q2 and the 100Ω collector resistor for Q1.

The last leaded resistor to fit is the 10kΩ bias resistor for Q1, which is fitted in a different way again. As shown in Fig.8, this resistor is fitted alongside the 100Ω collector resistor. One lead is bent down and over before cutting

Table 1: Resistor Colour Codes

❏	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❏	1	2.2MΩ	red red green brown	red red black yellow brown
❏	1	1.5MΩ	brown green green brown	brown green black yellow brown
❏	1	1MΩ	brown black green brown	brown black black yellow brown
❏	1	330kΩ	orange orange yellow brown	orange orange black orange brown
❏	6	100kΩ	brown black yellow brown	brown black black orange brown
❏	4	47kΩ	yellow violet orange brown	yellow violet black red brown
❏	2	22kΩ	red red orange brown	red red black red brown
❏	6	10kΩ	brown black orange brown	brown black black red brown
❏	1	6.8kΩ	blue grey red brown	blue grey black brown brown
❏	2	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❏	4	1kΩ	brown black red brown	brown black black brown brown
❏	7	680Ω	blue grey brown brown	blue grey black black brown
❏	2	470Ω	yellow violet brown brown	yellow violet black black brown
❏	3	100Ω	brown black brown brown	brown black black black brown
❏	2	47Ω	yellow violet black brown	yellow violet black gold brown

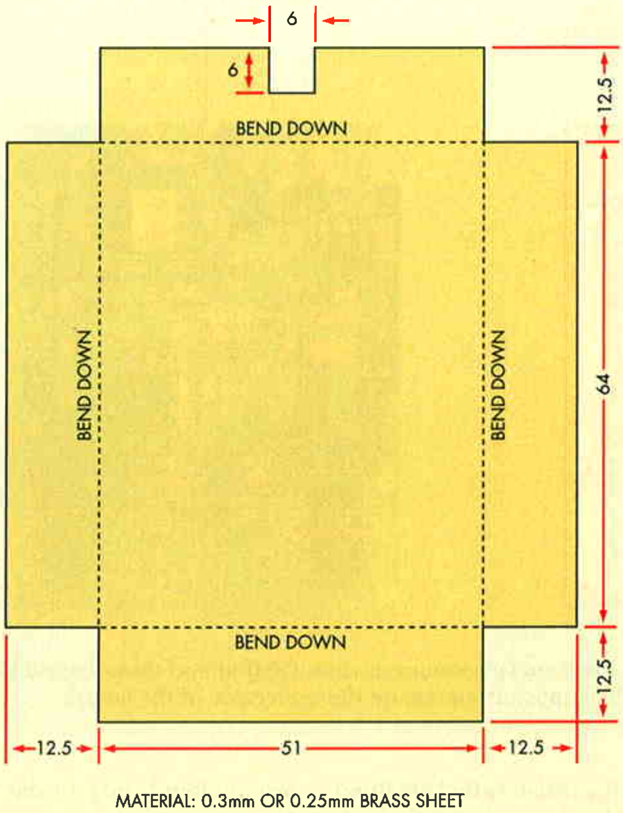


Fig.9: the shield box which encloses the microwave head board is made from a rectangular piece of 0.3mm or 0.25mm-thick brass sheet. Cut it out as shown in this diagram and fold down the sides to form the box.

it short, so that it can be soldered to the same pad on Q1's collector line as the 100Ω resistor. The other end is then bent around in a hairpin shape and then down, so that it can be soldered to the copper pad just below the base lead for Q1, where the two 10nF SMD bypass capacitors are also connected.

Be sure to cut this lead to length before you solder it, as it's not easy to cut off the excess afterwards.

The four 10nF leaded monolithic capacitors are next on the list. These all use the same arrangement used for some of the resistors – ie, one cranked lead and one lead bent down for through-hole mounting.

It's just a matter of carefully dressing their leads and cutting them to length before fitting them. The leads that pass through the board holes are again soldered on both top and bottom sides of the board.

Diode D2 goes in next and this is fitted in the same way as the resistor shown at the bottom of Fig.7. Make sure that it's the anode lead that passes down through the earthing hole.

Transistor Q2, the PN100 leaded transistor, can now be installed. This is again fitted in an unusual way: its

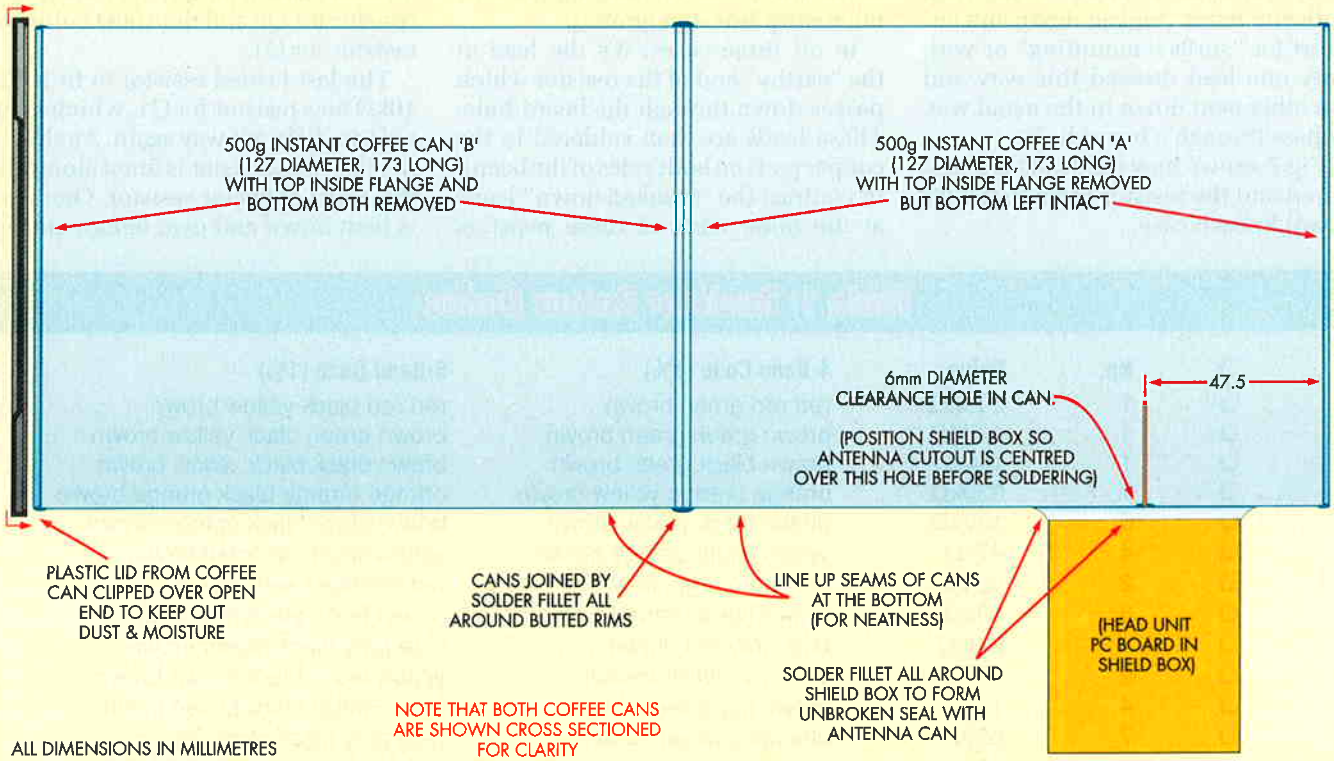


Fig.10: the antenna barrel for the microwave head unit is made from two coffee cans. It's made by first drilling a hole for the antenna in can "A", then soldering the two coffee cans together to form the barrel (see text).

emitter lead passes down through a board hole in the normal way, while the other two leads are bent at right angles about 4mm down from the transistor body, so that they "sit" on the pads on the top of the board in surface mount fashion. After bending them, cut these leads off about 2mm from the bends before soldering them to their respective pads. The emitter lead is soldered to the pads on both sides of the board.

The 220µF electrolytic capacitor mounts on its side in the lower lefthand corner of the board. Before mounting, its leads need to be bent outwards a little, then down through 90°. Its negative lead then passes through a board hole in the usual way (and is soldered at both top and bottom), while its positive lead is bent horizontally again and cut short for "surface mounting" to its pad.

A U-shaped loop of tinned copper wire is then installed over the electro's body, to hold it securely in position.

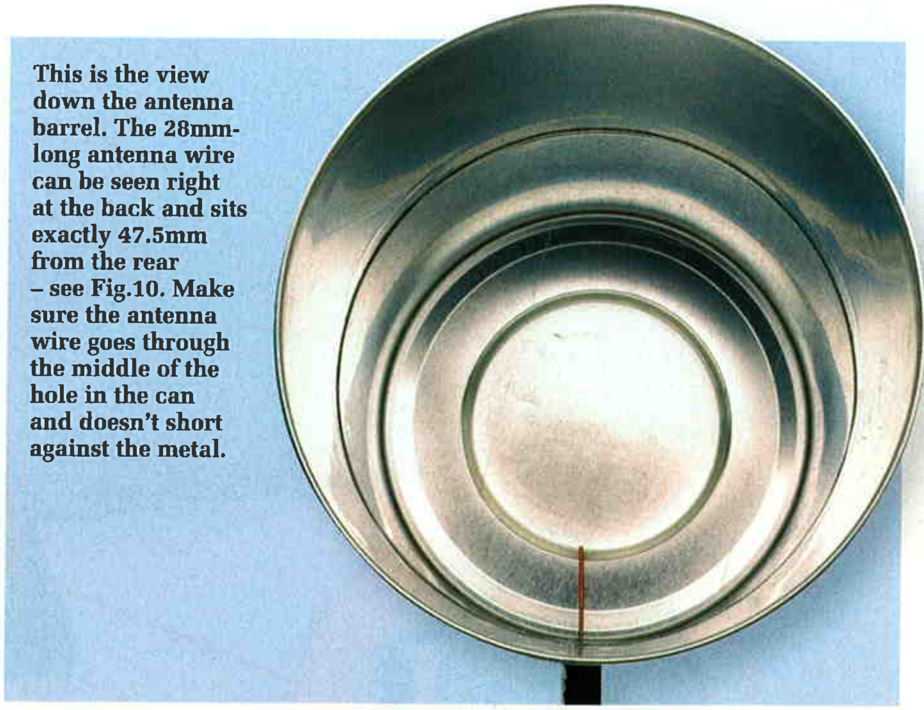
The two 1µF tantalum capacitors are also installed with their bodies flat against the PC board. In both cases, their leads are cranked downwards, for "surface mounting" on the pads below. Be sure to fit them with the correct polarity. Once they're in place, mix up a small amount of quick-setting epoxy cement to hold them securely in place – see Fig.8.

Your microwave head board is now just about complete. All that remains is to attach the antenna wire at top centre. This is made from a 32mm length of 1.3mm enamelled copper wire, with about 4mm of enamel insulation scraped off one end. This "scraped end" is then soldered to the rectangular pad at the top of the antenna feed line, as close to "on-axis" as you can make it.

Finally, check the free length of the wire with a steel rule or vernier calliper and if necessary, trim the far end to bring the free length to exactly 28mm.

Functional check-out

Now that your boards have both been wired up, it's time to give them a quick functional check-out. This is easily done by connecting them together via the USB cable, plugging a pair of stereo headphones into the 3.5mm jack on the counter/display board and connecting a 12V DC supply (positive to the centre pin). The latter can be a 12V bench supply or a 12V battery pack of some kind.



This is the view down the antenna barrel. The 28mm-long antenna wire can be seen right at the back and sits exactly 47.5mm from the rear – see Fig.10. Make sure the antenna wire goes through the middle of the hole in the can and doesn't short against the metal.

As soon as power is applied, the 7-segment LED displays should immediately begin showing a random count. Shortly after this, you'll also begin to hear hum in the headphones and possibly some other noises.

If all is well so far, try moving your hand back and forth near the antenna wire on the microwave head board. You should hear a buzzing sound when you do this, with a pitch that depends on your hand's speed. It will be higher in pitch when your hand is moving faster and lower when it's moving more slowly. And if you watch the LED displays at the same time, they should give a higher reading for fast hand movements too.

If your results are as we've just described, your Radar Speed Gun boards are probably working as they should. However, if there seems to be some kind of problem or you want to make sure, you'll probably want to do some troubleshooting. Here are the things you can try:

(1) With your multimeter set to DC volts, measure the voltage at the cathode (banded) end of diode D1 on the counter/display board. It should be very close to +12V relative to ground.

Use This Device In A Responsible Manner

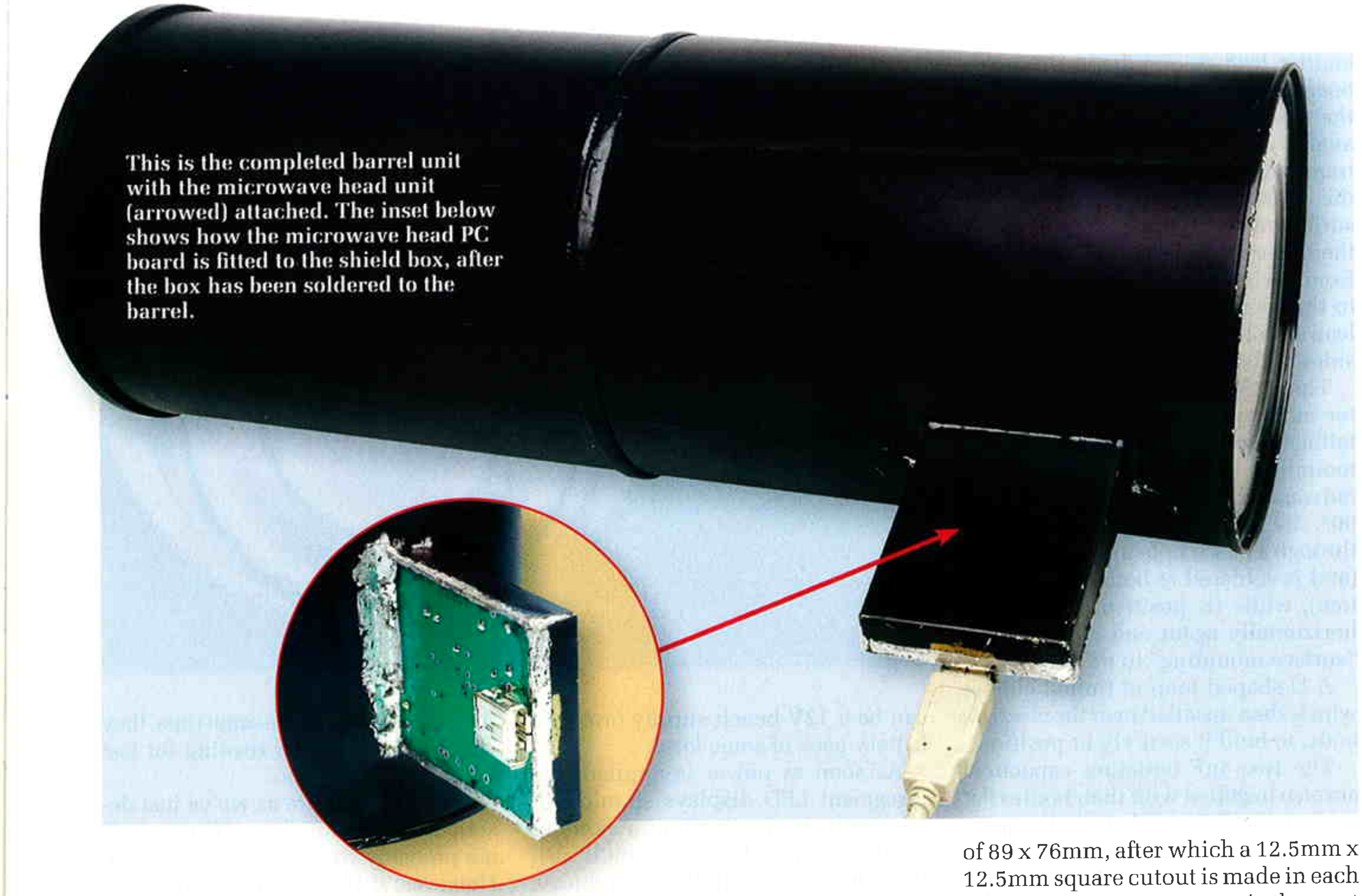
Be sure to use this device in a responsible manner. **In particular, *DO NOT* use this device to measure the speed of vehicles on a public road.**

The main reason for this is that drivers will not know what is being aimed at them, particularly as you will not be in police uniform. That in turn could cause alarm and could even cause some drivers to brake heavily or take evasive action. And if there was an accident, you might be held legally responsible in some way.

Similarly, *DO NOT* let anyone use the Radar Speed Gun in your car when travelling on public roads. This would not only prove distracting for the driver but the microwave radiation from the unit could cause interference to other spectrum users – including the radar speed units used by traffic police.

In any case, the police will probably be able to detect the radiation from your unit and could apprehend and charge you with trying to disturb the operation of their equipment.

In short, to avoid trouble with other motorists and the "boys in blue", use your Radar Speed Gun only on the racetrack, drag strip or in some other private area.



This is the completed barrel unit with the microwave head unit (arrowed) attached. The inset below shows how the microwave head PC board is fitted to the shield box, after the box has been soldered to the barrel.

(2) Check the voltage at pin 14 of IC6 – it should be very close to 11.4V
(3) Measure the voltage across the 220μF electrolytic capacitor on the microwave head board – it should measure approximately +7.5V.

If these voltages all check out correctly, most of the circuitry is probably working correctly.

If you have a oscilloscope, you can check that the crystal oscillator on the counter/display board is working properly by looking at the waveform on test point TP1. You should find a slightly rounded square-wave with a frequency of 38kHz. Alternatively, if you have a frequency counter, it should show the same frequency.

Now transfer your scope probe to TP2. Here you should find a train of fairly narrow positive-going pulses, with a peak-to-peak amplitude of about 11.5V and a frequency of 9.6349Hz if links LK1-LK4 are set for km/h readout. Alternatively, this frequency should be 15.5228Hz if you have cut the tracks and fitted the jumper shunts for mph readout.

These frequencies can also be checked with a frequency counter if you have one.

If all is well so far, transfer your scope probe to TP3 and again move your hand back and forth near the microwave antenna. You should see a train of narrow negative-going pulses, again about 11.5V peak-to-peak. These pulses will only be about 300μs wide and the frequency will depend on the speed that your hand is moving.

If your unit passes these tests, you're ready for the next stage in the assembly – making the head-end shield box.

Making the shield box

The kit for the Doppler Radar Speed Gun will include a rectangular piece of 0.3mm or 0.25mm-thick brass sheet. This is used to make the shield box which encloses the microwave head board – see Fig.9.

The brass sheet is first cut to a size of 89 x 76mm, after which a 12.5mm x 12.5mm square cutout is made in each corner. A 6 x 6mm square is then cut from the centre of one of the narrow ends, as shown. This is the clearance hole for the antenna, when it's all assembled.

When the cutouts have all been made and any burrs filed off, the four sides are then bend down by 90°, corresponding to the dashed lines shown in Fig.9. Make sure that the ends of the sides meet cleanly at each corner. This forms the basic shield box, with the head-end board itself forming the "top" when it's fitted.

To finish the box off, use a high-power soldering iron to run a small fillet of solder down inside each corner. This will ensure that the corners are properly sealed, for both physical strength and shielding. The box can then be placed aside while you make up the radar gun's antenna barrel.

Making the antenna barrel

To make the antenna barrel you'll need two clean tin cans, each measuring 127mm in diameter and 173mm long. These don't come with the kit but they're easy to obtain from your local supermarket because they are the kind used for 500g cans of low-cost instant coffee. They're typically

Where To Buy A Kit

This project was sponsored by Jaycar Electronics and they own the design copyright. Kits will be available from Jaycar stores and dealers.

priced at less than $10 each and that includes the coffee!

That means that you'll end up with one kilogram of instant coffee as well as the two cans. If you transfer the coffee into some jars, you'll have plenty of instant coffee for quite a while!

Note that the cans come complete with a clip-on plastic lid. Be sure to keep at least one of these lids, to use as a dust cover over the open end of the finished barrel.

Once the two cans are emptied, washed and dried, you can proceed to turn them into your antenna barrel. Both need to have their inner top flange removed and this is easily done using a can opener of the type which cuts around the inside of the rim using a sharp wheel. The same opener is then used to remove the bottom of one of the cans, which subsequently becomes the front half of the barrel – ie, can "B" in Fig.9. Don't remove the bottom from the other can though (can "A").

Next drill a 4mm hole in the side seam of the "A" can, with its centre as close as you can make it to a point 47.5mm up from the inside bottom of this can. The easiest way to do this is to first measure the distance inside the can from bottom to top. That done, move your rule to the outside and mark a point on the side seam that is down from the top rim by the total distance less 47.5mm. Finally, centre-punch this point and drill the 4mm hole.

After the hole is drilled, carefully enlarge it to 6mm diameter using a tapered reamer. You should then remove any remaining burrs using a jeweller's needle file or similar.

Next you should remove the lacquer from the outside of this can around this 6mm hole by rubbing it with steel wool soaked in methylated spirit. You should remove the lacquer from a rectangular area about 30mm up and down from the hole (along the seam) and about 12mm on either side, giving a cleaned area about 60 x 24mm. This is where the shield box will later be soldered to the can.

You can now use a heavy-duty soldering iron to solder the bottom rim of can "B" to the top rim of can "A". This simply involves butting them together and running a smooth solder fillet right around the mating joint. Note that it's also a good idea to line up their side seams as well, as this gives a neater end result.

Once you're happy that the two cans are cleanly and securely joined together to form the barrel, the next step is to solder the shield box (empty at this stage) to the side seam "underside" of can "A". Be sure to align the 6 x 6mm end cutout in the shield with the 6mm barrel hole. Again the idea is to run a neat but strong solder fillet around all three outer edges of the box sides. Another solder fillet can then be run along the edge on either side of the 6 x 6mm cutout.

The counter/display unit fits inside a standard plastic case. This case will be supplied pre-drilled and with a screened panel as part of the Jaycar kit.

Your barrel and shield box assembly are now be ready for the final and most delicate stage – that of soldering the head-end PC board assembly into the shield box.

Just before you do this, make sure that the top inside edges of the shield box sides and outer end are clean and free from oil or grease. If you wish, you can tin around these edges but don't leave more than a very thin layer of solder, otherwise you won't be able to slip the PC board into the box for final soldering.

Now take the head-end PC board assembly and turn it over so that the component side is underneath and with the antenna wire at the top. That done, angle the board downwards and pass the antenna wire through the 6mm hole and into the barrel, until the top end of the board meets the end of the shield box. Once it's there, lower the complete board assembly into the shield box, so that its copper groundplane is just below the box lip. It should now stay in this position while you attach it securely inside the box by running a small fillet of solder around the edges.

Here's a useful tip: you'll find this job a lot easier if you position straight lengths of 0.5mm-diameter tinned copper wire inside each edge before you begin soldering. This wire "encourages" the solder to bond across between the PC board copper and the brass inner sides of the box.

It won't be easy to cover the top of the antenna wire hole in the barrel using solder alone. The answer to this is to place a small piece of copper shim over the remaining hole, bent by about 80° in the centre so it forms a patch to seal the hole (it overlaps both the can metal and the PC board's ground plane copper). Solder the edges of this copper patch to both the barrel and the

Watch Out For Spurious Readings

Because the Doppler audio signals produced in the Radar Gun's microwave head are quite low in level, they need a great deal of amplification (between 2000 and 22,000 times) in the counter/display unit to bring them up to a level which can be converted into pulses for reliable counting. This large amount of amplification makes the Radar Speed Gun susceptible to interference from electrical noise and AC hum, which tend to cause spurious readings when it is not aimed at a moving object.

For example, if the amplifier picks up 50Hz hum, this will give a spurious reading of 11km/h. Similarly, 100Hz hum will give a spurious reading of 22km/h, while impulse noise from electric motors, etc, will give different spurious readings.

You'll also find that if you aim the Radar Speed Gun at fluorescent lamps, this too will give spurious readings – but for another reason. The discharge plasma in fluorescent tubes pulses on and off at double the mains frequency – ie, at 100Hz in the case of tubes running from 240V 50Hz. Because some of the Radar Speed Gun's microwave energy is reflected back from the plasma in bursts modulated at this rate, the unit's mixer produces a "false" Doppler frequency of 100Hz. As a result, you'll not only hear a loud 100Hz hum in the headphones but also get a spurious speed reading of 22km/h.

In practice, these spurious signals are not really a problem, since they are swamped by the much stronger return signals received when you aim the unit at a real moving target. Just don't be alarmed if your unit displays 11km/h or 22km/h (or some other figure) while indoors or near a source of electrical interference – that's perfectly normal.

PC board, to complete the shielding around the antenna.

This will ensure that all of the microwave energy passes into the antenna, to be radiated from the barrel.

The antenna barrel assembly should now be complete, although you might want to give it a coat of paint to hide its coffee can heritage. If you decide to do this, carefully place some layers of masking tape (or gaffer tape) all around the USB socket on the back of the shield box, to stop paint from entering the socket. You can then apply the paint to the outside of both the barrel and the shield box, using either a spray can or brush.

Our prototype unit was sprayed using black automotive lacquer.

Final assembly

All that remains now is to mount the counter/display board assembly into its box. The board mounts inside the lid on four M3 x 25mm tapped metal spacers and is secured using M3 x 6mm countersink head screws at the lid ends and roundhead M3 x 6mm screws at the board ends.

Before attaching the board, you need to fit the small rectangle of red perspex supplied with the kit into the cutout in the lid, to form the viewing window. It should be a fairly tight fit and you can secure it by using a drop or two of super glue or contact adhesive behind the edges.

You also need to fit the Hold/Run switch S1 into its rectangular cutout in the centre of the front panel. It pushes through from the front – but make sure that you orientate it so that the '1' on its rocker actuator is towards the left.

That done, turn the panel over and attach a short length of tinned copper wire to each of the connection lugs on the back of the switch. Attach them securely, by looping the end of each wire through the hole in its lug and then compressing the loop with your pliers, before soldering. This will ensure that the joints don't come apart when the wires are soldered to the PC board pads.

The board can now be lowered into position on the spacers, with the switch wires passing through their respective holes in the centre. Secure it using the roundhead M3 x 6mm machine screws, then solder the switch wires and fit the lid in position.

That's it – your Radar Speed Gun is now ready for its final check-out.

Final check-out

The Doppler Radar Speed Gun is simple to use. All you need to do is connect the two parts of the system together using the USB cable, connect a 12V battery pack (or some other source of 12V DC) and plug in a pair of stereo headphones (if you have them).

Within about 20 seconds of power being applied, you'll begin hearing sounds in the headphones, indicating that the Doppler signal processing circuitry has sprung into life and stabilised. After that, it's simply a matter of pointing the antenna barrel at a suitable moving target and holding it steady for a few seconds so the frequency counter's readout can stabilise with the speed reading.

You'll find that the sound in the headphones helps a lot in directing the beam at the vehicle and holding it in the right position. You'll soon get used to identifying the "whooshing" sound produced by the Doppler signals.

Once the speed of the vehicle is being displayed on the counter, you can operate the Hold switch to freeze the reading.

Remember that for the highest reading accuracy, the axis of the Radar Speed Gun's barrel should be aligned as closely as possible with the path of the moving target. Of course, this won't always be possible because you can't stand directly in the vehicle's path! However, if the vehicle is on a racetrack, you might be able to position yourself at the end of the straight, so that you can aim directly at the vehicles coming towards you.

If you can't do this and have to make your measurements at an angle of 25° or 30° to the vehicle's path, you can still work out its speed fairly accurately simply by dividing the readings by a correction factor. This correction factor is simply the cosine of the measuring angle.

For example, if you're making measurements at an angle of 25°, the correction factor will be cos(25) = 0.906. So if you get a speed reading of 110km/h, the vehicle's true speed will be (110/0.906), or very close to 121km/h. Get the idea?

Another thing that can effect the accuracy is movement of the microwave head itself. For the most accurate readings, the antenna barrel should be held as steady as possible. If you find this too difficult, you may want to fit the antenna barrel with a U-shaped metal bracket, so it can be mounted on a photographic tripod. **SC**

→61

SERVICEMAN'S LOG

The 50-year-old AWA TV set

Imagine watching a TV set that's now 50 years old – one that was made long before the introduction of colour TV in Australia! Of course, this particular set has had a few repairs during those 50 years.

Stephen Appleby was only one week old when his parents bought their 1956 AWA 205C (W series) Radiola "Deep Image" lowboy television set. It cost 210 guineas (1 guinea = one pound and one shilling, or £1/1/0), which was an awful lot of money back then (especially for a milkman).

His mother desperately wanted to watch the Melbourne Olympics which were due to start in November that year. What they didn't realise until it was too late was that there was a 3-month waiting list for the set and there were only 13 days left until the Games started!

Fortunately, one of his father's customers was an Amalgamated Wireless (Australia) Ltd company executive and so he left a note for him on his rounds, hoping he would be able to pull a few strings. The note was headed "Dr Appleby" ("Dr" in those days meant "debted to") and apparently that did the trick as the set was delivered from Rydalmere a few days later. It was installed by two men (the 21-inch set weighed a ton) and they also installed a flying bedstead antenna which was connected using 300Ω ribbon cable.

Well, Mrs Appleby was thrilled. In those days, only TCN9 was transmitting and the 16mm film was flown up from Melbourne to Sydney and then put on a telecine machine to convert it into an electronic signal for transmitting.

The AWA Deep Image set was considered to be the "Rolls Royce" model of its time. It boasted 24 valves (including four for video IF and two for sound IF), a 10-channel VHF fringe-area rotary tuner and two 9 x 6-inch elliptical electrodynamic speakers for "fidelity tone sound".

Actually, the sound system was better than that in reality. Unbelievably, each speaker was fitted in a bass reflex box inside the cabinet, along with a tweeter and crossover network.

The whole set had a limited guarantee to be "free from manufacturing defect and faulty material for a period of 90 days". And the picture tube was guaranteed for an extra 90 days.

This particular set was used daily for long hours and Stephen eventually inherited the set in 1982 when his parents acquired a new one. It was moved out to his farm in the country and he has watched it for 2-6 hours almost every day since then, right up to the present day.

Yes, it's still going some 50 years later. Unbelievable!

Of course, the set breaks down regularly, the main problem being "worn-out" valves, especially the power output types. Obtaining the valves was always a problem and they were also costly, so Stephen was always on the lookout for them.

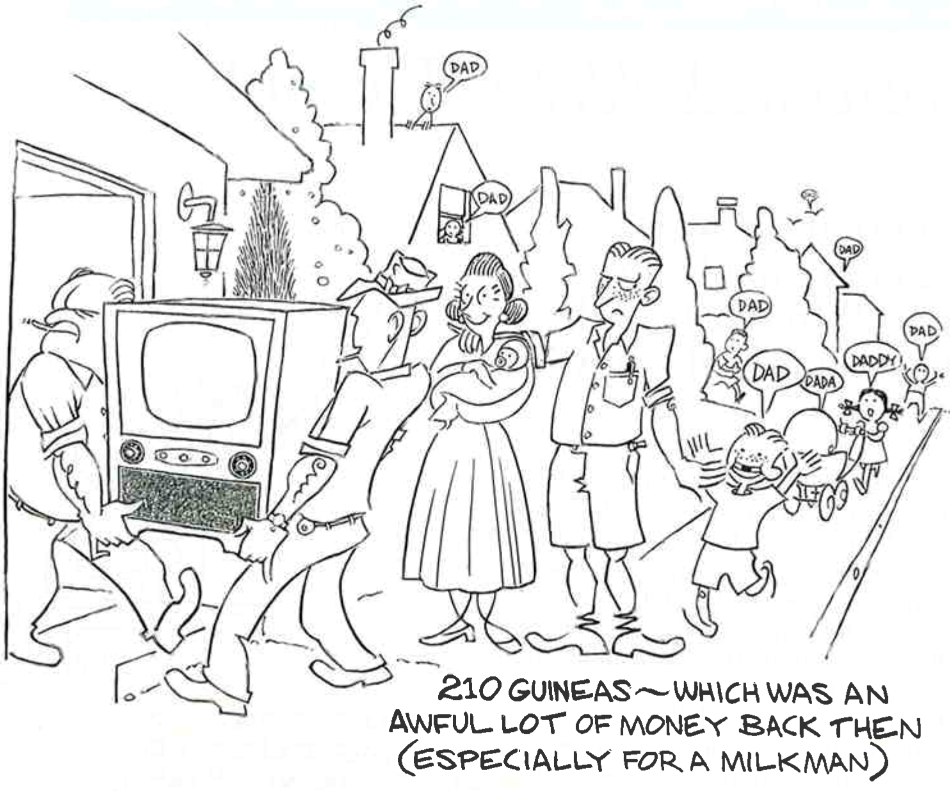
One time he thought he was onto a good thing when he was able to purchase eight boxed 6DQ6s from a retired technician at a good price. However, it was quite some time before he needed to use them and when he did, he discovered that all the valves inside the new boxes were secondhand and faulty.

By 2000, the set was really showing its age (44 years) and Stephen decided it was long overdue for a full overhaul. As a result, all the old Ducon wax paper capacitors and electrolytics which hadn't been replaced were changed (some 150 components, all told). He also replaced most of the old 10% carbon resistors for 2W metal film high-stability types. The tuner was also stripped down and cleaned.

This improved the old girl enormously however the picture was beginning to get a bit dim too. But where was Stephen going to get a new AWV 21CVP4P CRT? Thomas Tubes, who re-gunned them, eventually tracked one

Items Covered This Month

- AWA 205C Deep Image TV
- Teac CT-M4801 TV set
- LG CT-29K30E TV set (MC-8CB chassis)
- Panasonic NV-FJ 700A VCR
- Panasonic NV-FJ600A VCR
- Eurovox Maestro Series 2000 Model 92080354 CD stacker
- Teac CTW8250S widescreen CRT TV
- Sony KP-EF41 (RG-2 chassis) rear projection CRT TV



down for him in the basement of one of their resellers in the country.

The tube was a newer type 21CBP4A Silverama which had a straight gun as opposed to the older Ion trap bent gun types. This particular tube had been re-manufactured by Thomas Tubes in 1971 and was sold for $50 plus an entertainment tax of 15%. Thomas re-tested the tube before selling it to Stephen and he installed it himself later that same year.

The set is still used daily and almost right about now is its 50th anniversary. Apart from being monochrome, it can't tune channel 0 (the tuner is a 10-position type only) and no-one has tried using a VCR with it. However, one can imagine there would be a problem with the horizontal time constant causing line tearing.

The advent of colour TV over 30 years ago doesn't concern Stephen who is quite content with old faithful. After all, as he points out, while the technical quality improves, the programs only get worse!

Different sets, same symptoms

Two CRT TVs came in with about the same symptoms. One was a Teac CT-M4801 and the other an LG CT-29K30E (MC8CB chassis).

Though quite dissimilar sets, they both had a bright white raster with retrace lines, almost certainly due to low voltage on all three cathodes of the CRT.

The fault in the Teac was simple to find and was due to C420, a 10µF 250V electrolytic capacitor, going open circuit and leaking fluid. Replacing it restored the picture.

The LG on the other hand was a "fish of a different kettle". It has no less than three electros on the 200V rail – C408, C905 & C906. I replaced the first one even though they all looked OK and I could measure 200V all the way to pin 6 (video output) of IC901 (TDA6108JF). This made no difference so I then replaced the IC. This fixed the white raster and retrace lines but I then found that the set was not responding to the remote control or the front-panel control buttons – all I got was a blank screen with a green OSD channel number in the top lefthand corner.

I don't quite know when or where I learned about it but whenever you replace a damaged TDA6108JF, you should also check the "Black Current" TK line on pin 5 back to the jungle IC (IC512, TDA8844). There is a 7.5V zener diode (ZD904) on this line that often fails and in this case it had become leaky and was upsetting the SCL line, causing the set to lose control.

Sometimes the jungle IC itself can also be destroyed. Fortunately, in this case, it was just the zener and replacing it fixed the remaining problem.

Cheap as chips

Despite new HiFi VCRs being as cheap as chips, I still get a variety in for repair on a regular basis.

Recently, I had two 2002 Panasonics, an NV-FJ600A and a 700A, come in with the same faults. They both wouldn't play tapes and gave FO6 error messages on their displays.

These VCRs both use the "Z" mechanism deck (just before they changed to the R4 series) and FO6 is a loading error (stop during cassette in/eject operation).

Once inside a VCR, you have to first override the end optical sensors (otherwise the ambient lighting won't let you play tapes). And in one unit, you could see the loading motor try to load the tape around the drum but stop before it was fully in location.

The reason for this was that a number of plastic teeth in the take-up loading arm (VXL2670) were broken where it meshes with the metal loading rack. Replacing this fixed the problem but didn't explain how it happened.

I checked the Mode Select switch S6002 but could find nothing wrong, so for good measure I also replaced the Main Lever (VML3166) which connects the main cam gear to the loading rack.

In the other machine, the loading motor refused to turn at all and it now gave an FO4 error (stop during unloading). This was because there was no 5V out of Q1002, because fuse IR004 (UNH000300A) was open circuit (this is a 300mA fuse which is in the shape of a transistor).

When the sets were fully reassembled, I soaked tested them but found nothing else wrong. Hopefully, I've found all the faults.

Just ask nicely

I don't normally do car stereos as it is really a specialist job, requiring a jig and a large number of service manuals. However, I was asked very nicely whether I wouldn't mind reassembling a 10-CD stacker (only) for a

VX Calais. There was a loose round piece that looked like a CD centre platter and the owner was certain a man of my charm, wit, good looks and experience could fix it! Well, flattery will get you everywhere.

When I had removed the covers and all the loose CDs left in the machine, I could immediately see that this wasn't going to be straightforward. What's more, if the loose part was what I thought it might be, how would I be able to refit and align the height accurately for the laser to focus?

First, I had to order the correct service manual (1030) from Eurovox for the Maestro Series 2000 Model 92080354. When it arrived a few days later, I could see the problems mounting up. I then ordered a new M902 spindle motor assembly which was expensive – but not as expensive as the entire optical pickup assembly.

Removing it meant taking out the MD board first, followed by the servo board, until I got to the optical pickup assembly. This then had to be disassembled and all the mechanical parts transferred to the new spindle motor frame. It's not a job for the fainthearted.

Nevertheless, I managed to reassemble the whole thing in a few hours without losing any screws or having any parts leftover. The only snag was that I had to return the stacker to the client untested, as I had no means to test it.

I haven't heard anything back from him, so it's a case of so far, so good!

Frustrating Teacs

The frustrating thing about Teacs of the VESTEL variety is identifying the correct circuit for the model you are working on. Even when you think you have the correct manual, there are often lots of changes in the production chassis and it is hard to know if it is the right one.

I had a Teac CTW8250S widescreen CRT TV come in and a label on the back indicated it had an 11AK19PRO chassis. By contrast, the labelling on the chassis indicates it is an 11AK19P4, while the service manual lists it as an 11AK19P3! So which one is correct?

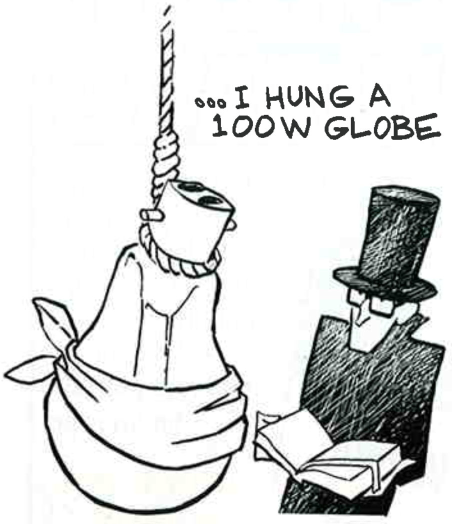
The problem with the set was that it was dead and it turned out to be the line output transistor (Q605, BU2508D) and a few dry joints. However, these faults masked another problem which appeared when the picture was restored. There was now excessive width and pincushion distortion.

Initially, I thought I'd cracked it when Q603 (BUK444) was found to be short circuit and R629 (2.7Ω) open circuit. However, replacing these made no difference.

Next, I started checking and changing all the tuning capacitors in the line output stage, as well as checking the inductance of the coils. All were OK. I then tried going into the Service Menu by pressing the Blue INSTALL button on the remote, followed by 4, 7, 2 & 5. That done, I tried adjusting the width and east-west controls for different aspect ratios but again it made no difference.

By now, there were only a few more components left to check in the east-west correction circuit. In fact, many of the parts shown on the circuit aren't even fitted!

There is the EEPROM where the data is memorised, the microprocessor and the jungle IC (IC401, TDA8844). The voltage on pin 45 of IC401 was 3.5V and when this was shorted to ground, it caused the width to come right in,



implying I was on the right track.

I changed the EPROM (IC502) first, as it was the smallest and easiest. The microprocessor (IC901) was also easy as it was in a socket and I fitted one from a scrapped chassis. It was the jungle IC that was the most difficult as it was a 52-pin high-density IC fitted under a number of metal screening cans.

However, all this effort proved useless. The geometry stubbornly remained the same.

It was a clever friend of mine who worked out the cause and the solution. The east-west FET (Q603, BUK444) has different specifications according to different manufacturers and I had paid no attention to the manufacturer of the one I had fitted. This FET is DC biased by R606, which in my set was only 15kΩ. However, in other sets, this resistor can vary up to 82kΩ.

In this case, adding an extra 33kΩ in series with the existing 15kΩ resistor (making 48kΩ) biased the FET into its operating range, in turn allowing the menu to make the appropriate adjustments. And that fixed the problem.

I must admit that I have often heard of transistors sometimes requiring circuit changes to allow for their gain but this is the first time I have had to do this for a FET, especially as the replacement had the same type number on it.

Customer abuse

More and more LCD displays are coming in, usually for customer related problems.

Recently, I had a 2004 Super Multi-functional TFT Colour LCD TV come in dead. This had an external 12V 13W regulated power supply but the client had tried to run the set directly from a car cigarette lighter socket which, as everyone knows, is nominally 13.6V but can vary up to 16V. What he should have used was a regulated DC-DC supply adapter (ie, one with a 12V IC regulator).

Anyway, we both agreed it had probably blown a fuse. Unfortunately, no-one knew who the agent was for "Super", let alone whether there was any circuit for a Type SP-13A.

I removed the covers after I eventually found two concealed screws (one under the serial number label and the other in a deep hole at the base) and searched and searched for a fuse. I could find the 12V coming into the unit in one or two places but nowhere else.

Eventually, after a lot of searching, I found a glass tube with wires coming out at each end – rather like a lilliput/miniature festoon style globe. This was open circuit but the major clue was the "FS1" marked on the PC board next to it (yep – mind like a steel-trap). I took a punt and soldered a strand of wire (from a multi-strand cable) across it and that did the trick, the set now coming on.

Everything was working OK except that the red Standby LED wouldn't always come on, although the green LED was OK. However, it was beyond my means to economically find out why this was happening.

At least the set was otherwise performing OK and so we let it go at that.

Sony rear-projection set

The 1998-2000 Sony KP-EF41 (RG-2 chassis) rear-projection CRT TV has been a reliable and popular model. It was a further development of the RG-1 chassis fitted in the KP-E41 series and had an interesting one button automatic convergence system.

Now eight years old, we are beginning to see a few of these sets which, like all rear projection units, can be difficult to fix. And from bitter experience, I will only repair them back at the workshop where I can raise the whole set to waist height. Gone are the days where I will crawl around on the floor, peering into dark holes.

If these sets reside near beach-side suburbs, the insulation of the HV block often fails and arcs. The HV block is basically a 3-way splitter for the 34.5kV EHT to the CRTs, as opposed to the flyback transformer (T504) which can also fail as a result.

Recently, I had one of these sets in (KP-EF41SN3) and you could hear and see the arcing from one of the EHT cable sockets which had developed a crack. Unfortunately, by the time we had diagnosed the fault and unplugged the HV block, more damage had been inflicted and the set was now completely dead.

It didn't take long to discover that the line output transistor (Q502, 2SD2539) had gone short circuit and I initially thought that that, along with the cracked socket, would be the end of my troubles. Unfortunately, I wasn't so lucky because after replacing them, the set was still completely dead.

My next step was to take a look at the power board (G). First, I removed and checked C6030 (0.039mF, 1kV) as it sometimes causes strife. This one was OK so I linked CN6007 to CN6006 and pins 1 & 3 of CN6008 to feed the standby 7V rail to the Power-on control. In addition, I hung a 100W globe between the +135V rail (on CN6011-1) and ground.

That done, I found the power supply was working perfectly OK, with correct voltages on all rails. I then refitted the power supply into the set and this time shorted pin 4 of CN6008 (or the link on the board next to CN807) to ground, which is the Protection Line. This let the set start up but I was reluctant to leave it on for any length of time as protection circuits are there for a good reason.

The protection line meanders across the entire set, so I started disconnecting it to various circuit sections in an effort to narrow down the fault. I soon found that unplugging CN506 to the D board would allow the set to come on.

Once again, I was blessed by having a scrapped set on hand from which I could swap modules. This really can save a lot of time with a problem like this. Anyway, I swapped both the D and AG boards and all the plugs one by one until I realised that the protect circuit wasn't being switched on by them. Instead, replacing the E board cleared the fault, so the service fault lay there.

This was getting confusing and it was time to carefully analyse all the functions performed by CN506, which is a 10-pin connector. Three of the pins are ground and two are ±15V which all measured OK. That left the PROT, ABL (Automatic Brightness Limiter), HD (horizontal Drive), PIN (Pincushion Correction) and HP (Horizontal Pulse) pins. I figured that a signal from the E board was turning the microprocessor protect mode on.

However, before getting involved in any fancy convoluted theories, I managed to drag myself back to basic principles – when in doubt, measure the B+, or in this case, all the supply rails on the E horizontal deflection board. This I did, and I initially thought that they were all OK. Then I remembered that this was a KP-EF41SN3 model and its E board is different from that in the SN2 and SN1 models as described in the service manual I was working from.

In the SN3 model, the ±13V rails are derived via IC regulators IC807 and IC814 from the ±15V rail – not from the flyback transformer. And when I measured the output of IC814 (NJM78L12A), there was nothing. Fitting a new one gave only a low output and the device was getting hot and that meant there had to be a problem on this rail, even though it didn't measure short circuit.

After a lot of painstaking circuit tracing, I found that Q805 (2SC3311A) had overheated (it had a burnt appearance) and had gone short circuit. This transistor functions as a buffer stage in the ABL vertical blocking line to the shading control (IC803). Replacing this restored the +13V rail but just why this particular fault triggered the protection line is a mystery.

For good measure, I also fitted a new HV block and at last got a picture. However, I still wasn't out of the woods because the convergence was way out, especially along the bottom, and I was unable to adjust it.

Replacing both the convergence ICs (IC809 and IC810, STK392-150) improved the situation a lot but there were still problems, especially at the bottom of the picture. Replacing IC803 (CA0007) finally fixed that problem.

Sorting out plugs CN503 and CN504 to the green and red CRT horizontal deflection circuits eventually allowed me to get the static convergence and auto convergence to work properly. However, I had to connect them in the opposite way to that shown in the circuit.

The final touches to the dynamic red-green convergence had to be made in the service mode (GH SIZE, LIN and RH SIZE), with the data saved and written onto the EEPROM afterwards. I'm sure that you will now understand why I insist that these units be repaired in my workshop! **SC**

HeartBeat: A CPR Trainer

Design by Jim Rowe
Words by Ross Tester

During mid-2006, Australian emergency health care providers and first aid bodies largely fell into line with the Australian Resuscitation Council guidelines for the delivery method and timing of cardio-pulmonary resuscitation – or CPR. Here's a low-cost trainer which provides audible beats to get the timing right.

For many years, CPR in Australia has been taught differently by different organisations. Apart from the obvious drawbacks of two differently-trained first-aiders trying to work together to resuscitate a patient, every organisation maintained their method was better than their "competitors".

Now that's all changed, with Australian first aid organisations – Surf Lifesaving, Red Cross, Royal Lifesaving, St Johns and so on – agreeing with the International Liaison Committee on Resuscitation Guidelines, with the training/accreditation/certification changing so that no matter who taught you, you would work the same as anyone else.

It has also been very much simplified, in the hope that many more people will learn CPR and be able to deliver it in an emergency.

A staggering fact is that, even today, less than 10% of sudden cardiac arrest victims (ie, heart attack) who are unconscious and not breathing are given CPR – in other words, 90%+ are not given any lifesaving treatment – because no-one knew what to do!

While it is true that some, perhaps many, of those victims would not have survived anyway, isn't it better to know that you have at least tried to assist instead of helplessly standing by?

A wise old first-aid instructor once told me that badly-done CPR was infinitely better than perfect watching.

The changes to CPR

By far the biggest change was in the number of chest compressions per minute – now roughly double at up to 100 – and the much lower importance on providing as much air (oxygen) to the patient with breathing.

The reasons for this change were twofold but intertwined: it was found that patients simply didn't need the amount of oxygen being delivered by the old "five full breaths" – and this took valuable time when compressions should be being delivered.

The more important aim was to keep blood pressure up – this was achieved by faster compressions and less "stoppages" to deliver breaths. The odds are very high that the blood already has enough oxygen in it to sustain life – the first aider's job is to make sure that blood keeps flowing!

Another interesting change is the virtual elimination of searching for a pulse in the patient. In trials in the USA, in the adrenaline-charged atmosphere of delivering CPR to an apparently-lifeless patient, it was found that in more than half the tests, the first-aiders either found a pulse that wasn't there (so didn't deliver CPR when it was needed) or didn't find a pulse that was there, so delivered CPR in error. Again, even looking for a pulse was seen as wasting valuable time.

(Just about everyone can find their own pulse, especially when shown where. Most can find it on a friend fairly quickly. But translate that to – literally – a life and death situation, and it becomes a LOT harder).

So now it is assumed there is no pulse and CPR is commenced immediately. It has been found, again in US trials, that the old belief that performing CPR on a beating heart would likely do damage is not true – there is much less likelihood of damage than there is of death without CPR!

The new ratio

The old ratio of compressions to breaths was 5:1. The new ratio is 30:2. There is now no difference between adult and child, or between one-person CPR and two-person CPR, as there used to be.

As we said, it's simpler!

Furthermore, we no longer spend significant time identifying the "correct" spot for compressions (it used to be called "walking the ribs") – it's now a quick judgement and then straight in! Near enough really is good enough.

Our trainer

The trainer presented

The Silicon Chip HeartBeat CPR Trainer is small enough to fit in the palm of your hand but delivers the timing necessary for correct CPR.

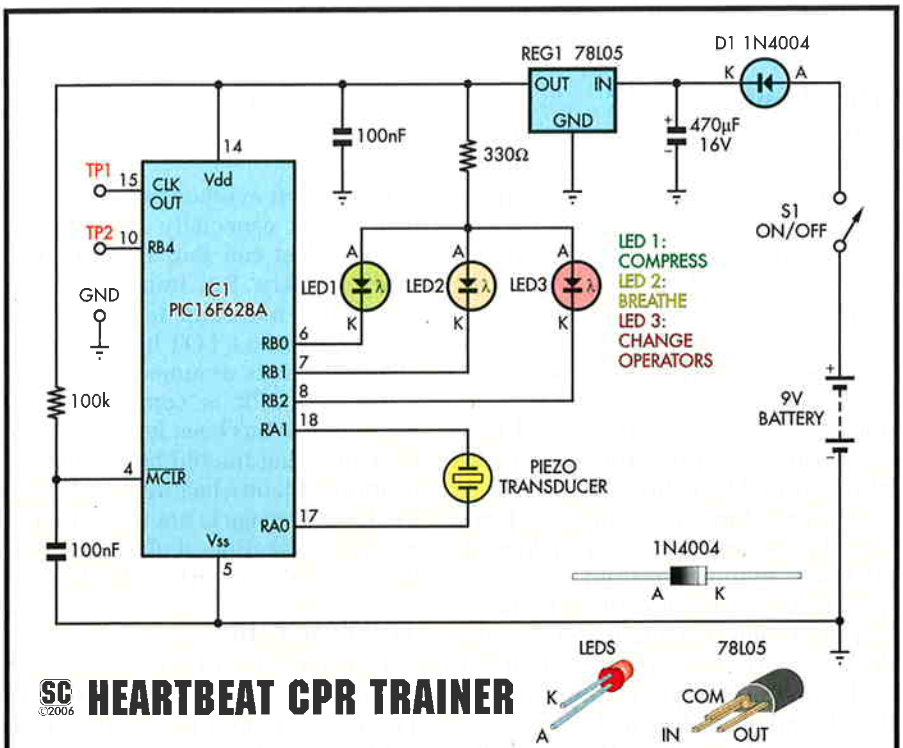


Fig.1: the circuit is based on – or more correctly is almost entirely! – a PIC16F628A microcontroller. Using this particular PIC means that we can do just about everything we want to with one chip!

here is aimed at those learning CPR, so they will develop the rhythms and timing and perish the thought, if ever they are required to deliver "real" CPR, it will come naturally.

It will also prove valuable in re-accreditation or proficiency checks and can be used for the real thing to provide a reality check.

As we mentioned before, the timing for CPR is now 100 compressions per minute (not far off two per second), with a ratio of 30:2 – thirty compressions to two breaths. The breaths of course take longer to "put in" than compressions, so up to two seconds is allowed per breath.

Therefore, our trainer gives 30 short beeps in a period of about 18 seconds, followed by two long beeps of about two seconds each with about one second between, with the cycle then repeating ad infinitum.

Change operators

There is one more prompt our trainer gives. Every six compression/breath cycles, (about two minutes) it gives a "warble" tone. This is to tell the CPR operators to switch positions.

If you have ever had to do CPR "for real", you will know how incredibly tiring it is.

At least part of that is psychological, with your brain telling you that you may have the life of a person in your hands – but it is also very demanding, physically.

The human chest was never designed to be compressed by 50mm – but that's what you have to do 100 times per minute (don't try this on yourself or a friend!).

As well as being as incredibly tiring (and even painful) on the back, shoulders, arms and wrists, CPR is very demanding on the knees, particularly on a hard surface.

There is very good evidence (those trials again!) to suggest that even the best CPRers start to lose effectiveness and efficiency after just one minute (even if they don't feel all that tired).

We double that and allow two minutes. Then the trainer says "time's up!" by giving a "warbling" tones, meaning that the person delivering compressions should swap with the much-less-physically-demanding breath -giver (EAR operator).

The warble tone lasts about 1.5 seconds to allow the operators time to swap.

The timing beeps continue ad infinitum, because CPR must be maintained until (a) the person recovers and shows "signs of life"; (b) higher-level help arrives (doctors, ambulance paramedics, etc); or (c) those doing the CPR are physically unable to continue due to complete exhaustion and no further assistance is available. (There are recorded cases of victims recovering after more than an hour of CPR).

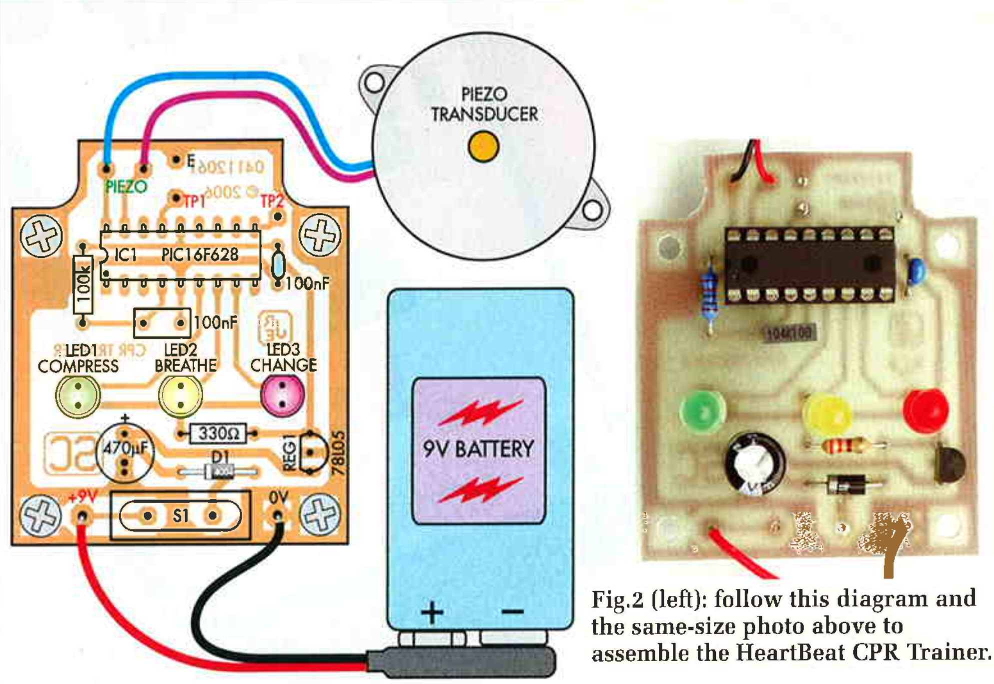
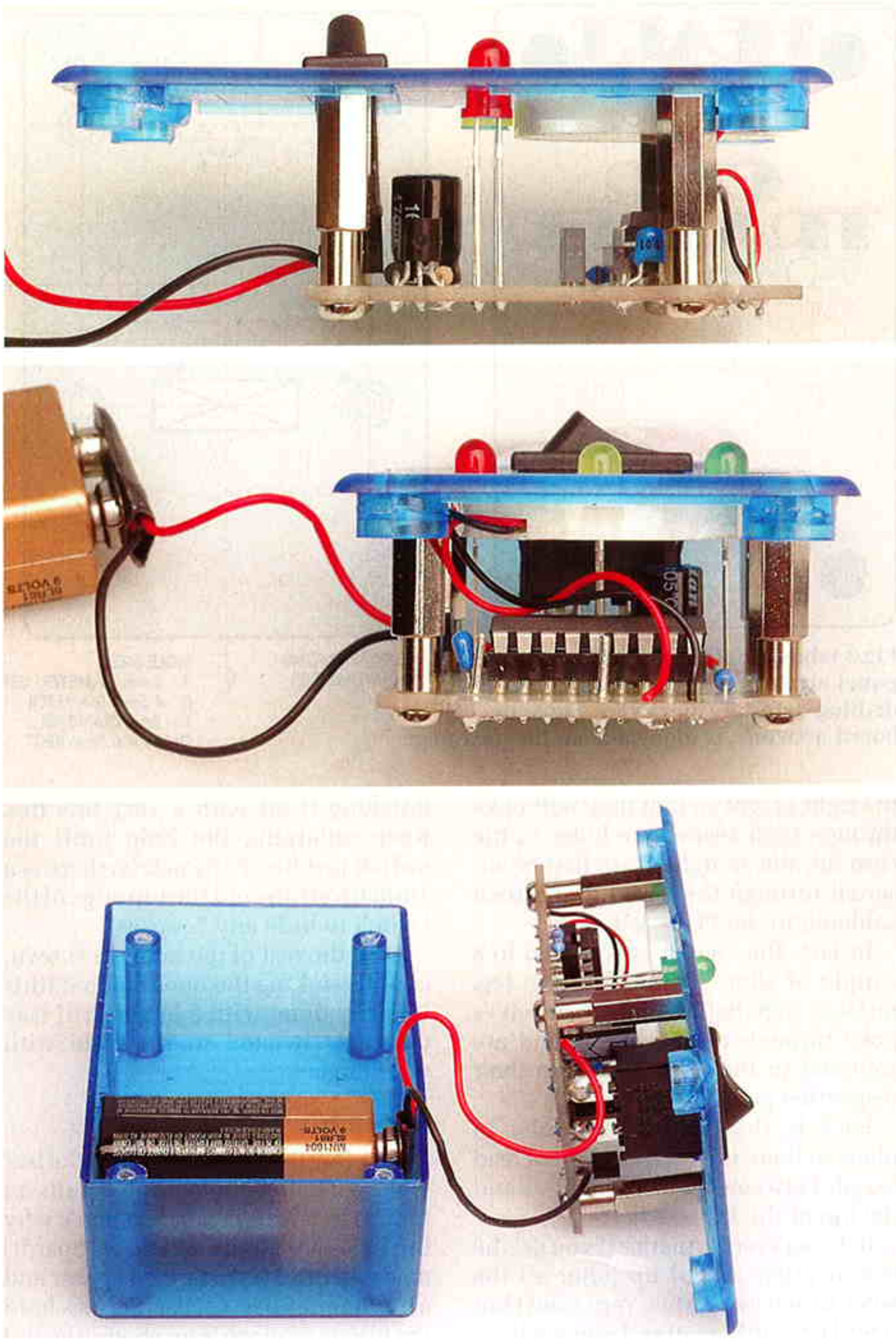


Fig.2 (left): follow this diagram and the same-size photo above to assemble the HeartBeat CPR Trainer.



These three shots give a good idea how the PC board is mounted to the front panel, then assembled into the case along with the 9V battery. Note that the switch must be mounted through the front panel before soldering to the PC board.

Parts List – HeartBeat CPR Trainer

- 1 PC board, 46 x 53mm, code 04112061
- 1 small translucent blue ABS case, approx. 82 x 51 x 30mm (Jaycar HB 6004, Altronics H0175
- 1 piezo transducer, 30mm diameter (Jaycar AB3440)
- 1 9V battery snap (Jaycar PH9230, Altronics P0455)
- 1 9V battery (alkaline preferred)
- 1 SPST switch, PC-mounting (Jaycar SK0975)
- 1 18-pin DIL IC socket
- 4 15mm M3-tapped spacers
- 4 5mm untapped spacers
- 4 5mm M3 csk head screws
- 4 10mm M3 panhead screws
- 1 PIC16F628A microcontroller IC, programmed with CPRTRAIN.HEX
- 1 78L05 low-power 5V regulator
- 1 1N4004 diode
- 1 green LED, 3mm (LED1)
- 1 yellow LED, 3mm (LED2)
- 1 red LED, 3mm (LED3)
- 1 470μF 16V electrolytic capacitor
- 1 100nF MKT capacitor
- 1 100kΩ 0.25W resistor, 5%
- 1 330Ω 0.25W resistor, 5%

The circuit

We use a PIC16F628A microcontroller to generate the timing pulses and drive the piezo tweeter supplying the beeps, so the circuitry is very simple. The micro also drives three LEDs which flash in time with the beeps.

The first (green) LED mimics the beeps giving the timing for compressions. The second (yellow) LED lights when the breath beeps sound. The third (red) LED lights at the same time as the warble tone (again by the micro) to indicate operator changeover.

A single switch starts and stops the timing sequence. If you turn the switch off, the beeps (and LEDs) start again from zero. There is no external oscillator – clock pulses are generated by the PIC itself and the software driving it sets up the correct timing.

The only other components in the circuit are associated with the power supply. Power is derived from a 9V battery, with diode D1 preventing reverse-polarity connection.

The 470μF electrolytic capacitor decouples the supply which is then regulated to 5V by the 78L05. The 100nF capacitor following prevents unwanted oscillation in the 78L05.

Two test points are provided: TP1 connects directly to the PIC's CLK OUT (pin 15) should you wish to verify the oscillating frequency.

TP2 connects to port pin RB4 which is ideal for measuring the length of the various pulses.

A convenient earth point is provided close to both test points.

Programming the PIC

For those building from scratch, the PIC will need to be programmed. If you have the facilities to do this yourself, the code (a hex file) can be downloaded from www.siliconchip.com.au.

Incidentally, we *strongly* recommend that the PIC be inserted into a socket, rather than soldered direct to the PC board, to allow for both troubleshooting now and, if needed, any later firmware changes. Make sure when you solder the socket in that it agrees with the polarity on the component overlay (notch towards the green LED) – and then when you put the PIC in it too matches that polarity

Construction

There's certainly not much to building the HeartBeat – we'd estimate the average hobbyist should finish it in 20 minutes!

Start by checking your PC board for any defects (shorted or broken tracks especially) and if all is well, insert and solder the IC socket (note the notched end and which way it goes as shown on the component overlay).

The five PC stakes follow, then two resistors, two non-polarised capacitors, the diode (get *it* around the right way!) and then the electrolytic capacitor and the regulator (ditto and ditto).

We haven't printed a resistor colour code or capacitor code list as we normally do – there are only two resistors and one capacitor. If you have a resistor in your hand with basically browns and blacks, it's the 100kΩ; if it has a couple of orange bands, it's the 330Ω. If in any doubt, check the values with your digital multimeter before soldering them in.

Don't throw away all the component pigtails – you're going to need a couple of them shortly.

At this stage you can solder on the wires connecting to the piezo transducer – leave say 30-50mm of leads on it. The piezo transducer can be connected either way around (despite its having red and black wires!) as we are using it here in virtual "push-pull" mode.

Incidentally, the type of piezo transducer is important. There are many piezo "sirens" available but these are ***not*** suitable as they have inbuilt electronics to drive them. We use the PIC to drive ours so combining both types of drive will definitely not work!

Now solder on the battery snap leads, (this time watch the polarity). We'd be inclined to leave all of the length of wire on the battery snap; they can squish up between the PC board and the case lid if necessary.

You will note we have not yet inserted the IC in its socket nor soldered in the switch or LEDs. The reason for the first should be obvious; the LEDs and switch not quite so.

The LEDs have to be soldered at

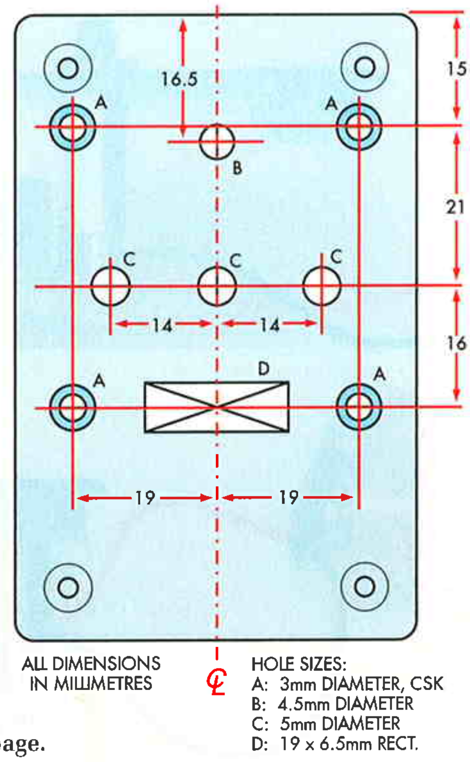


Fig.3 (above) and fig.4 (right): front panel artwork and front panel (lid) drilling detail, respectively. Fig 5, the PC board artwork, is alongside on the next page.

the right height so that they will poke through their respective holes in the case lid; the switch has to first be inserted through the case lid and then soldered to the PC board.

In fact, the switch is soldered to a couple of short lengths of wire (eg, resistor pigtails!) which themselves poke through the PC board and are soldered in the normal way to their respective pads.

Back to the LEDs: they solder in place so there is exactly 20mm of lead length between their undersides and the top of the PC board.

It doesn't *really* matter if you get the colour order mixed up (after all the label shows what they represent) but it will certainly matter if you get their leads around the wrong way.

Apart from the switch, the only component left to go on the board is the PIC IC, which can now go in. Push it into its socket so the notches on the ends align; make sure as you do that none of the legs are bent under the IC or outside it.

Drilling the case

The only holes you have to make are in the case lid – these are shown in Fig.4 – and the only tricky one of these is the cutout for the switch.

It's a slot 19mm long x 6.5mm wide and is best made by drilling a line of small holes inside the rectangle and finishing it off with a very fine file. Keep enlarging the hole until the switch just fits. Fortunately, there is a 1mm lip all around the top edge of the switch to hide any "oopses".

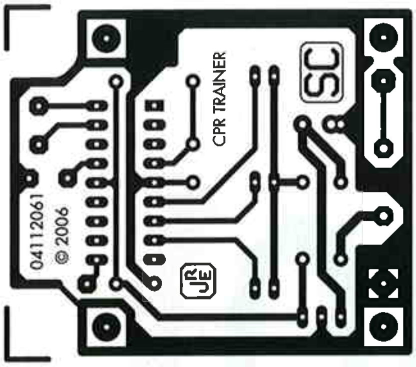
Drill the rest of the holes as shown, countersinking the ones marked (this is easily done with a larger drill (say 6-10mm) twisted in the hole with your fingers.

Assembly

The way the HeartBeat fits in the box is shown in the photographs. It sits on four 21mm pillars (aha! so that's why the LEDs are 20mm off the PC board!) made up of a 15mm tapped spacer and a 6mm untapped spacer. Screws hold the pillars in place from above (the lid) and from below (through the PC board and the untapped spacers).

First we need to mount the piezo transducer to the case lid It simply glues on the underside of the lid so that its hole (centre top of lid) and the hole in the piezo align. You may find that one (or even both) of the screw-mounting lugs needs to be clipped off so it doesn't foul either the standoffs or the case lid mounting points. As we are glueing the transducer on, that's no problem.

A tiny drop of superglue is fine or you can use other plastic glues or even silicone sealant. Whatever you do, don't get any glue into either hole – the



one in the case but especially not into the piezo! When the glue is dry, you can complete the assembly.

As you put the spacers and screws in, push the LEDs through their respective holes in the lid.

We're assuming you already have the HeartBeat front panel (shown in Fig.3) glued onto the case lid with the hole cut out for the switch. If so, push the switch through the panel until it clicks in place (make sure the 'O' engraved on the switch goes to the 'OFF' side).

Now push those resistor lead cutoffs through the holes under the switch, twist them around the switch terminals to make them captive, then solder each to both the switch terminals and the PC board pads underneath.

Testing

There really isn't any testing nor setup to do. If everything is soldered as it should be and the PIC is programmed correctly, it cannot help but work!

Switch it on and LED 1 should start flashing as the piezo starts beeping. After 30 beeps you should hear two long beeps and LED 2 should flash in time. After two minutes LED 3 should flash and you should hear the changeover warble. That's it!

Woops! It's not working?

99% of problems with kits are due to poor soldering – dry joints especially. Check your soldering and component polarity. You can measure the voltage across the large electrolytic capacitor (it should be around 8.5V) and there should be 5V between pins 14 and 5 of the IC (don't short other pins together as you do it!).

If these voltages check out OK, about the only other easy check is the LEDs. Remove the IC from its socket and short socket pins 6, 7 and 8 to earth (0V) respectively. Each of the LEDs should light in turn.

If all of this checks out, the chances are you have a problem with the PIC chip – and the only way you can check that out easily is with a PIC programmer. SC

What is CPR?

Earlier in this article we've said that CPR stands for Cardio-Pulmonary Resuscitation. We've also said that everybody should learn CPR.

But what is CPR?

You've probably heard of mouth-to-mouth resuscitation (it's more properly called Expired Air Resuscitation, or EAR) – effectively forcing air into the lungs of someone who has stopped breathing of their own accord.

You may also have heard of external heart massage (more properly called External Cardiac Compression, or ECC) – manually compressing the heart from outside the body to force it to pump blood through the body when it is not "beating" of its own accord.

CPR is, simply, a combination of both EAR and ECC.

It can be done with one person but is much better done with two or even three people.

Basically, one person places his/her mouth over the victim's mouth (and/or nose), opens the airway by tilting the head back, seals the nose with either the cheek or finger and thumb and breathes air into their lungs.

The second person places the palms of their hands in the middle of the chest, over the victim's breastbone and pushes – hard – so that the breastbone is forced down about 50mm. This effectively "squashes" the quite soft heart between the breastbone and the spine. The heart contains a number of one-way valves and any blood already in the heart is pushed out, through the lungs (where it picks up oxygen from the air breathed in) and then through the arteries to the various organs of the body. As the compression is released and the breastbone moves back up, the muscles around the heart help it regain its "normal" size. This pulls blood in from the veins, ready for next time the heart is compressed.

This process mimics that of a normal, beating heart – the difference being that normally the heart does it all by itself, more than two and a half billion times during a typical 80-year lifetime.

EAR works because when you or I breathe, the air that comes out is still rich in oxygen. Normal (sea level) air contains about 20-21% oxygen. When you breathe it in then out again, it still contains about 17% oxygen. That's more than enough to sustain life.

If the heart has stopped beating (whether by shock, drowning, heart attack, or other cause) it stops pumping blood – and therefore oxygen – around the body. Without oxygen, the vital organs become irreparably damaged – at most, in about four minutes at normal temperatures.

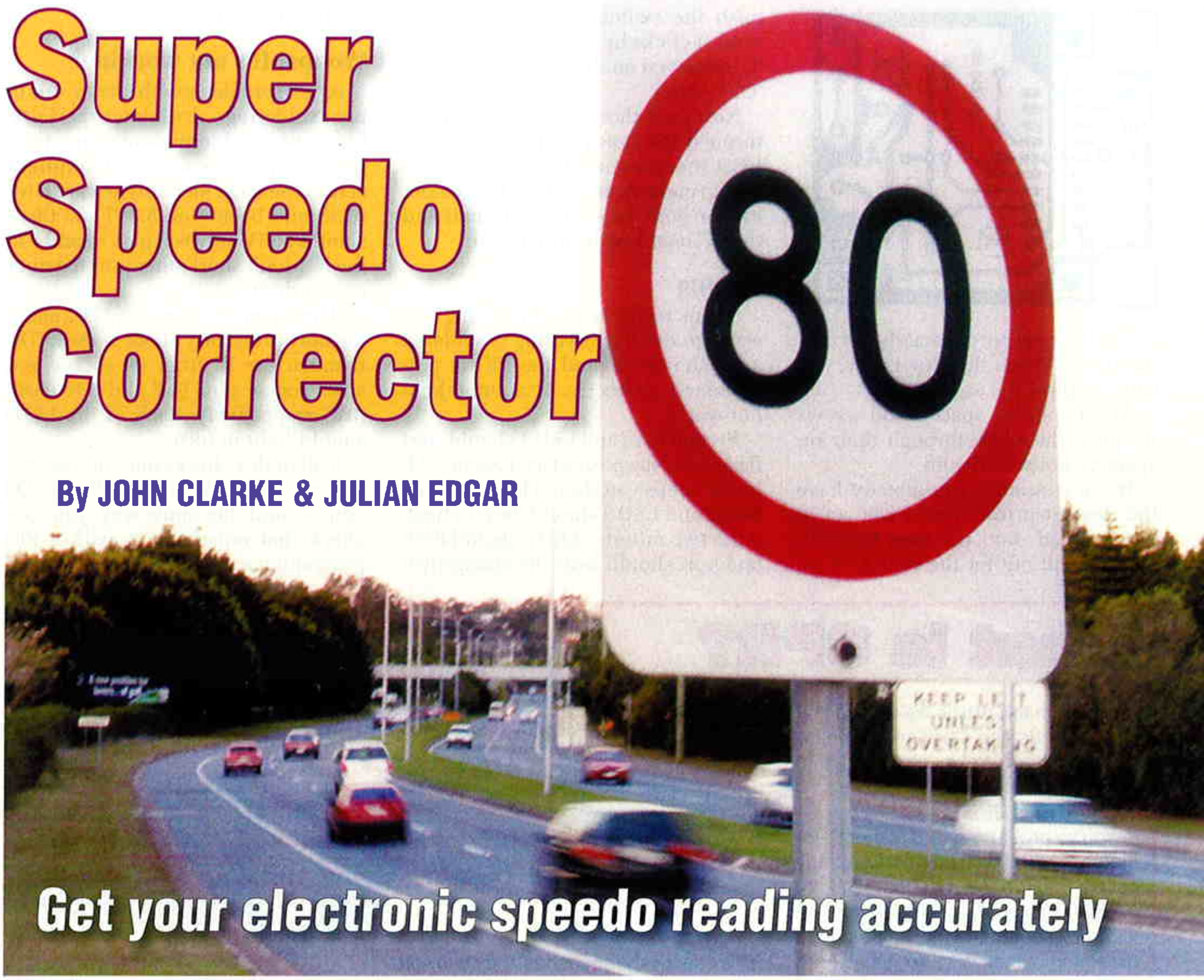
So it is most important to commence CPR as soon as possible.

CPR is quite easy to learn (especially now!) and there are numerous first aid and emergency care organisations very keen to teach you.

Not only because we often work around live circuits, SILICON CHIP actively encourages all readers to learn CPR. The life you save could be someone near and dear to you – or it could be a complete stranger. Either way, it's a life saved.

Super Speedo Corrector

By JOHN CLARKE & JULIAN EDGAR



Get your electronic speedo reading accurately

THESE DAYS, having an accurate car speedo is vital if you're to avoid fines and loss of licence points. But how do you correct the speedo if it is reading high or low? It's easy with our Super Speedo Corrector which will work with any electronic speedo, either digital or analog. It allows you to alter the speedo reading in 1% increments, either up or down.

Before you can use the Speedo Corrector, you'll have to find and identify the speedometer sensor output wire or the speed signal output wire from the ECU. In some cars that's easier said than done, so make sure you have a wiring diagram and that you can physically access the speedo input wire which is normally at the back of the instrument cluster. If you can't find the right wire, you won't be able to install the Speedo Corrector.

Speedo Corrector: Main Uses

- Correct inaccurate speedos in standard cars.
- Correct inaccurate speedo caused by changed differential or gearbox ratios.
- Correct inaccurate speedo caused by changed tyre diameters.
- Correct tachometers

This project is a development of the Speedo Corrector first published in the SILICON CHIP book "Performance Electronics for Cars". Advantages over the original project include an automatic set-up procedure where the Super Speedo Corrector calibrates itself to suit the speed signal output characteristics, an on-board status LED that flashes to show correct operation and an AC output signal that will work with Nissan speedometers.

Circuit description

The circuit (Fig.1) is based on microcontroller IC1 which is programmed to alter an incoming frequency by a set amount. The exact amount is set using two rotary switches, which alter the frequency in 1% steps.

The speedometer signal is applied to the input of the circuit that has the op-

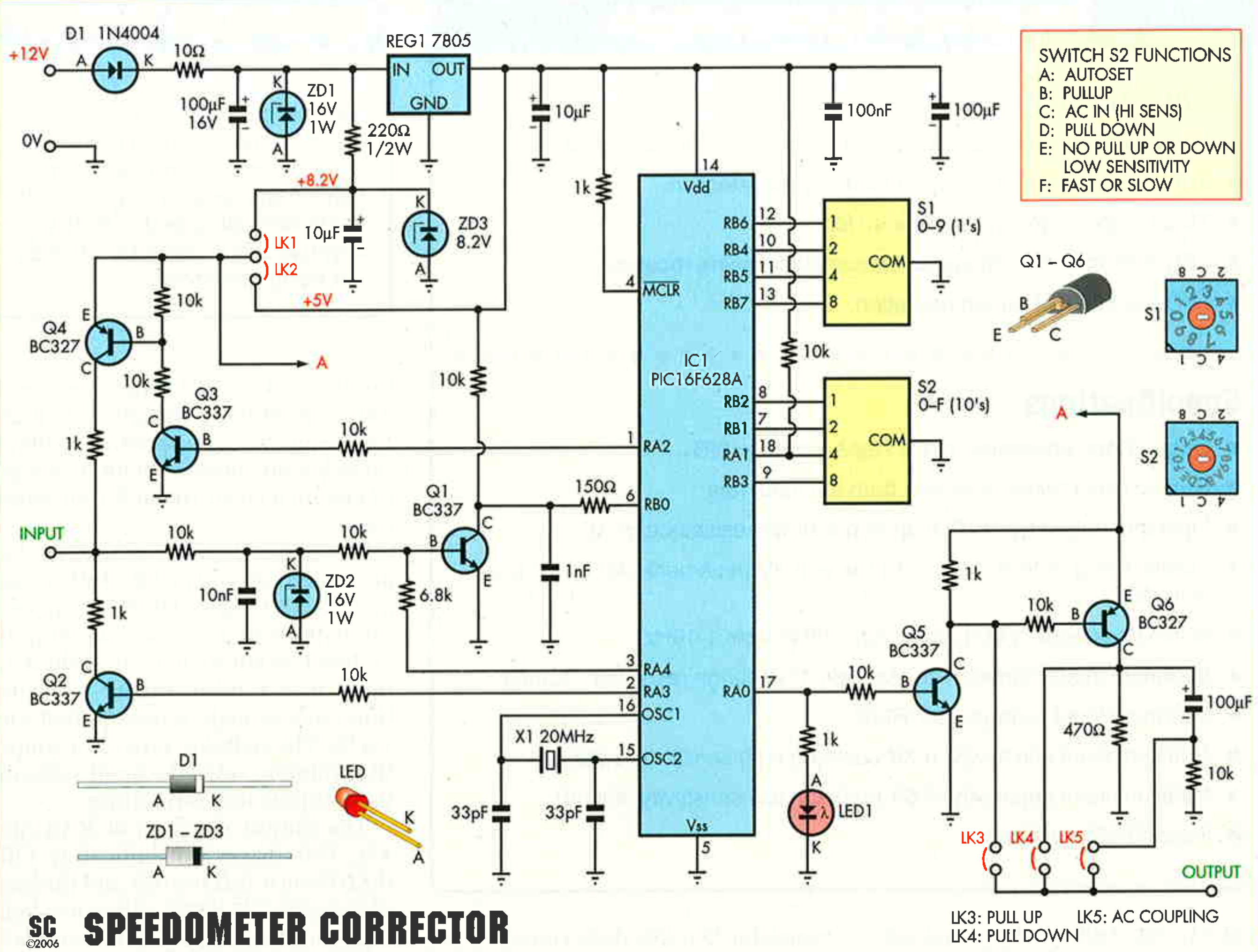
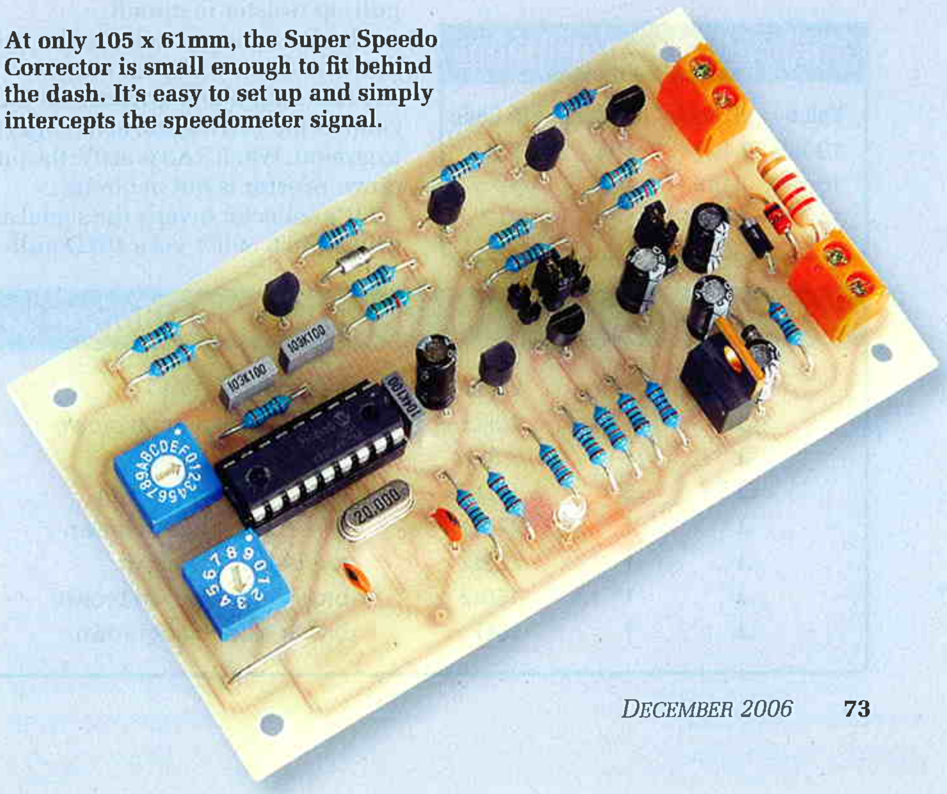


Fig.3: all the clever stuff in this circuit is done by PIC microcontroller IC1. It takes the speedo signal and multiplies it by a factor set by two rotary BCD switches (S1 & S2). The speedo signal frequency can be either increased or decreased in 1% increments – see text.

tions of a 1kΩ pull-up resistor selected with transistor Q4 or a 1kΩ pull-down resistor selected with transistor Q2. By selecting either link LK1 or LK2, the pull-up resistor can be connected to either the +8.2V supply or the +5V supply. The input signal is then fed via a 10kΩ resistor to zener diode ZD2, which ensures that levels cannot go above +16V or below -0.6V. A parallel 10nF capacitor filters the signal which then drives transistor Q1 via a voltage divider consisting of 10kΩ and 6.8kΩ resistors.

This 6.8kΩ resistor at the base of Q1 can be either connected to ground via the RA4 output of IC1 or left floating when the RA4 output is set as a high-impedance input. When the resistor is connected to ground, the signal level required to switch Q1 is about 2.5V. Alternatively, when this resistor is ef-



At only 105 x 61mm, the Super Speedo Corrector is small enough to fit behind the dash. It's easy to set up and simply intercepts the speedometer signal.

Features & Specifications

Main Features

- Allows alteration of speedo reading so it reads faster or slower.
- Automatic or manual set-up of input signal detection.
- Three output signal types catered for.
- LED indication of valid speed sensor signal being received.
- LED indication of output operation.

Specifications

- Output Rate: adjustable in 1% steps from 0 to 99%.
- Output: either faster or slower than the input rate.
- Input and output types: Pull up or pull down resistance or AC.
- Output swing: 0 to 8.2V or 0 to 5V or 8.2V peak-peak AC or 5V peak-peak AC.
- Minimum operating frequency: Adjustable from 1-16Hz.
- Maximum input frequency to maintain 1% change resolution: 1.2kHz.
- Maximum input voltage: 50V RMS.
- Minimum input sensitivity: 0.7V peak (on high sensitivity setting).
- Minimum input sensitivity: 2.5V peak (on low sensitivity setting).
- Power 9-15V at 25mA.

Mechanical Speedo?

The Super Speedo Corrector will work only on electronic speedometers – ie, those that don't have a mechanical rotating cable driving them. If you have an older car with a mechanical speedo, then you won't be able to correct it – at least not using this circuit.

fectively out of circuit, the sensitivity is lowered to around 0.7V peak.

The RA2 output of IC1 is used to select the pull-up resistor. When this output is at 5V, it switches on transistor Q3 and this in turn switches on transistor Q4. Q4 then connects the 1kΩ pull-up resistor connecting from the input to Q4's collector. This then connects the pull-up resistor to the +8.2V or +5V supply rail. If RA2 is at 0V, Q3 and Q4 are off and there is no pull-up resistor in circuit.

The RA3 output selects the pull-down resistor when its output is at 5V. This output drives transistor Q2 to connect the 1kΩ resistor at its collector to ground. When RA3 is at 0V, the pull-down resistor is out of circuit.

Q1's collector inverts the signal and drives pin 6 of IC1 via a 10kΩ pull-up resistor and a 150Ω series resistor. A 1nF capacitor filters out any high-frequency voltage variations. Pin 6 includes an internal Schmitt trigger to ensure a clean signal for measurement.

The rotary BCD switches (S1 & S2) are monitored via the RB1-RB7 inputs and the RA1 input. The RB inputs are normally held high via internal pull-up resistors within IC1, while the RA1 input uses a 10kΩ resistor to ensure this input is high, unless pulled low via S2. The switches provide a unique BCD (binary coded decimal) value on these inputs for each setting.

The output signal is at RA0 (pin 17). This drives the indicating LED (LED1) via a 1kΩ resistor and the base of transistor Q5. Q5's collector is held high via a 1kΩ resistor which connects to either the +8.2V or +5V supply (via link LK1 or LK2).

Q5's collector provides the pull-up output signal and also drives Q6 which has a pull-down resistor at its collector to provide the pull-down output. Coupling the pull-down output via a 100μF capacitor provides an AC output. The 10kΩ resistor provides the discharge path, while links LK3, LK4 and LK5 select the pull-up, pull-down and AC outputs, respectively.

An internal power-on reset for IC1 is provided using the MCLR input (pin 4)

Table 1: Capacitor Codes

Value	μF Code	IEC Code	EIA Code
100nF	0.1μF	104	100n
10nF	.01μF	103	10n
1nF	.001μF	102	1n0

Table 2: Resistor Colour Codes

☐	No.	Value	4-Band Code (1%)	5-Band Code (1%)
☐	11	10kΩ	brown black orange brown	brown black black red brown
☐	1	6.8kΩ	blue grey red brown	blue grey black brown brown
☐	5	1kΩ	brown black red brown	brown black black brown brown
☐	1	470Ω	yellow violet brown brown	yellow violet black black brown
☐	1	220Ω	red red brown brown	red red black black brown
☐	1	150Ω	brown green brown brown	brown green black black brown
☐	1	10Ω	brown black black brown	brown black black gold brown

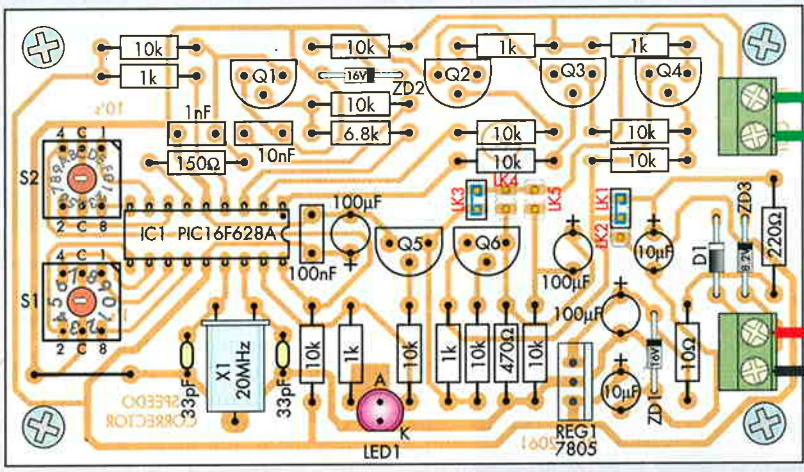
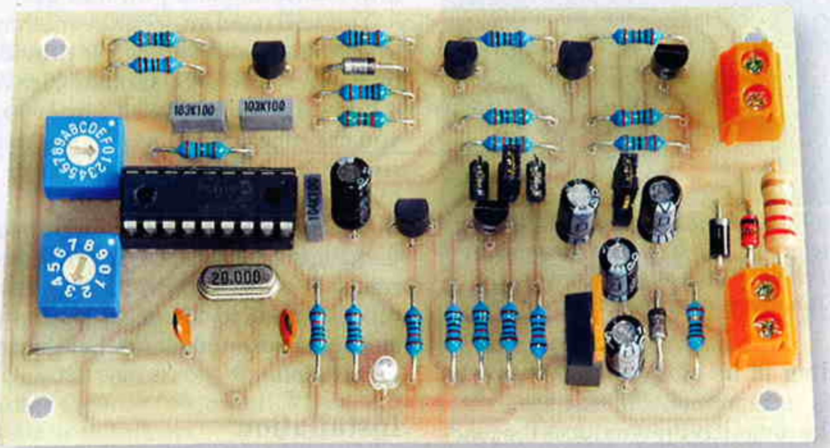


Fig.2: when assembling the PC board, take care with the orientation of the BCD switches, the PIC and the other polarised components. Use this diagram and the photos of the completed project (below) to help you in your assembly.



Corrections are easy to dial-up – just set the two rotary switches to give the up or down percentage correction that's needed. Here, the Super Speedo Corrector is configured to reduce the speedo reading by 3%.

which is connected to the 5V supply via a 1kΩ resistor. This keeps the IC reset until the power supply voltage is correct.

IC1 operates at 20MHz using crystal X1. This frequency was chosen so that the software program runs sufficiently fast to operate with speedometer signals up to 1.2kHz. Note that the Super Speedo Corrector will operate with speedo signals above these frequencies, however the accuracy of speedometer correction will be reduced.

Power for the circuit is applied via diode D1 which provides reverse polarity protection. Zener diode ZD1 and the 10Ω resistor provide transient protection to protect the input of REG1. The 100µF capacitor at REG1's input provides a further degree of transient voltage suppression. A 10µF filter capacitor is provided directly at REG1's output and the 100µF and 100nF capacitors decouple the supply to IC1.

An 8.2V supply is derived from the supply at REG1's input via a 220Ω resistor and zener diode ZD3. This supply is for the pull-up resistors if required.

Construction

The Super Speedo Corrector circuit fits onto a small PC board coded 05112061 and measuring 106 x 60mm. Fig.2 shows the parts layout.

Construction is straightforward but be sure to correctly install the polarised components such as the PIC microcontroller, electrolytic capacitors and the diodes. Note that Q4 and Q6 are not the same as Q1, Q2, Q3 & Q5, even though they look the same.

The BCD switches must be mounted with their dots positioned as shown on the overlay diagram (Fig.2). The BCD switch with 0-9 capabilities is S1 and the BCD switch with 0-F on it is S2.

Making adjustments

The speed reading can be altered in 1% increments. This is most easily explained if you use a test speed of 100km/h. If the speedo is wrong by 5km/h at 100km/h, the adjustment needed is about 5%.

S1 (the switch nearest the bottom when the PC board is orientated with the connections at the right) corrects the speedo reading in single units

Tacho As Well?

The Super Speedo Corrector will also work with electronic tachos that take their feed from the ECU (ie, all cars with engine management).

The configuration procedure is the same as for use of the device as a speed interceptor, except that the "speed sensor" becomes the tacho output signal from the ECU. This application is particularly suited to engine and gearbox swaps.

24V Operation

The Super Speedo Corrector can be used on 24V vehicles if the following changes are made: change ZD1 to 33V 1W; change the 220Ω 0.5W resistor that feeds ZD3 to 1kΩ 1W; change the 100µF 16V capacitor at the input to REG1 to 100µF 35V.

Non-Linearity?

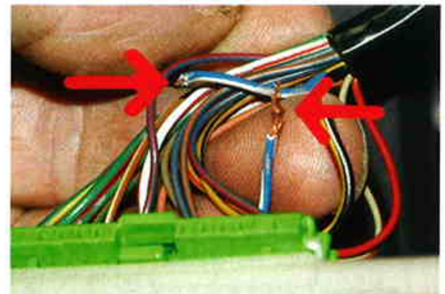
The Super Speedo Corrector will not compensate for non-linear errors. In other words, if the speed reads 10% high at 25km/h and 4% high at 100km/h, you won't be able to use the Super Speedo Corrector to get the speedo accurate at all speeds. However, most speedo errors are proportional and so can be dialled-out with the Speedo Corrector.

Finding the speed input wire to the speedo can involve a dash disassembly job. In this Honda, the steering column had to be dropped, the dash fascia removed and the speedo cluster unbolted and pulled forward. Make sure you're aware of the safety precautions that need to be taken if the car is equipped with airbags.

and S2 changes the output in tens. So where you want a correction of 5%, simply set S1 to "5" and S2 to "0". If the required correction is 16%, set S1 to "6" and S2 to "1".

Using the two BCD switches in combination allows the speedometer reading to be altered by as much as 99%, in increments of just 1%.

The default output reduces the reading of the speedo. This default was picked because most speedos read fast (often by about 5%). Alternatively, if you wish to increase the speedo read-



Once located, the speed sensor wire must be cut. The wire that goes to the speed sensor connects to the Super Speedo Corrector's "IN" terminal and the wire going to the speedo connects to the "OUT" terminal.

ing , set S2 to its F position and wait for a 2-flash acknowledgement from the LED. This needs to be done with the unit connected and powered up.

You will need an accurate reference to set the speedo. This can be provided by a handheld GPS, another car with a known accurate speedo or even, if you ask nicely, a police car. Just make sure that you have an assistant to do the adjusting as you drive!

You can also use the "speedo check" distances that are marked on some roads – although strictly speaking, this is intended for checking the accuracy of the odometer rather than the speedometer.

Installation

Now for the installation but first, a word of warning: if you need to pull the dash out to locate the speed input wire to the speedo, make sure you're

Table 3: Functions Of S2 Settings

Switch Setting	Function	IC1 Pin Status
A	Autoset (automatically finds a suitable input setting)	Pins 1, 2 & 3 change. Pin 17 goes from 0V to 5V to 0V at a 1-second rate to flash LED when automatic sensing is complete
B	Pull-up resistor (low sensitivity @ 2.5V peak)	Pin 1 @ 5V, Pin 2 @ 0V, Pin 3 @ 0V
C	AC input (high sensitivity @ 0.7V peak)	Pin 1 @ 0V, Pin 2 @ 0V, Pin 3 open circuit
D	Pull-down resistor (low sensitivity @ 2.5V peak)	Pin 1 @ 0V, Pin 2 @ 5V, Pin 3 @ 0V
E (initial setting)	No pull-up resistor or pull-down resistor (low sensitivity @ 2.5V peak)	Pin 1 @ 0V, Pin 2 @ 0V, Pin 3 @ 0V
F (default is slow)	Fast or slow option (LED acknowledgement: 1 flash = slow, 2 flashes = fast)	

Note 1: in most applications, only the 'A' (automatic) setting will need to be used during set-up.
Note 2: switch setting must be selected for a minimum of four seconds to initiate new function.

Digital Speedo Lag

If the Speedo Corrector is fitted to a car with a digital speedo, some lag may occur in the action of the speedo. Typically, this is noticeable when abruptly coming to a stop from a slow speed (eg, 10km/h), where the speedo may keep displaying a number greater than zero for up to a second, even when the car is stationary.

Lag may also make itself evident when moving away from a standstill, where the speedo initially shows 0km/h before then jumping to 15km/h or 16km/h.

This problem can be overcome by the use of the special "digital speedo function" built into the Corrector. This function is enabled during set-up by setting S1 to a position other than 2 before selecting A on S1. Positions 1–9 on S1 vary the number of pulses for which the Speedo Corrector calculates the output frequency of the speedo sensor (odd switch numbers calculate over one pulse and even numbers calculate over two pulses) and the time delay before the corrector stops sending a signal to the speedo after the input signal ceases.

The delays are: positions 0 & 1 – 1 second; positions 2 & 3 – 500ms; positions 4 & 5 – 250ms; positions 6 & 7 – 125ms; positions 8 & 9 – 62.5ms.

If the speedo reading noticeably lags behind actual vehicle speed, try different positions of S1 before each time setting S2 to A and proceeding with the self set-up process described in the main text. The optimal setting is that which gives the shortest lag while still reliably operating the speedo.

aware of the safety precautions that need to be taken if the car is equipped with airbags.

In the vast majority of cars little set-up will be needed – the corrector will mostly work out for itself what configuration is required. These are the steps to follow:

(1). Connect power (use an ignition-switched source), ground, speedo "in" and speedo "out" (to the speedo). Position the corrector so that a passenger can observe the on-board LED.

(2). Set S1 to 2.

(3). Set S2 to A.

(4). Install link LK2.

(5). Drive the car for a minute (the speedo will not work).

(6). Observe that the LED flashes at 1Hz when the car is moving. This shows that the Speedo Corrector has set itself for the type of speedometer signal that is present and is receiving a valid signal from it.

If the LED doesn't flash, install link LK1 (instead of LK2) and try again.

(7). Set S2 to 0

(8). Set S1 to 0

(9). Try the link options LK3, LK4 or LK5 until speedo works (the speedo should read as it did with the car standard).

(10). Set S1 & S2 to give the required correction (S1 is for single units, S2 for tens).

Table 4: Link Functions

Link	Function
LK1	8.2V max. output
LK2	5V max. output
LK3	Pull-up output
LK4	Pull-down output
LK5	AC output

(11). If the speedo reading needs to be corrected upwards rather than the default downwards, set S2 to F and then wait for the LED to flash twice. Then set S2 back to its required correction value. To return to downwards speed correction, again set S2 back to "F" and wait for a single flash acknowledgement.

If the required settings are already known (eg, in the case of auto electricians fitting large numbers of the design to just one type of car), Table 3 shows how S2 can be used to manually set the input configuration, while Table 4 shows the output configurations achievable by the different link positions. Any changes to the switches will not be registered by the circuit until after about four seconds, so make sure you don't switch off power during this time! This delay allows you to rotate the switches to the required position without any unwanted changes occurring.

Conclusion

Once the Corrector is working properly, it can be mounted in its UB3 box and tucked up behind the dash out of sight. But don't then assume that your speedo is then always going to be dead accurate – accuracy depends on tyre diameter, which changes with wear and when new tyres are fitted.

Of course, with the Super Speedo Corrector, it's easy enough to then make the required speedo calibration change! **SC**

Parts List

- 1 PC board, code 05112061, 105 x 61mm
- 1 UB3 plastic utility box, 130 x 68 x 44mm
- 2 2-way PC-mount screw terminal blocks
- 1 DIP18 IC socket
- 3 2-way 2.5mm jumper headers
- 1 3-way 2.5mm jumper header
- 2 jumper shunts
- 1 20MHz crystal (X1)
- 1 0-9 BCD rotary switch (S1)
- 1 0-F BCD rotary switch (S2)

Semiconductors

- 1 PIC16F628A-I/P microcontroller programmed with speedcor.hex (IC1)
- 4 BC337 NPN transistors (Q1,Q2,Q3,Q5)
- 2 BC327 PNP transistors (Q4,Q6)
- 1 1N4004 1A diode (D1)
- 2 16V 1W zener diodes (ZD1,ZD2)
- 1 8.2V 1W zener diode (ZD3)
- 1 3mm high-intensity red LED (LED1)

Capacitors

- 3 100µF 16V PC electrolytic
- 2 10µF 16V PC electrolytic
- 1 100nF MKT polyester
- 1 10nF MKT polyester
- 1 1nF MKT polyester

Resistors (0.25W 1%)

- 11 10kΩ
- 1 6.8kΩ
- 5 1kΩ
- 1 470Ω
- 1 220Ω 0.5W
- 1 150Ω
- 1 10Ω

PRODUCT SHOWCASE

Fluke's new Power Quality Logger and Recorder

Fluke Australia's new 1740 three-phase power logger and 1760 three-phase power quality recorder give electricians and technicians fast and accurate power quality measurement, analysis and testing

The logger will troubleshoot and analyse power quality issues and is capable of logging up to 500 power parameters for up to 85 days. It is ideal for identifying intermittent and hard-to-find power quality issues, quality of service compliance, assessing baseline power quality, load studies and energy and power quality performance validation.

The recorder provides advanced power quality analysis and consistent compliance testing.

The tool has been designed specifically for analysis of utility and industrial power distribution systems, in medium and low voltage networks. It provides flexibility to customise thresholds, algorithms and measurement selections and the captured data can be downloaded to a laptop in the field.

Contact:
Fluke Australia
26/7 Anella Ave, Castle Hill, NSW 2154
Tel: (02) 8850 3333 **Fax:** (02) 8850 3300
Website: www.fluke.com.au

Agilent's true-RMS DMMs: "within budget, without compromise"

Agilent U1251A and U1252A handheld digital multimeters offer a 4.5-digit resolution with a 50,000 count full scale and basic DC voltage accuracy of up to 0.025%, providing the flexibility to perform quick validation measurements or perform tolerance checks and marginal failure troubleshooting.

They also offer true RMS, dBm, and AC+DC readings to measure both sinusoidal and non-sinusoidal waveforms accurately.

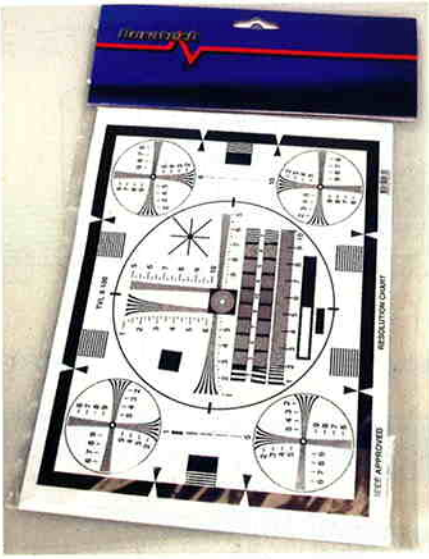
The also have J and K-type temperature measurement (-20° to +55°), 4-20mA process loop measurement with % readout, and dBm measurement. Data can be stored with the optional IR-USB link to PC.

The accompanying Agilent Graphical User Interface (GUI) further extends the potential of these instruments by allowing you to customise your data logging needs.

The U1252A also has a 20MHz frequency counter and a programmable square-wave generator built in.

Contact:
Agilent Technologies
347 Burwood Highway , Forest Hill Vic 3131
Tel: (03) 9210 5555 **Fax:** (03) 9210 5899
Website: www.agilent.com

IEEE 208 TV/Video resolution chart from Jaycar



With the increase in popularity of video production, Jaycar now stocks an IEEE208 TV/Video Resolution Chart.

For the professional or serious amateur, this chart is used for testing TV or video resolution, frequency response characteristics, and performance of cameras and display devices. The primary application is for users and manufacturers to quantify the limit where fine detail contained in the original image is no longer reproduced by the camera system.

It's also used to test the performance of complete imaging systems by determining the point at which the system is no longer able to separate the resolution lines in the chart.

These charts have previously only been available at over $100. The Jaycar version, which conforms to IEEE 208-1995 (Measurement of Resolution of Camera Systems), costs just $9.95 (Cat. BJ-6025). They are available from Jaycar Electronics stores, resellers and Jaycar Techstore online.

Contact:
Jaycar Electronics
PO Box 6424, Silverwater NSW 1811
Tel: (02) 9741 8555 **Fax:** (02) 9741 8500
Website: www.jaycar.com.au

AC-DC RF Field Analyser for WiFi

The new Bantam Instruments "Wireless Wizard" hand-held spectrum analyser seeks out WiFi access points in the frequency range of 2.4 - 6.0GHz . This covers all WiFi channels and the instrument's omni-directional 2.4GHz and 5.0GHz antennas are similar to those used in WiFi systems. There are a further 18 channel, 4.94GHz to 4.99GHz public safety band analysis feature provided. All network channels can be displayed, and the instrument can zoom in on any channels of interest and then revert to display of the entire band.

Contact:
Westek Electronics Pty Ltd
2/6-10 Maria St, Laverton Nth Vic 3026
Tel: (03) 9369 8802 **Fax:** (03) 9369 8006
Website: www.westek.com.au

It's a little Devil – and it's HOT!

Hot Devil have introduced a range of seven low-cost, high-performance butane-powered soldering irons and gas torches – with prices starting at less than $14.00!

They cover a wide range of applications including soldering electronics, auto electrics, hobbies and much more. Designed to suit both the professional and hobbyist, they are easy to use, they're portable so there's no mains power needed and there is no fuss. Each can refill in seconds.

Visit the website below for more information.

Contact:
L.N. Marketing Pty Ltd
PO Box 141, Patterson Lakes, Vic 3197
Tel: (03) 9775 0713 **Fax:** (03) 9775 1428
Website: www.hotdevil.com.au

Wireless and Cricket Fever at RS Components

Using radio to replace wires is rapidly becoming established in telecommunications, industrial automation, security and asset management, building systems and leisure.

Recognising the significance of wireless technology, RS has selected a new range of wireless techologies, including RFID, Narrow Band, AM/FM, ZigBee, Bluetooth and W-LAN. There is also a range of developments boards, evaluation kits and antennas.

RS has also introduced a new range of display solutions, with a mix of products and technologies to suit all applications, from TFT and EL panels, LCD graphics and character modules, through to industrial monitors and fully embedded display solutions.

And they haven't forgotten the accessories: driver/inverter kits, touchscreens, panel-mounting printers and card-readers are included too.

RS offer 180,000 products from 1600 suppliers. With the current interest in cricket, they are promoting cricket gifts such as Shane Warne cricket balls, cricket towels, Gray Nicholls cricket sets and official team tops. Customers are able to acquire these items for free when they spend with RS Online (see the RS website for terms and conditions).

Contact:
RS Components Pty Ltd
PO Box 6864, Wetherill Park NSW. 1851
Tel: 1300 656 636 **Fax:** (02)
Website: www.rsaustralia.com

Going bush in the 4WD or camper? Want to add a second battery for security and safety? Here's the safe way to do it.

12/24V Auxiliary Battery Controller

for 4WD/Campers/Cars/Trucks/etc

It's common practice to add a second battery to motor homes, 4WDs, caravans and so on, so that any electrical or electronic devices used while stationary do not drain the main vehicle battery. It's important at the best of times but can become a matter of life and death half way up the Oodnadatta Track!

There have been all manner of schemes "invented" to connect the second battery, ranging from simple permanent paralleling (definitely not recommended!), isolating switches and many "electronic" solutions.

This is one of the latter but it is different to most, in that it uses a latching relay – which we'll explain shortly – to do the switching. This results in a very low standby current – less than 500µA – which can be even further reduced, to just 50µA, by eliminating the indicator LED. If, for example, you are using solar cells for long-term battery charging and you're the other side of Woop-Woop, every microamp is sacred

Design by Branko Justic*
Words by Ross Tester

(with apologies to Monty Python).

By the way, the reason that permanent paralleling is not recommended is that it is all-too-easy to flatten both batteries to the point where they won't start the vehicle. And a manual isolating switch is not an ideal solution to the problem because it is just that: manual. Too many times we've heard of flat main batteries because someone forgot to disconnect them, or flat auxiliary batteries because someone forgot to connect them.

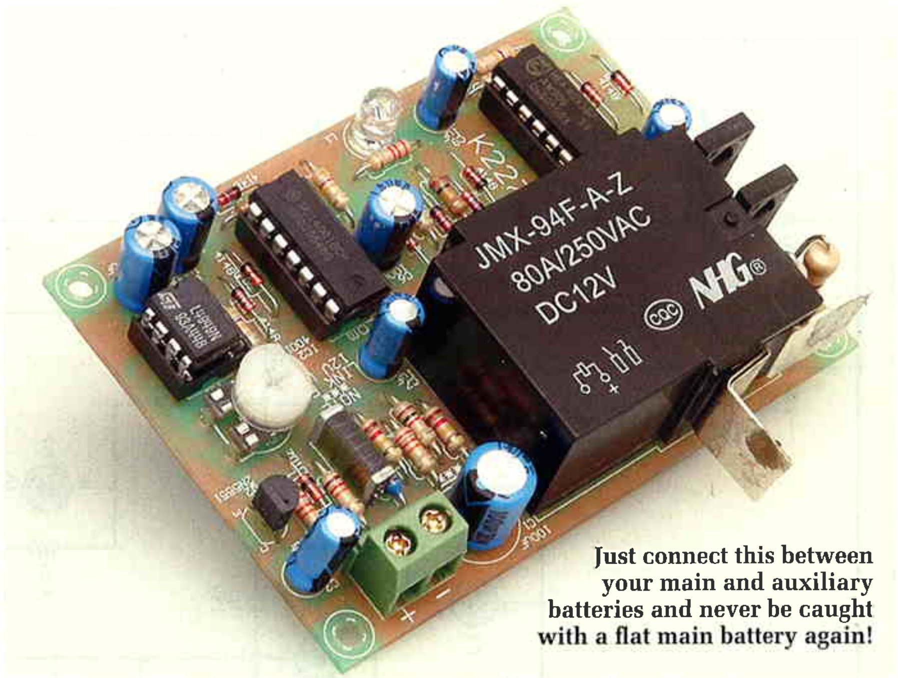
Our circuit does it automatically for you by connecting the two batteries whenever the main battery is charged to a high enough voltage – say 13.5V – to allow this to be done safely. Almost invariably, that is when the motor is running and the main battery is being charged from the alternator. (It could, of course, also be when the main battery is connected to a battery charger.)

If you connect a charged main battery to a relatively flat auxiliary battery, a quite large current can flow for a short time from one to the other, resulting in a short-term voltage drop in the main battery.

Normally, this might cause a protection circuit such as this to drop out, stopping the current flow and bringing the main battery voltage back up, resulting in the circuit connecting the two batteries again, resulting in a voltage drop, resulting in . . .

The result can be relay chatter (and lots of contact arcing – not good!) as it rapidly switches on and off. This circuit precludes this by putting in a 30-second delay (via a monostable based on IC2).

The adaptor can be used with either 12V or 24V systems, so it suits both small and large vehicles. As a bonus, it can protect the main battery by acting as a low-voltage dropout – lead-acid vehicle batteries do not like being discharged too far and this will stop that happening



Just connect this between your main and auxiliary batteries and never be caught with a flat main battery again!

How does it work?

We'll assume this is a 12V system but the same explanation holds for a 24V system (simply double the figures!).

To understand how the circuit works, you need to remember that the unloaded voltage of a charged vehicle battery that is at normal ambient temperature and has not been used for some time is usually around 12.6V. When the vehicle is started, the alternator charges the battery and the voltage rises to around 14V.

The circuit is shown in Fig.2. Starting from the top left, Q1 is a simple regulator which prevents the supply to IC1 (L4949) spiking above about 15.5V, which is quite possible in a vehicle.

IC1 is the heart of the circuit and is described as a monolithic integrated 5.0V voltage regulator with a very low dropout voltage and additional functions such as power-on reset and input voltage sense.

We're not using it exactly as the manufacturer intended – in this circuit only the voltage sensing comparator and the 5V regulator sections are used.

Pin 8 provides the regulated 5V output used by the rest of the circuit.

Pin 2 is the input for the voltage sensor section of the IC. It is connected to a voltage divider across the main battery supply, consisting of four resistors (six for 24V) and a 2kΩ trimpot (VR1), which sets the trigger voltage. The 22nF capacitor filters out any spikes or noise, which are highly likely in vehicle wiring.

Let's assume you turn on the ignition and your main battery is a bit on the low side. The L4949 would sense this but in fact, it doesn't matter because very little happens in the circuit, apart from an indicator which we'll get to shortly.

It's only when the main battery voltage rises to the IC's threshold that the action starts!

With the engine started, the main battery voltage rises. When the voltage at pin 2 reaches IC1's threshold (1.34V), an internal transistor at the output (pin 7) is turned off. Pin 7 there-

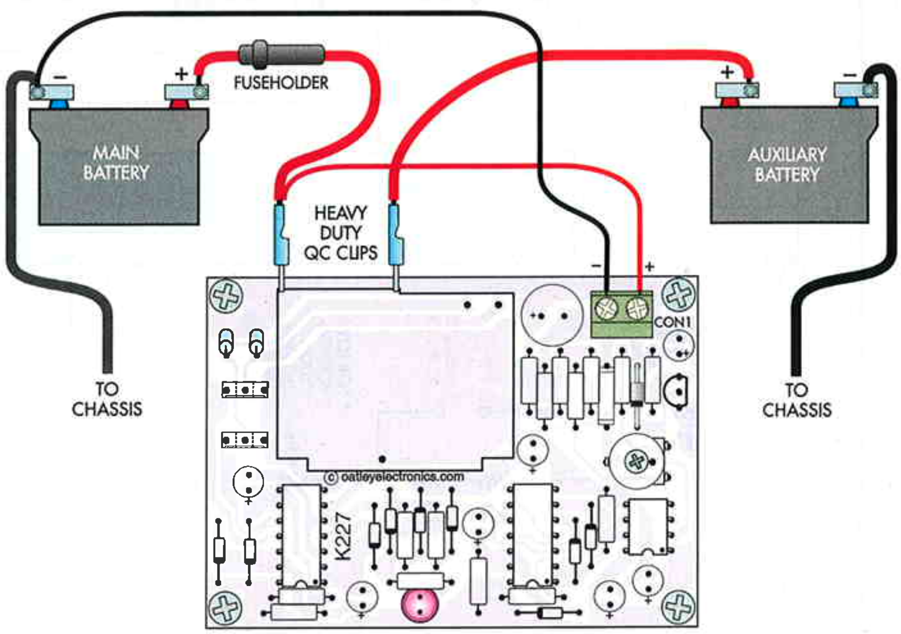
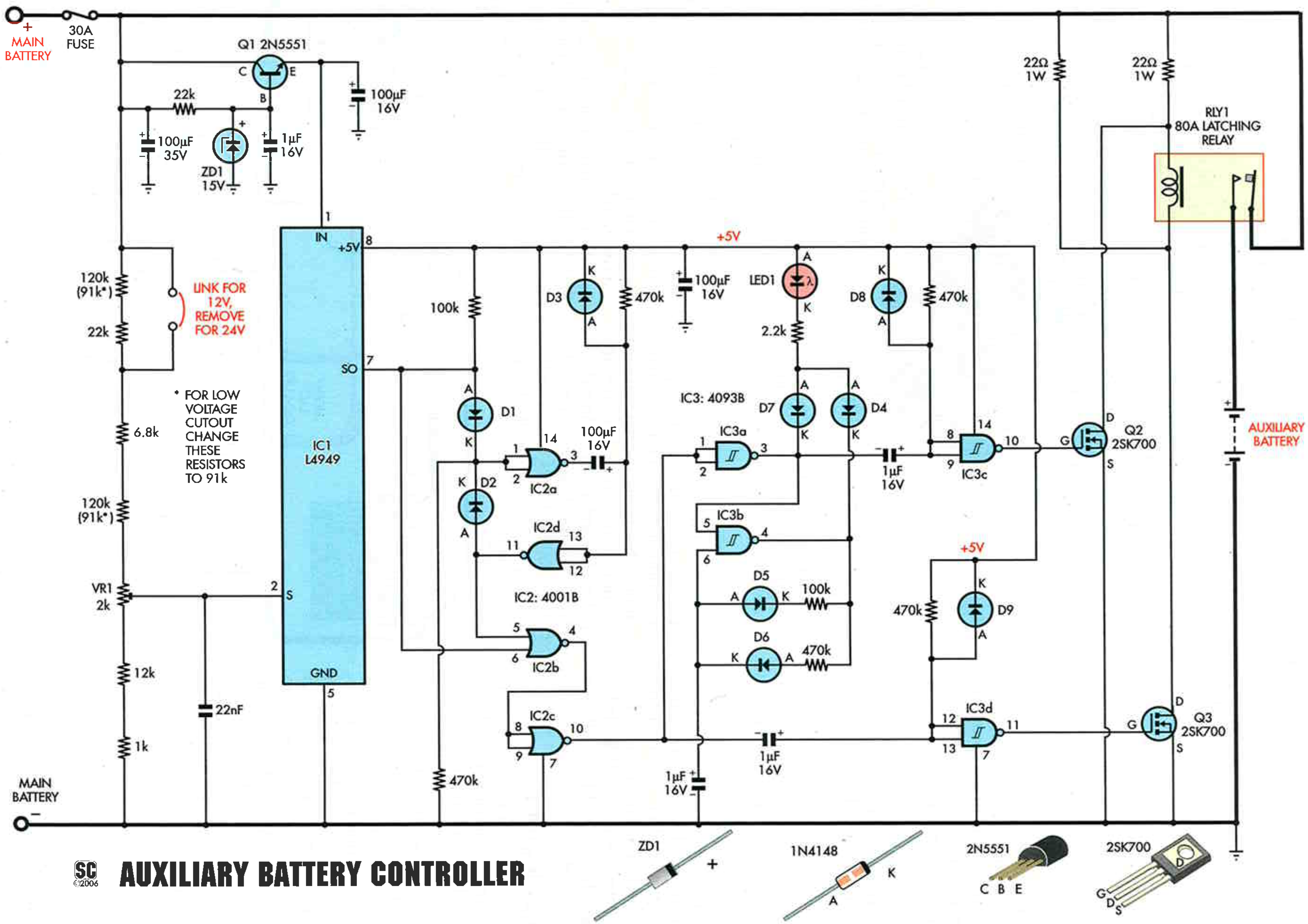


Fig.1: here's how the Auxiliary Battery Controller fits into the system. It won't connect the auxiliary battery if the main battery doesn't have enough charge.



AUXILIARY BATTERY CONTROLLER

Fig.2: the circuit is based on an L4949 precision 5V source and low-dropout regulator. Only one of Q2 or Q3 can conduct at any one time and then it's only for half a second or so, just enough time to flip over the latching relay.

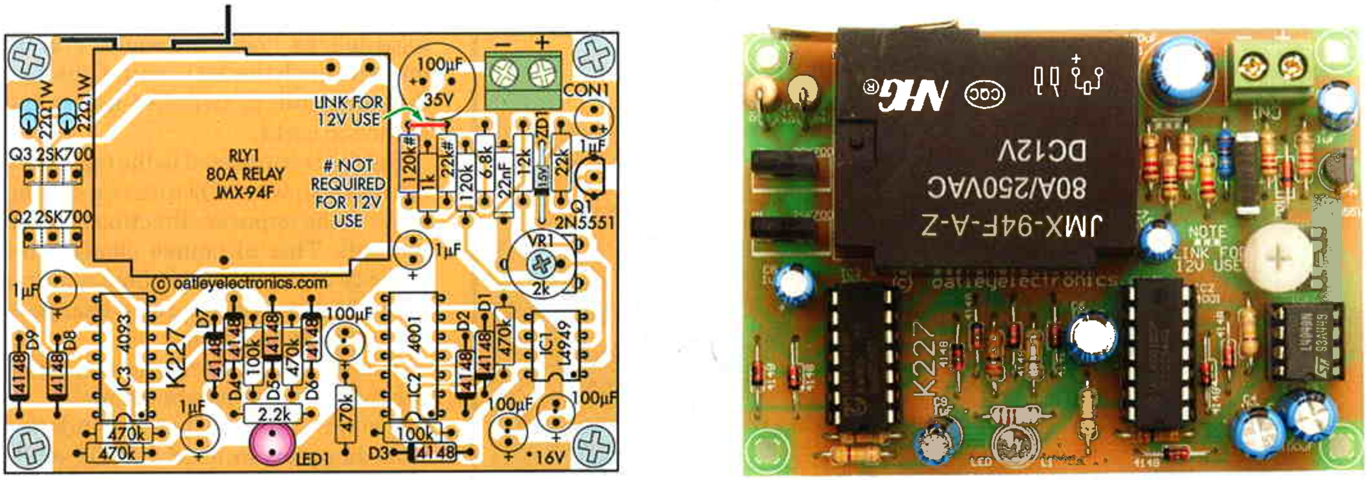


Fig.3: there's nothing particularly tricky about soldering the PC board – except perhaps getting all the diodes around the right way! You can solder direct to the relay terminals or use appropriate heavy-duty crimp connectors. Note the link for 12V use.

fore goes to logic high via the 100kΩ pullup resistor.

IC2a and IC2d, along with the 100µF capacitor, 470kΩ resistor and diodes D3 and D2, form a monostable. It is triggered by IC2a's input while the output is pin 11 of ICd.

The monostable's input pins 1 & 2 are normally pulled low by the 100kΩ resistor to 0V and the output at pin 11 of IC2d is also low since IC2d's inputs are pulled high via the 470kΩ resistor to +5V.

When the battery voltage goes high, so does pin 7 of IC1 and this pulls pin 6 of IC2b directly high and pins 1 & 2 high via diode D1. This causes pin 11 of IC2d to go high for about 30 seconds while the 100µF capacitor charges up. This stops the circuit from hunting up and down quickly if the battery voltage varies substantially.

So with IC2b's inputs high, its output goes low, forcing the output of IC2c to go high. This in turn sends IC3a's inputs high and its outputs low. The 1µF capacitor between IC3a and IC3c now charges, quite quickly, meaning IC3c's input goes from low to high, in about half a second.

IC3c's output does the opposite – it goes from high to low in the same time. While high, it turns on Mosfet Q2, briefly energising the relay coil and closing the contacts.

Because it is a latching relay, the contacts stay closed. This connects the auxiliary battery directly across the main battery, allowing it to charge.

OK, so what happens if the voltage at pin 2 of IC1 falls below the threshold (1.24V)?

Much the opposite, in fact. This time, both of IC2b's inputs are taken low, quickly charging the 1µF capacitor between IC2c's output and IC3d's inputs. IC3d's output goes briefly high, switching on Q3 and energising the relay coil, with current flowing in the opposite direction.

Therefore the latching relay switches its contacts over, disconnecting the auxiliary battery from the main battery so that the main battery won't discharge into the auxiliary battery.

Latching relay

The relay contacts are rated at 80A, 250V AC, so it is capable of switching in even a relatively discharged auxiliary battery.

The relay contacts would not normally be subjected to anything like this punishment because when they break (the worst-case scenario when arcing normally occurs) it would almost always be with either a fully charged (or mostly charged) auxiliary battery, so the charging current would be very much reduced, probably to only a couple of amps, if that.

As we mentioned before, RLY1 is not a "normal" relay. It's a latching relay, which can be changed over by reversing the current flow in its coil.

Q2 and Q3 power the relay coil from opposite sides. In Q3's case, it can be

Where from, how much

This project was designed by Oatley Electronics, who hold the copyright. A complete kits of parts (Cat K227) is available for $19.00 plus $7.00 pack & post within Australia. Contact Oatley Electronics, PO Box 89, Oatley NSW 2223, or via their website, www.oatleyelectronics.com.

Parts List – Auxiliary Battery Controller

1 PC board, 80 x 58mm, coded OE-K227
1 SPST latching relay, 12V 80A contacts
1 2-way screw terminal block, PC mounting
1 8-pin IC socket
2 14-pin IC sockets

Semiconductors
1 L4949 IC (IC1)
1 4001 quad NOR gate (IC2)
1 4093 quad NAND gate (IC3)
1 2N5551 NPN transistor (Q1)
2 2SK700, P239 N-channel Mosfets (Q2, Q3)
1 high-intensity red LED (LED1)
1 15V 400mW zener (ZD1)
9 1N4148 diodes (D1-D9)

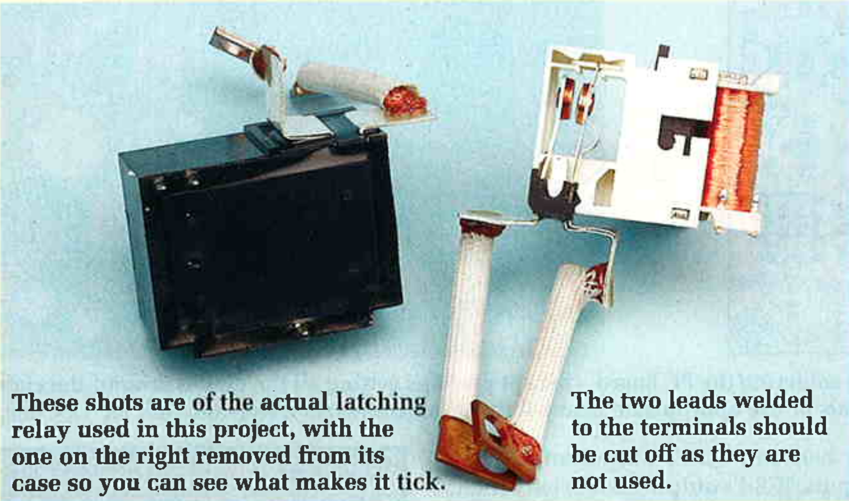
Capacitors
1 100µF 35V electrolytic
3 100µF 16V electrolytic
4 1µF 16V electrolytic
1 22nF polyester

Resistors (0.25W 5%)
5 470kΩ 2 120kΩ 2 100kΩ
2 22kΩ 1 12kΩ 1 6.8kΩ
1 2.2kΩ 1 1kΩ 2 22Ω 1W
2 91kΩ (for low voltage dropout)
1 2kΩ horizontal trimpot (VR1)

Not supplied in the Oatley kit:
1 high-current fuseholder and 30A fuse
Heavy-duty (200A) battery cabling in red and black
Connectors to suit
Suitable mounting case

* Oatley Electronics

What is a latching relay?



These shots are of the actual latching relay used in this project, with the one on the right removed from its case so you can see what makes it tick.

The two leads welded to the terminals should be cut off as they are not used.

We thought a brief explanation of this component would be in order because a latching relay is not something that you come across every day. In fact, even those "in the trade" may not understand the operation nor purpose of a latching relay.

First, a conventional relay: this has an electromagnet, formed by a coil wound on a soft iron core. While current flows through the coil, a magnetic field is created which attracts a spring-loaded steel armature towards the iron core. The armature either pushes or pulls electrical contacts towards or away from each other, making or breaking a circuit (and in most relays, both – breaking one circuit then making another). When the current stops, the magnetic field collapses, so the armature springs back and the contacts revert to their normal state.

A latching relay is much the same, except that once the armature has switched over to the opposite position, it will stay there, even when the current through the coil stops. It will only switch back the other way when told to by the controlling circuit. You could even disconnect the latching relay from the circuit completely and it would still stay in the last-set position.

A good analogy is a standard switch: you push the lever one way and it stays there until you push it the other way. The difference is that instead of a finger pushing or pulling a lever, you have the magnetic field pushing or pulling the armature. The armature may be held in place by a permanent magnet or it may be mechanically latched, based on a spring and detent system (which, incidentally, is how most switches stay in the selected position).

Another analogy is a bistable multivibrator or flipflop – it has two stable states, neither of which has any pre-eminence over the other.

Latching relays may have two coils – one switching to one position, the second switching to the other – or it may have a single coil, where the current is reversed through the coil to switch to the opposite state. This is the type of latching relay used in this project.

It is a common misconception that latching relays do not consume power when energised. Although current is not required through the coil to hold the armature in position, current will still flow if applied, negating the reason for using a latching relay over a conventional relay. Therefore, a short pulse of current is normally used to actuate it, just as in this project.

Where conventional relays have a "normally open" (NO) and "normally closed" (NC) position, latching relays with changeover contacts don't – because there is no "normal" position. In our case, the relay is a SPST type so, like a switch, the contacts are either open or closed (off or on, if you like).

Finally, no relay coil suppression diodes can be used on a single-coil latching relay because of the polarity reversal. Therefore the voltage rating of any switching transistor (or Mosfet in this case) must be high enough to safely handle the spike which occurs when current ceases and the magnetic field collapses.

regarded as "conventional": current flows through the 22Ω resistor, through the relay coil, is switched by Q3 and thence to earth.

But Q2 is connected to the top side of the coil – so when Q2 turns on current flows in the opposite direction through the coil. This of course changes the polarity of the magnetic field and it is this which makes the relay change to the opposite position.

There's more information on latching relays in the separate panel.

Just in case you were wondering what happens to IC3d and Q3 while this is going on, the answer is nothing! The 1μF capacitor between IC2c and IC3d is discharged but IC3d's inputs are held high by the 470kΩ resistor to +5V. Therefore its output stays low and Mosfet Q3 is turned off.

LED indicator

We haven't yet mentioned IC3b and the components around it. This lights the LED to indicate charging (a continuous glow) or not charging (flashing).

IC3b, the diodes and resistors between its output and pin 6 input, and the associated 1μF capacitor form a low-frequency (4Hz) oscillator.

If IC3a's output goes low, as it does when the master battery voltage is high, LED1 is connected to earth via D7 and IC3a, so it glows continuously. This indicates that the auxiliary battery is charging.

But if IC3a's output goes high, which occurs when the main battery voltage is low, LED1 flashes at about 4Hz via isolation diode D4, indicating that the auxiliary battery is not charging.

Putting it together

All components except (of course!) the auxiliary battery and the in-line fuse, mount on a single PC board which measures 80 x 58mm.

The same board is used for the 12V and 24V versions – a link on the PC board shorts out the appropriate pads for the 12V version. As usual, start with a visual inspection of the PC board – just in case. Problem boards are very unusual these days but it is possible.

Start with the resistors – their values are shown in the resistor colour code table but for 100% assurance, check them with a digital multimeter before soldering them in. Use one of the pigtails for the 12V link. The two 22Ω 1W

Resistor Colour Codes

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	5	470kΩ	yellow purple yellow brown	yellow purple black orange brown
❑	2	120kΩ	brown red yellow brown	brown red black orange brown
❑	2	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	22kΩ	red red orange brown	red red black red brown
❑	1	12kΩ	brown red orange brown	brown red black red brown
❑	1	6.8kΩ	blue grey red brown	blue grey black brown brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	2	22Ω (1W)	red red black brown	red red black gold brown
❑	2	91kΩ*	white brown orange brown	white brown black red brown

* if used – see text

resistors mount end-on, as shown in the photos.

Next to go in are the diodes, including the zener – normally we leave semiconductors to near last but these are fiddly little things so get them out of the way now. Be careful with polarity – most face one way but some are opposite!

Now solder in all the capacitors; again, the electrolytic variety are all polarised. Fortunately, all bar one (the large 100μF 35V unit) are oriented on the PC board the same way.

From here, it's just a case of populating the rest of the board – the input socket, trimpot, IC sockets (if used), the LED and transistor and finally the two Mosfets. Once again, the IC sockets, LED, transistor and Mosfets are all polarised – follow the component overlay (and the silk screen on the PC board surface) carefully.

The thicker line on the overlay and silk screen denotes the metal side of the Mosfets. Heatsinks are not required on the Mosfets given their low duty cycle.

That leaves one thing – the relay. It will only go on one way. There are normally a couple of short lengths of heavy wire welded to the relay contacts (as shown in our photos) – cut these off as they are not required. You can solder the heavy-duty leads to the batteries direct to these contacts or you can use appropriate-sized automotive quick connect terminals. Make sure the cable you use is rated at 20A or higher – we measured peak currents of 15A with a "flat" auxiliary battery and a fully-charged main battery.

To avoid I^2R losses, the leads between the batteries should be kept as short as possible. We'd be inclined to mount the adaptor closer to the main battery than the auxiliary if there was a preference.

Naturally, it should be mounted in some form of box to keep moisture away and the box mounted in a well-ventilated area away from the radiator, moving belts, etc.

Don't forget the 30A fuse between the relay and main battery – the fuse-holder should be one rated to take the current (ordinary "appliance" type in-line 3AG fuseholders will probably melt!).

Capacitor Codes

Value	(μF value)	IEC Code	EIA Code
22nF	0.022μF	22n	223

In use

Once you have the trimpot set up with the voltage you want it to switch over at, operation is completely automatic. When your main battery reaches the threshold, the relay clicks over to connect the auxiliary battery and main battery; when the voltage drops down, the relay clicks over again to disconnect the two.

You can confirm these actions with a variable power supply and multimeter before final installation – you don't even need to connect an auxiliary battery.

Low voltage dropout protection

This project can double-up as a low voltage drop-out for a 12V or 24V battery.

Simply by changing the two 120kΩ resistors in the voltage divider string to 91kΩ, the drop-out voltage is adjustable between 10V and 11.7V. The drop-in voltage is about 0.6V above these figures. SC

DEC' 06

ALTRONICS XMAS BONANZA!

Seasons Greetings From Altronics Staff

Altronics has all your enthusiast gift ideas wrapped up this Christmas!

TRUE RMS Datalogging DMM with RS232

The full house multimeter, packed with features and value! Excellent for R&D, service work and scientific applications. **Features:** • Dual display (frequency, AC voltage & temperature) • 10 Location memory • Time mode with alarm, clock and stop watch • MIN, MAX, AVG and relative modes • Decibel • Capacitance and inductance • Temp. mode (°C/°F) • Pulse signal injection function for logic and audible testing, etc • Continuity and diode test • Logic test • Fused 20A input • Data hold and run mode

HOT PRICE!

$179 Q 1098 RRP $199

Hugely popular unit, thousands in use! A great Xmas gift idea for the enthusiast

Subwoofer Sensation!

1000's SOLD ACROSS AUSTRALIA! This fantastic subwoofer adds mind blowing realism to your home theatre or stereo system. Featuring a 180W 10 inch driver with built in amplifier producing a tiny 0.1% THD. A stunning frequency response of 35Hz-1KHz. • level control • crossover adjustment • phase reversal switch.

INSTALLS IN JUST MINUTES! NO EXPERTISE REQUIRED!

$250 C 5200 RRP $349

Portable Blow Torches

Super-hot 1300°C flame for just about any job! Handheld or self standing design for tasks such as heat-shrinking, model making, silver soldering and more! Gas feed and air flow adjustments allow a wide range of temperatures to be selected. Easily refilled with butane gas. T 2494 features a robust all aluminium design.

$29 T 2492 RRP $39.95

$59 T 2494 RRP $79

Soldering Station FOR LIFE

Don't settle for those cheap & nasty soldering stations, insist on a professional MICRON. Precision digital heating control for the easiest soldering experience you'll ever have! It's copious list of features include: • Ceramic heating element • Zero-volt switching • Comfortable slim handle for all day use • Temperature lock • 200-490°C range • Antistatic strap point.

FREE! 1kg roll of solder (T 1115) & roll holder (T 2439) valued at $42.10

$229 T 2438S VALUE!

2 Year Warranty!

"We have been using the T 2438 for 10 hours a day for the last 12 months. Our technicians are impressed with the quick heat up time, temperature accuracy and ease of use" - Richard Opie - Pentacom, QLD

17 in 1 Multitool

Great for the glovebox or toolbox! Features 17 handy tools in a single unit such as knives, saw, can opener, screw-drivers, pliers, cutters etc!

$20 T 2280 RRP $24.95

Great for those quick jobs!

SUPER STOCKING STUFFER!

LED Torch Bargain

Great for finding keyholes in the dark. Available in red, yellow, blue, green, white and UV purple. ***Choose any colour you like!***

$5ea X 0189-94 RRP $7.95ea

Autoranging DMM with True RMS

With features usually only found in meters twice the price! Capable of measuring AC waveforms with high accuracy, plus easy auto-ranging operation. **FEATURES:** • ACV & DCV to 750V • 10A rating (AC/DC)• Resistance to 40MΩ • Capacitance to 100μf • Temp to 1000°C • Continuity • Frequency to 10MHz • Diode test • Auto power off • Rubber holster & test leads included. • Data hold & relative modes

20% OFF!

$55 Q 1073 RRP $69.95

Replace those worn out remotes with just one.

Combines the functions of up to 6 remotes into a single remote! Pre-programmed to suit most AV equipment. Plus you'll never press a wrong button again with the handy red backlight!

Bargain Gift Idea!

$25 A 1009 RRP $35

Monitor your circulatory health at home!

Measures your systolic/ diastolic pressures and heart rate. Provides a simple way to get fast and accurate blood pressure readings. Stores 30 readings for up to 3 individuals.

Why pay up to $169 elsewhere?

$89 X 4002 Was $119

With jumbo 'easy-read' display & arm band.

Mini Pinhole Camera

Discrete surveillance solution for a bargain price! Pro quality product for a great price. CCD sensor, B&W only. **Limited stocks**

$50 OFF!

$99 S 9008 RRP $149

Handy Keyring Laser Pointer

Get your point across! Great for lectures, seminars, building sites, guided tours etc. Points out objects up to 50m away. Includes batteries.

$12 A 0205 RRP $14.95

SUPER PRICE!

Pilot headset for life

Last chance to buy at just $199! Amazing value for money when compared to competitors products. Incredibly comfortable to wear, even on long flights. Great gift idea for the amateur pilot in your family.

Over 20000 now in use throughout Australia, NZ, PNG and around the globe!

$199 C 9070S VALUE!

FREE: Protect your headset investment with this padded case! Free this month, valued at $28.50

Precision Driver Set

A fantastic addition to any technicians tool kit. Features a comfortable driver handle which uses 19 interchangeable, pozi, hex, torx and blade tips. Ideal for servicing on comms & digital devices etc.

Pro quality!

$15 T 2185 RRP $21.95

Compact CMOS Colour Camera

Only 30mm high! Can be mounted just about anywhere. Great for home or business surveillance. CMOS colour sensor. Also features audio for added flexibility. **Limited stocks**

$40 OFF. Perfect for monitoring your front door!

$109 S 9060 RRP $149

ALTRONICS ONE-STOP ELECTRONICS SHOP

3 Big Electronics Super-stores:

Perth WA: 174 Roe St Auburn NSW: 15 Short St Springvale VIC: 891 Princes Hwy

Order Hotline 1300 797 007

Check out the huge 8 page flyer also in this issue for more fantastic gift ideas!

Handy Hygrometer & Thermometer

$35 A 0157 RRP $44.95

Great for home brew kits, cellars or just keeping an eye on the weather! Features a jumbo LCD displaying inside & outside temperatures (plus trend indicators). Waterproof sensor makes it perfect for aquariums. In-built alerts and max/min hold functions keep track of conditions.

Also displays ideal dew point for wine or cigar storage. GREAT GIFT IDEA FOR THE WINE COLLECTOR

Cut price PC phone calls

VoIP is a great way to keep in touch with friends anywhere, PLUS save a heap on your phone bill.

SAVE A FORTUNE ON YOUR LONG DISTANCE PHONE BILL!

Voice-Over-Internet-Protocol (VoIP) Phone. Use your broadband connection as a regular telephone by making use of the new VoIP technology. Designed for use with Skype® or MSN Messenger® software. Allows easy and very cheap voice communication between PC users around the globe. It can even be used to dial normal land lines directly (with the use of an on-line subscription service). Supplied with software to suit Windows XP/2000/Me.

$29 C 9040 RRP $35

Stay in bed! Stay on time!

This fabulous projection clock shows the time in huge numbers on your ceiling or wall. Features • Alarm clock with snooze • Compact and easy to use • Powered by plugpack (M 9421 $17.95) or 2 x AA batteries.

$20 A 0135 RRP $27.95

SAVE $70!

$129 S 5136 RRP $199

Secure your home this holiday period for under $150!

DON'T PAY A SECURITY COMPANY! Protect your home, family & possessions. Also great for small business. This fantastic alarm system features unique "2 wire" technology which cuts installation time! (Just about anyone could install & program this system in HALF A DAY!) Everything you need to secure your home: Alarm panel, siren, strobe, 4 reed switches and 2 PIR sensors, plugpack, 50m of cable. **Features:** • Entry/exit delay • 4 zone monitoring • Tamper protection • Battery backup • User PIN code • PIRs use pulse count triggering to reduce false alarms • Panic function • Door chime • S 5137 additional PIR's $39

Handy 19 Range DMM

with Square Wave Output

SAVE 20%

Small enough to fit in your pocket, this DMM is great for the mobile serviceman or student lab kit. With square wave output and backlighting! • DCV to 600V • ACV to 600V • DCA to 10A • Logic Test • Resistance to 2000k • Continuity Buzzer • Transistor Hfe • Data Hold.

$19 Q 1124 RRP $24.95

Mini Keyring JET Blowtorch

Produces a powerful jet like flame! Great for camping, hiking or even as a cigar lighter! • adjustable flame • refillable gas chamber • one click ignition • sturdy metal case • 12 month warranty.

$15.95 T 2488S BARGAIN!

FREE 250ml can of high grade butane. Valued at $4.95. T 2450

Super Tough Torch, Waterproof To 30m!

$29.50 X 0200 BARGAIN!

Great for the glovebox!

Super bright LED torch powered by 7 high power Japanese made LEDs (rated at 100,000hrs). Fantastic for divers & fisherman etc. Includes 4 x AA batteries.

BARGAIN RJ45 Connector Packs

Stock up on handy RJ45 data connectors for custom making your own custom patch leads.

$40/100pk P 1418A RRP 55¢ ea

25% OFF!

Measure distances at the press of a button!

SAVE 40%

This fantastic digital ultrasonic tape measure tells you distances in an INSTANT! Super easy operation. A handy built in laser allows you to see exactly what you're measuring. Max distance 13m.

$24 T 2250 RRP $44.95

Colour! Bargain 2.4GHz Cameras

Wireless security made easy!

Superb clarity video from these **professional grade** cameras. Ideal for home or business surveillance. Each have In-built wireless transmitters.

$220 S 8716 Dome RRP $419

$160 S 8723 Pro RRP $329

B&W

COMPONENT CLEARANCE • COMPONENT CLEARANCE • COMPONENT CLEARANCE • COMPONENT CLEARANCE

Bargain Mixed Pot Packs

Great for project builders and experimenters. Available in two types. Dual gang 24mm D shaft (R 2274S) and 40T 9mm PCB mount (R 1928S). 10pc's per pack, mixed values contents may vary.

$5 R 1928S RRP $8

$14 R 2274S RRP $19

Magnetic Connectors

Small yet powerful conductive magnets for testing, prototyping, sensor triggers etc. Sold in matching pairs.

Mag Connectors		5 pairs for
P 9190	1.80x1.6mm	$5.25
P 9191	60x4.5mm	$5.50
P 9192	70x4.7mm	$7.75

Great for experiments!

Mini Tactile Switches

Building a new project? Add some style with these 10mm mini tactile switches. Available without LED or with red, green or yellow LED. **MIXED PACKS OK!**

$10/10pk S 1100 No LED RRP $1.55ea

$15/10pk S 1101-3 LED RRP $2.25ea

Powertran® 6V Transformer

$4ea M 2835L RRP $6.95

Great for small projects! 150mA max.

40% OFF. As used by OEM's!

Powertran® PCB Power Transformers

$5ea M 7030 3VA 15V RRP $9.50

$5ea M 7015 3VA 7.5V RRP $9.50

3VA and 5VA varieties. Stocks are strictly limited. 240V primary.

$6ea M 7052 5VA 6V RRP $10.50

Compact & highly efficient!

87

Express Order Hotlines

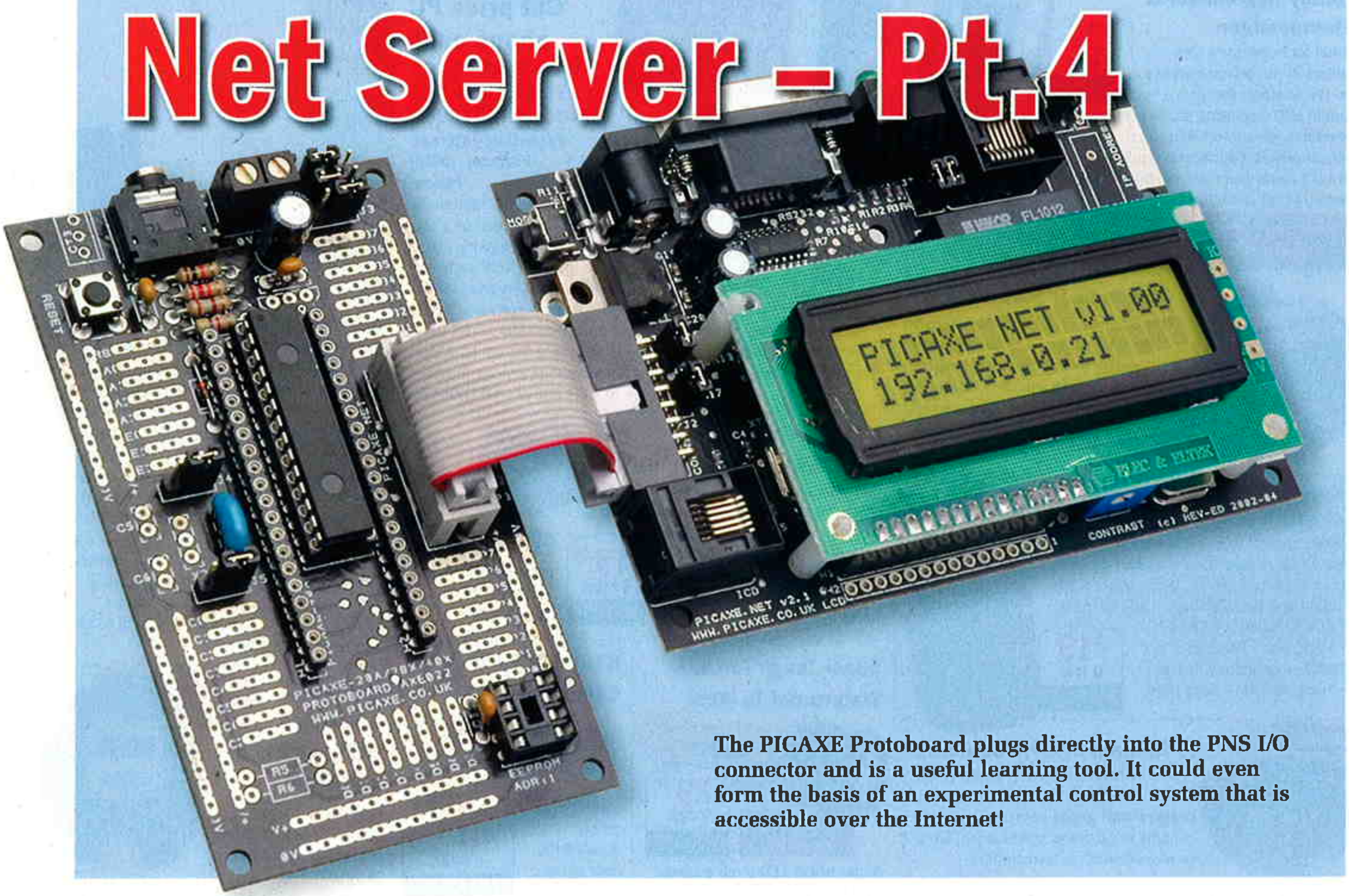
Phone: 1300 797 007 Fax: 1300 789 777 www.altronics.com.au

ALTRONICS ONE-STOP ELECTRONICS SHOP

Control your next electronics project from virtually anywhere on the planet!

PICAXE Net Server – Pt.4

By CLIVE SEAGER



The PICAXE Protoboard plugs directly into the PNS I/O connector and is a useful learning tool. It could even form the basis of an experimental control system that is accessible over the Internet!

Last month, we showed you how to use the PICAXE Net Server (PNS) to control a motor and monitor a switch in a pet feeder via the Internet. As promised, this month we look at a more sophisticated monitoring system.

AS DESCRIBED last month, basic applications requiring simple on/off control can be driven directly from the PNS with only a few extra parts. However, more complex applications often call for a dedicated controller, perhaps based on a PICAXE chip.

Fortunately, a PICAXE chip in such a system can be programmed to interact with the PNS by sharing information (such as sensor data) in a common area of memory. These variables can then be displayed within web pages or even manipulated by the PNS to alter system behaviour.

Temperature controller

Environmental temperature control is one example of a process that demands a dedicated control system. A temperature controller might be used to regulate the temperature in a dwelling, greenhouse, fish tank or even home-brew storage tank – to name a few examples!

An outline of a rudimentary controller that could be used to maintain room temperature (in a cold-weather climate) within a specific range is shown in Fig.1. It is based around a PICAXE-28X chip, which controls a heater and fan via transistor switches and relays. A DS18B20 sensor provides temperature feedback.

If the PNS were not connected to the temperature controller, then the

BASIC program in Listing 1 would be all that's required. The program waits until the temperature drops below a minimum of 16°C, at which point the heater (on output 2) is switched on. When the temperature subsequently rises above 22°C, the fan (on output 5) is switched on.

In this example, the purpose of introducing the PNS into the system is to be able to remotely monitor the room temperature. To do this, the PICAXE chip needs to copy the temperature value into the PNS shared memory space every time the DS18B20 sensor is read.

Shared memory

The PNS includes an area of memory that can be accessed by both itself and a connected PICAXE chip. This shared memory is located within the DS1307 chip on the PNS circuit board and is accessible via the I^2C serial bus (see Fig.2).

Handshaking is employed to ensure that both the PNS and PICAXE chip do not access the shared memory simultaneously. In normal operation, the PNS has control of the I^2C bus and the PICAXE chip simply ignores I^2C communications.

However, when the PICAXE is ready to update the shared memory, it sets the *RTS* signal (*output0*) high. Once the PNS is ready to release the I^2C bus, it responds by taking the *CTS* signal (*input 5*) high. At this point, the PICAXE chip is free to use the I^2C bus. Once communication is complete, the PICAXE lowers the *RTS* signal. The PNS responds by lowering *CTS* and retaking control of the bus.

The modifications required to the PICAXE program to enable shared memory access are shown in Listing 2. As you can see, memory location 50 is used to store the temperature variable (*temp*).

Of course, this application shares only one PICAXE variable but more variables can be shared if desired. In addition, it's possible to reverse the process, allowing a value entered on a web page to be transferred back to a PICAXE variable. Refer to the PNS data sheet for details on how this can be achieved.

Hardware setup

The PICAXE Net Starter Pack includes a PICAXE Protoboard (part no. AXE022) which comes fitted with a

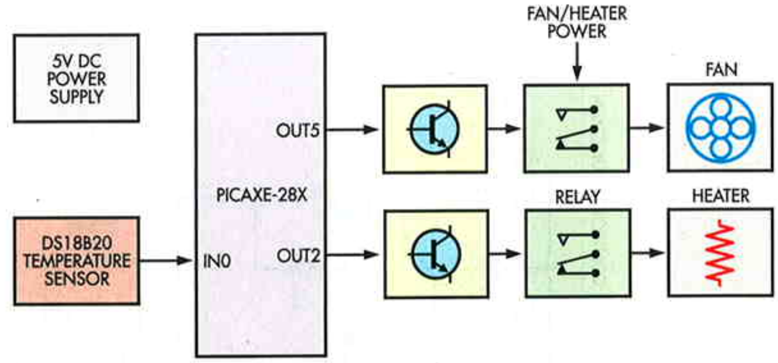


Fig.1: here's the basic outline of what would be required for the rudimentary temperature controller described in the text. It uses a PICAXE micro to control a fan and heater via two transistors, which in turn switch two relays. A DS18B20 sensor provides temperature feedback.

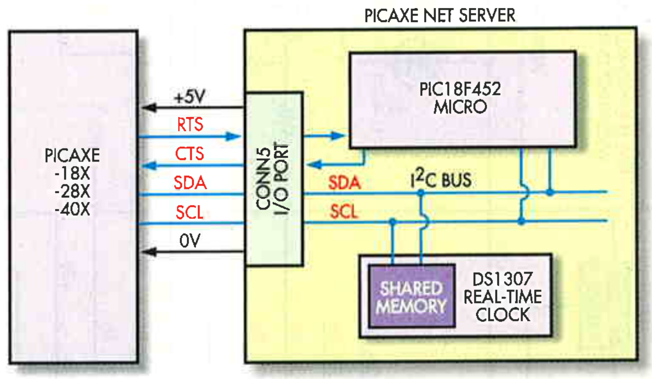
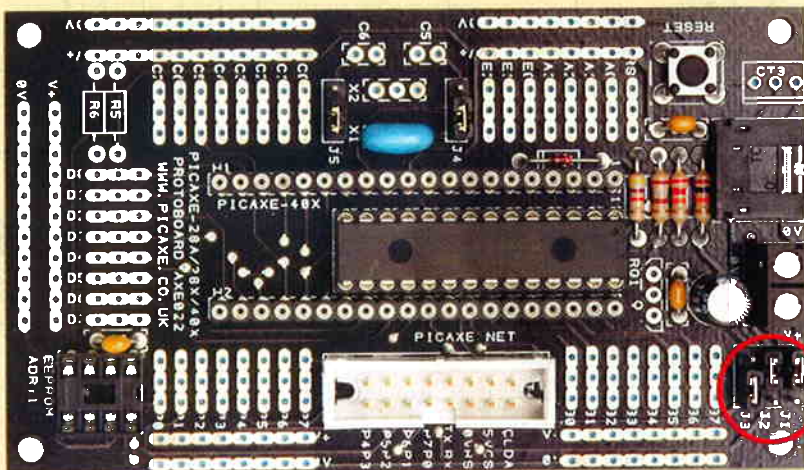
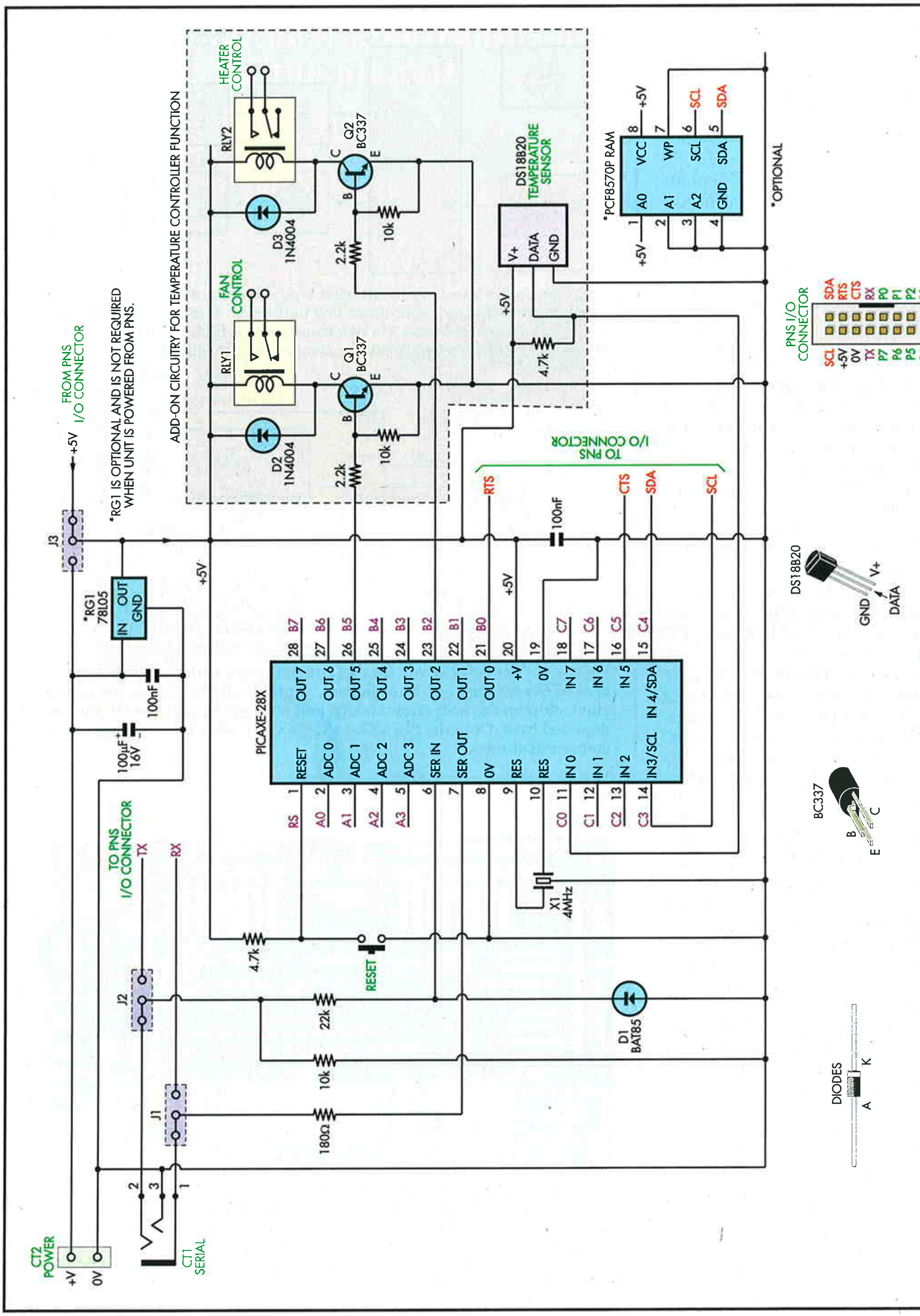


Fig.2: external PICAXE micros can communicate with the PNS via an area of shared memory. This memory is physically located in the DS1307 clock chip on the PNS circuit board and is accessed over the I^2C bus, as depicted here. Only the PICAXE-18X, -28X and -40X micros support I^2C communications.



A PICAXE Protoboard is included in the Net Starter Pack and it comes preassembled with a PICAXE-28X chip. Rows of pads around the board provide easy access to all of the micro's port pins. When jumpers J1 & J2 are positioned as shown (the default), the PICAXE chip is programmed via the on-board stereo socket. For remote programming over the Internet, move J1 & J2 to the righthand position.



SC ©2006 PICAXE PROTOBOARD-BASED TEMPERATURE CONTROLLER

◀ Fig.3 (left): here's the circuit for most of the PICAXE Protoboard (only the optional oscillator circuit consisting of X2, C5, C6 , J4 & J5 has been omitted). Note the area enclosed within the grey box – this is not part of the Protoboard circuit. Its purpose is to demonstrate what would be required to convert the Protoboard into a rudimentary temperature controller, as outlined in Fig.1.

PICAXE-28X chip. This board can be connected directly to the PNS via the supplied ribbon cable, which connects the I^{2}C bus (SDA & SCL) and handshaking (RTS & CTS) signals.

The PNS also provides power (+5V) to the Protoboard over this connection, so no separate power source is required for most experiments. Before powering up, make sure that jumpers J1–J3 are positioned as shown in the accompanying photograph.

Fig.3 shows the majority of the circuit for the Protoboard. Also included (within the grey box) is the additional circuitry needed for the temperature controller function we described earlier. If you want to build your own temperature controller, then this additional circuitry (comprising Q1, Q2, RLY1, RLY2, etc) can be constructed on Veroboard or similar and connected to the PICAXE-28X port pins via the empty rows of pads on the board.

Warning: the two 5V relays (RLY1 & RLY2) must not be used to switch 240VAC mains voltages. If mains appliance switching is required, then the relay contacts can be wired to appropriately rated external switching devices, such as the "Remote Relay" (DSE Cat. K-3041) published in the May 2006 edition of SILICON CHIP.

Note that it's not necessary to construct the entire add-on circuit (within the grey box) to experiment with shared memory and the PNS web pages presented here. Instead, you may wish to connect just the DS18B20 temperature sensor and it's 4.7kΩ pull-up resistor; this will at least allow remote monitoring of ambient temperature.

PNS web page

Our web page for this month is very simple, as all it needs to do is display the temperature value. Again, the code is split between two files, *temp.cgi* (Listing 3) and *index.htm* (Listing 4).

The file *temp.cgi* retrieves the temperature value every three seconds by reading the value from shared memory address 50. As usual, *index.htm* uses frames and *temp.cgi* to build the home page.

Refer to Pt.3 last month to learn how the code works and how to download it into the PNS.

Remote PICAXE programming

So what happens if you want to

Listing 1: tempcontrol.bas

```
symbol temp = b1

main:
  pause 3000
  readtemp 0,temp
  if temp < 16 then heater_on
  if temp > 22 then fan_on

all_off:
  low 2
  low 5
  goto main

heater_on:
  high 2
  goto main

fan_on:
  high 5
  goto main
```

Listing 2: tempmonitor.bas

```
symbol temp = b1

init:
  i2cslave %11010000, i2cslow, i2cbyte
main:
  pause 3000
  readtemp 0,temp
  gosub PNS_write
  if temp < 16 then heater_on
  if temp > 22 then fan_on

all_off:
  low 2
  low 5
  goto main

heater_on:
  high 2
  goto main

fan_on:
  high 5
  goto main

' Sub to update PNS memory
PNS_write:
  high 0                        'set RTS
CTS_loop:
  if pin5 = 0 then CTS_loop     'wait for CTS
  writei2c 50,(temp)            'write temp to byte 50
  low 0                         'clear RTS
  return
```

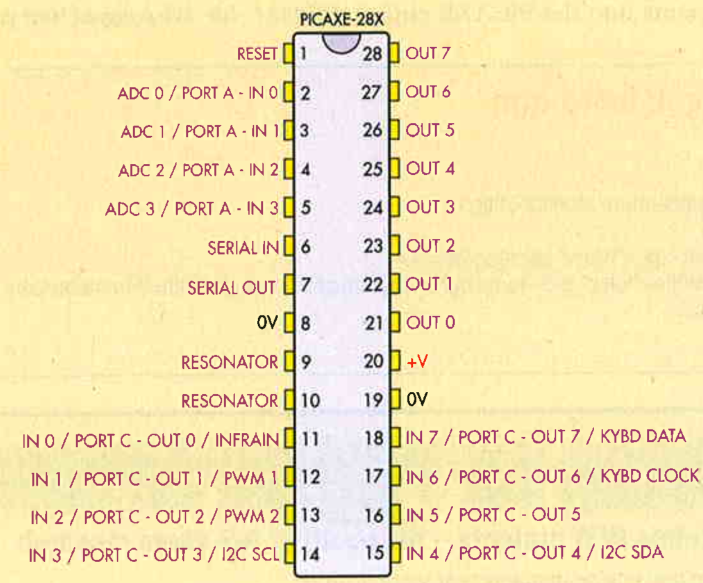


Fig.4: the circuit in Fig.3 uses abbreviated labels for the PICAXE-28X pins. Here's a more comprehensive pinout diagram.

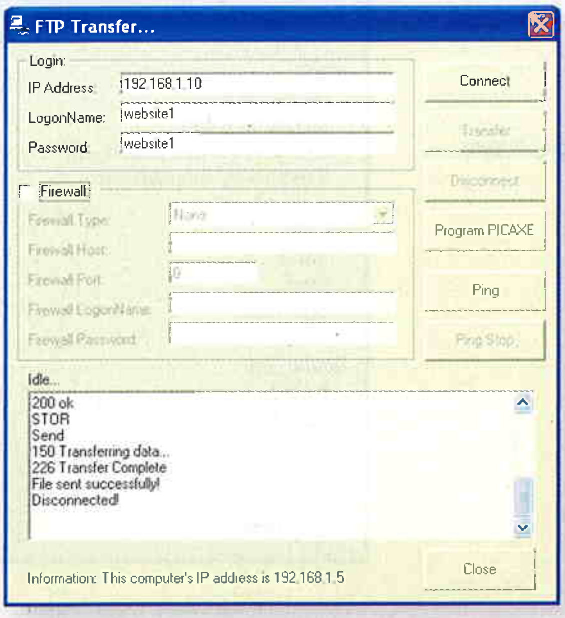


Fig.5: once the compiled PICAXE code has been successfully transferred to the PNS, all you need to do is click on "Program PICAXE" to remotely reprogram the PICAXE chip on the Protoboard!

Listing 3: temp.cgi

```
<html>
<meta http-equiv="refresh" content="3">
<head>
<title>Temperature Monitor</title>
</head>
<body>
<center>
The temperature value is ?50 &deg; Celsius
</body>
</html>
```

be able to change the temperature threshold values of the PICAXE program remotely? One way to achieve this would be to expand the BASIC program and html code so that you can alter these values on a web page. Another way would be to download a new BASIC program into the PICAXE chip over the Internet!

To enable the PNS to download new programs into the PICAXE chip remotely, you must first move jumpers J1 & J2 on the Protoboard to the right-hand side (see photos). This connects the PICAXE chip download pins to the PNS serial port via signal lines "TX" and "RX" on the PNS I/O connector.

Important: you must first disconnect the Protoboard (or move J1 & J2 back to their default lefthand positions) before connecting the PNS to your PC via the RS232 cable. We suggest that you place masking tape or similar over the 9-pin "D" connector on the PNS to prevent accidental dual connection.

To initiate the download process, first open the desired BASIC program in the Programming Editor and then select *PICAXE->Wizards->PICAXE Net Server->PICAXE Download* from the menu. The program is first compiled and if this is successful, the "FTP Transfer..." dialog appears (Fig.5).

Now click on the "Connect" and "Transfer" buttons in turn. Once the "File sent successfully" message is displayed, the PNS can be issued with a "Program PICAXE" command. This can be achieved manually via a web page form or by clicking the "Program PICAXE" button.

Summary

This is the final instalment of our 4-part series on the PICAXE Net Server. We hope that our examples have aptly demonstrated how this versatile unit could be used to bring low-cost remote Internet access to many different types of projects.

For more information, check out the complete PNS datasheet (*NET001.pdf*), available for download from **www.picaxe.co.uk**. **SC**

Listing 4: index.htm

```
<html>
<head>
<title>Temperature Monitor</title>
</head>
<frameset cols="100%" frameborder=1>
<frame name="temp" src="temp.cgi" marginheight=2 marginwidth=2 frameborder=1>
</frameset>
</html>
```


Salvage It!

BY JULIAN EDGAR

The good bits in microwave ovens

You've got to be extremely careful with microwave ovens – even a "dead" one can kill you! Here's how to render it safe and salvage some very useful parts.

FIND A HEAP OF discarded consumer goods and nine times out of ten there will be a microwave oven in there.

Provided it's free, there are plenty of small but useful components inside a microwave oven that are worth salvaging. However, there's also a potentially fatal surprise for anyone who delves into the innards of a microwave oven without knowing what they're doing.

So how can you make sure you survive the encounter and what will you find in there that's useful?

Danger!

Inside a microwave oven is a capacitor that may well be fully charged to well over 2000V. **If so, that capacitor has enough stored energy to kill you, so it must be made harmless before you can proceed any further.** In addition, there may also be other charged capacitors on the mains input just waiting to deliver a nasty shock.

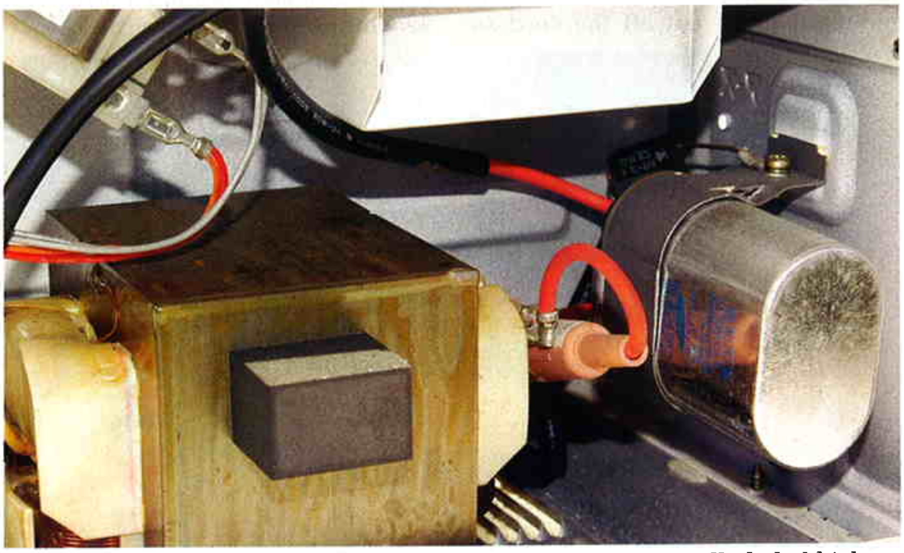
In most ovens, there is a bleed resistor across the high-voltage capacitor to discharge it after the oven is switched off. However, there is no guarantee that this resistor has done its job or is even still intact.

If the bleed resistor has gone open circuit (or if no bleed resistor is present), then the high-voltage capacitor could still easily have several thousand volts on it long after the oven has been switched off and disconnected from the wall socket. What's more, it can retain this lethal charge for many months.

That means that you have to assume that the capacitor is charged to a lethal voltage and must be safely discharged before you can remove any parts from the oven. You do that by first briefly shorting each capacitor terminal to chassis and then shorting the terminals directly together to make sure – all without touching anything.

First, you will need two long, insulated screwdrivers suitable for working with high voltages (ie, 5000V or more), thick rubber gloves (eg, those used for handling acids, not the thin type used for washing up), a short length of heavy-duty insulated wire with well-insulated alligator clips at each end (see panel), thick rubber-soled shoes (or a thick rubber mat to stand on) and protective goggles (to protect your eyes from flying molten metal).

Once you have connected the Active and Neutral pins of the power plug together (to discharge any capacitor on the mains side), cut the power cord off so the oven cannot possibly be plugged into the mains. This is a very important safety step.



On the left is the mains transformer and on right is the potentially lethal high voltage capacitor. You need to be able to access the terminals of the capacitor to be able to safely discharge it. Note that the thick heavily insulated cables seen here connect to the magnetron – discharging of the capacitor may also be achievable at the magnetron.

To safely salvage the components from a microwave oven you must first discharge the high voltage capacitor that's inside. To do so you'll need two high voltage insulated screwdrivers (one shown here), thick rubber gloves of the sort sold for handling chemicals, and a heavy-duty jumper lead equipped with well-insulated alligator clips (see panel). Additionally, you'll need safety goggles and rubber soled shoes or a thick rubber mat.

Use A Heavy-Duty Clip Lead

Note that the light-duty clip lead shown in these photos is for demonstration purposes only.

In practice, you should use a heavy-duty clip lead made from 10A mains wire (to insure adequate insulation and current rating), with well-insulated alligator clips at either end. **DO NOT use alligator clips with thin insulation.**

Before using the clip lead, use a multimeter switched to a low ohms range to ensure that the lead is intact – ie, there should be zero ohms between the two crocodile clips. Check the lead each time it is used, to ensure it is still intact.

The first step is to connect the Active and Neutral pins of the power plug together using the alligator clip lead (be sure to wear the rubber gloves). This will discharge any capacitors across the mains input **(but NOT the high-voltage capacitor).** Alternatively, you can simply short all three pins on the plug to a metal plate. **Once this has been done, cut off the cord so that the oven cannot be plugged into the mains.**

Next, remove the back of the microwave **(don't touch any of the parts or wiring)** and locate the high-voltage capacitor. It will be in a metal canister near the transformer. Thick, heavily-insulated leads will connect the capacitor, magnetron and transformer. In addition, the labelling on the capacitor will often indicate its high working voltage (eg, 2100V AC).

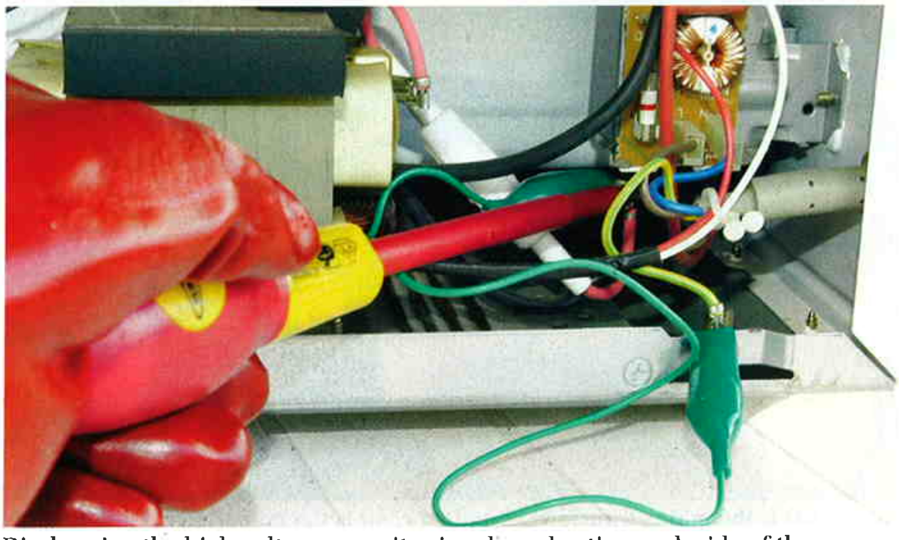
Wear rubber gloves

First, make a visual inspection to ensure you can access the capacitor's HV terminals and any exposed terminals on the back of the magnetron. **DO NOT touch the capacitor's terminals or any of the high-voltage wiring (this includes the wiring to the magnetron).** If the capacitor's terminals are hard to access and you don't know what you're doing, replace the cover immediately and quit while you're ahead.

Now, wearing the gloves, safety glasses and rubber soled shoes (or standing on the rubber mat), attach one alligator clip of the jumper lead to a good earth point (unpainted) on the metal chassis and the other alligator clip (at the other end of the lead) to the metal tip of one of the screwdrivers.

Next, holding the screwdriver by its insulating handle, touch the tip of the screwdriver (complete with its attached alligator clip) to the exposed terminals of the magnetron and then to each of the capacitor's terminals in turn. There may be a bright flash and a bang as the capacitor discharges, hence the need for the goggles. Of course, if the capacitor is not charged, nothing will happen (or, if nothing happens, it might not have discharged).

Note: exercise extreme caution if you have to undo the bracket holding the capacitor in place is order to access its terminals. Also, in many cases, you will have to prise up the insulated clips on the capacitor's terminals to expose them. **Use an insulated screwdriver for this job and make sure you are wearing the rubber gloves.**



Discharging the high voltage capacitor involves shorting each side of the capacitor (ie, each of its terminals) to earth, using a high-voltage insulated screwdriver, thick rubber gloves and a jumper lead equipped with alligator clips. Any exposed terminals on the magnetron should also be shorted to earth.

Microwave Ovens Are Dangerous!

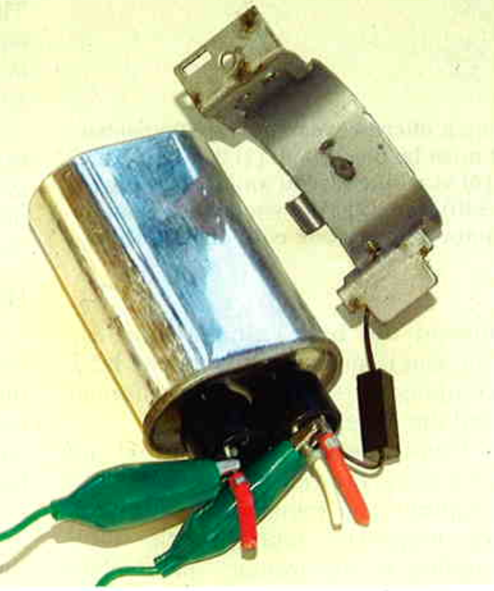
Microwave ovens can be lethal devices. Never take the cover off a microwave oven and apply power or work on a live one. The high-voltage mains transformer and its associated high-voltage capacitor that power the magnetron can easily kill you.

In fact, the high-tension output from the transformer and the 3000V DC or so developed by the capacitor and diode rectifier circuit are considerably more dangerous than the 20-30,000V EHT in a colour TV set. That's because the microwave high-tension supply is designed to supply real current!

Even after it has been switched off and disconnected from the mains, a microwave oven circuit is extremely dangerous. The high-voltage capacitor can retain a lethal charge for quite some time (perhaps even months) after its last use.

The moral here is simple – NEVER poke around inside a microwave oven (even a "dead" one) until the high-voltage capacitor has been safely discharged (see article).

Do not even think of removing the cover of a microwave oven to salvage parts unless you are experienced, know exactly what you doing and fully understand the instructions given in this article for discharging the high-voltage capacitor. This is not a job for amateurs or for those with limited knowledge. People have been killed working on supposedly "dead" microwave ovens and salvaging a few parts is not worth your life!



When the high-voltage capacitor has been discharged, it should be removed and its terminals bridged, so that you know it is definitely discharged. Important: use a heavy-duty clip lead when discharging the capacitor – see panel on p94. A light-duty clip lead like the one shown here has inadequate insulation for high voltage use and can easily fuse (they even go open-circuit in normal use).

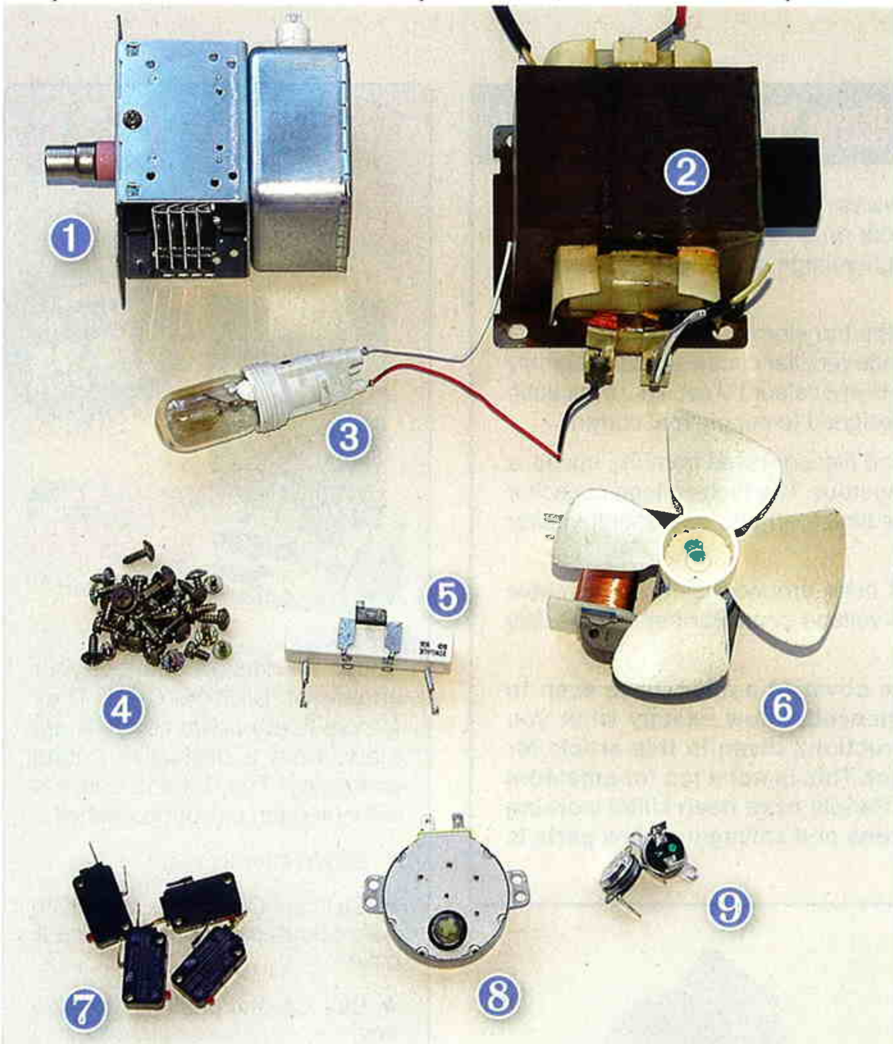
Now wait a few minutes and then discharge the capacitor again. This step is necessary because the initial discharge may have only partially discharged the capacitor.

Making sure

By now the capacitor should have discharged but it might not have if there is a wiring fault in the oven (eg, if the wiring to the magnetron is open circuit), which is why the oven was discarded in the first place.

The only way to be sure is to directly bridge the capacitor's terminals. That's best done by first using your DMM to check the integrity of the shorting clip. You can then connect the clip lead between the two screwdriver tips and then simultaneously apply each screwdriver tip to the capacitor's terminals to short them together (ie, via the attached clip lead).

That done, unclip the jumper lead from the screwdrivers and connect it across the capacitor's terminals.



Here are the parts typically salvageable from a microwave oven: (1) Magnetron – good magnets inside; (2) Transformer – it must be discarded; (3) 25W 240V bulb – good as a spare for your own oven; (4) Machine thread and self-tapping plated screws; (5) High power resistor; (6) 240V fan, (7) Microswitches – usually four in each oven; (8) 240V synchronous motor and gearbox with about 5 RPM output; (9) Temperature switches.

You can then remove the HV capacitor and **we strongly recommend that you solder a wire bridge across it's terminals.** Only now can you take off the gloves, goggles and rubber shoes.

It cannot be over-emphasised that microwave ovens with charged internal HV capacitors are extremely dangerous! You *absolutely must* ensure that the HV capacitor is discharged before proceeding.

What ever you do, don't remove the capacitor and leave it where some unsuspecting person might pick it up!

Salvaging useful parts

Most people don't immediately associate a microwave oven with big strong magnets and microswitches. However, along with quite a few other bits and pieces, you'll find these in virtually all salvaged microwave ovens.

After you've discharged and removed the high-voltage capacitor, you can remove the two nearby large components – the mains transformer and the magnetron.

Unfortunately, despite initial appearances, the transformer isn't worth keeping. The transformer is a step-up design that multiplies the 240V applied to the primary about eight times, thus giving around 2000V on the secondary. Therefore, it would theoretically appear that if 240V is applied to what was previously the HV secondary, about 30V will be available on what was previously the primary.

However, these transformers use a secondary that is earthed at the transformer frame, so **the secondary MUST NOT be connected to mains power.** Interestingly, on these transformers, there's also another secondary that looks suitable for a low voltage output when mains power is connected to the original primary. However, that would leave 2000V across on the terminals next door – potentially lethal.

In short, throw the transformer in the rubbish bin (so no-one else is tempted to use it). It's too dangerous to use in any other application.

By contrast, the magnetron is worth salvaging – no, not to make a ray gun to shoot the neighbour's cat but for the extremely powerful disc shaped magnets that are inside. These can be used wherever you need strong magnets. One good application is to glue a magnet to the base of a plastic or metal dish in which to keep nuts and bolts. That's especially useful when you're disassembling a piece of equipment – even if you knock over the dish, the nuts and bolts won't go anywhere.

Note that these magnets can be fractured, leaving very sharp edges – so be careful when handling them.

While you're in this section of the oven you can remove the temperature switches. All ovens have one and some have two. These are normally-closed (NC) designs that go open circuit if an over-temperature condition occurs. These can be salvaged for use in other equipment. Often the trip temperature is written on the switches – 95°C and 125°C are common.

You'll also find several microswitches (usually four). These snap-action switches are used in the door interlock mechanism and usually have a high current rating; eg, 16A at 250V AC.

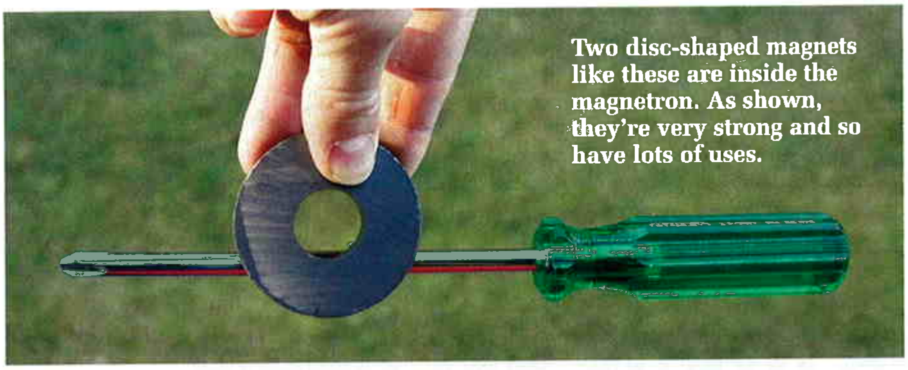
Don't forget the fan

All microwave ovens use an internal fan. These 240V fans are not enclosed (ie, the motor terminals and windings are exposed) but they are fine if mounted inside a case, with suitable insulation applied to the terminals.

Even if you don't have a use for a 240V fan, you'll find the blade assembly easily pulls off the shaft and can just as easily be pushed onto the shaft of a small DC motor. In fact, my personal desk fan comprises an ex-microwave fan-blade assembly powered by an ex-VCR DC motor, mounted on a small salvaged in-line power supply. It is quiet, compact and very effective – and each summer I marvel at the longevity of the motor which in its two lives must have done an awful lot of revolutions!

What else?

So what else will you find in the



Two disc-shaped magnets like these are inside the magnetron. As shown, they're very strong and so have lots of uses.

oven? Well, in addition to the above "goodies", you will find a high-power ceramic resistor (typically 20W and 800Ω), a compact 25W 240V light bulb (best put aside as a spare for your own microwave oven) and the turntable motor. The latter is a compact and enclosed 240V AC synchronous unit that uses an internal geartrain to provide an output speed of about 5 RPM. This is ideal for use wherever you want something to slowly rotate (a spit on a barbecue perhaps?). It can also be mechanically driven backwards, to act as a compact high-voltage alternator; eg, for use as a hand-cranked LED torch (see Salvage It! for January 2006).

The touchpad/LCD/timer assembly can also be removed and put to use – see "A Digital Timer for Less than $20" in the August 2003 issue of SILICON CHIP.

Conclusion

The parts salvaged from a microwave can be used in lots of other applications. These parts include switches, magnets, fans, high-power resistors and the turntable motor. They take up very little storage space and can be quickly and easily salvaged.

But whatever you do, make sure that you first carefully and safely discharge the high-voltage capacitor – we want you to be around to salvage lots of other goodies in the future! **SC**

Rat It Before You Chuck It!

Whenever you throw away an old TV (or VCR or washing machine or dishwasher or printer) do you always think that surely there must be some good salvageable components inside? Well, this column is for you! (And it's also for people without a lot of dough.) Each month we'll use bits and pieces sourced from discards, sometimes in mini-projects and other times as an ideas smorgasbord.

And you can contribute as well. If you have a use for specific parts which can easily be salvaged from goods commonly being thrown away, we'd love to hear from you. Perhaps you use the pressure switch from a washing machine to control a pump. Or maybe you salvage the high-quality bearings from VCR heads. Or perhaps you've found how the guts of a cassette player can be easily turned into a metal detector. (Well, we made the last one up but you get the idea . . .)

If you have some practical ideas, write in and tell us!

Vintage Radio

By RODNEY CHAMPNESS, VK3UG

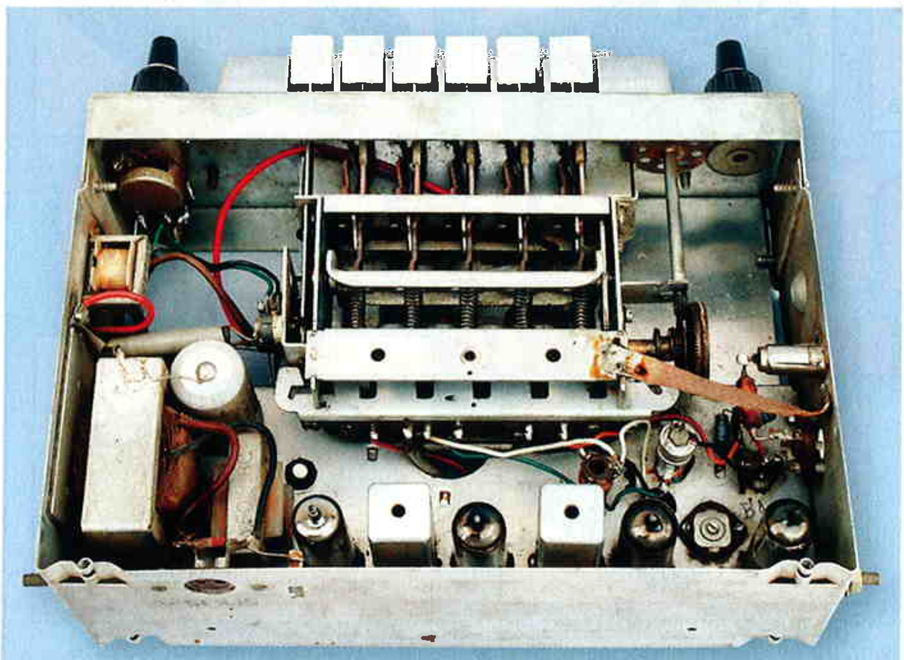
The AWA 976A Hybrid Car Radio

Developed during the 1960s, hybrid car radios combined a valve front-end with an audio output stage based on germanium transistors. They quickly replaced valve-based designs with vibrator power supplies but were themselves made obsolete within a few years.

In the beginning, the radios used in cars were nothing more than small domestic valve receivers. They were powered by an assembly of filament (A), high tension (B) and bias (C) batteries, which was rather unwieldy.

In most cases, these radios would have been used only while the vehicle was stationary (and with the engine off), as the ignition noise from vehicles such as the Model-T Ford would have been horrendous. In short, they were hardly a practical proposition and their use would have been restricted to a small percentage enthusiasts.

It soon became obvious to the manufacturers that there was a market for dedicated car radios and suitable sets began to appear during the early 1930s. In fact, it was this development that prompted valve manufacturers to produce valves with 6.3V heaters, to suit the 6V electrical systems used in cars at the time.



This is the view inside the chassis with the top cover removed. Note the pushbutton tuning mechanism.

The ubiquitous vibrator also made its appearance during the early 1930s and this meant that car radios could now be completely powered from the vehicle's electrical system. These vibrators were initially half-wave devices but were swiftly replaced by the full-wave types which are familiar to vintage radio enthusiasts.

Hybrid radios

Vibrator power supplies and 6.3V and 12.6V heater valves were almost universally used in car radios up until the early 1960s, until the introduction of hybrid car radios. These hybrid sets used a mix of valves and germanium transistors and no longer required a vibrator to supply the high-tension (HT) voltage. Instead, a special range of valves was developed that could operate satisfactorily on either 6V or 12V of HT. In fact, the upper plate voltage rating of many of these valves was around 33V.

However, while these valves worked quite satisfactorily in the radio frequency (RF), converter, intermediate frequency (IF) and low-level audio stages, they could not draw enough current (due to the low plate voltage) for the audio output stage. On the other hand, early transistors were rather poor performers at the frequencies used in RF, converter and IF stages but were quite satisfactory at audio frequencies.

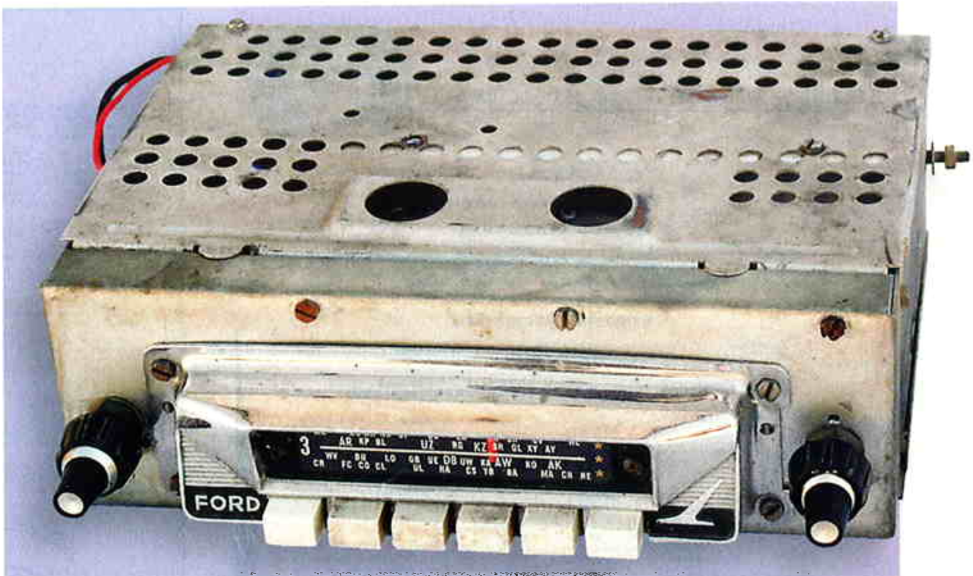
As a result, these transistors were used in the audio output stages and they provided enough output power to drive a loudspeaker.

This combination of low-HT valves and germanium transistors proved to be quite successful. However, this arrangement was to be short-lived. Within a couple of years, transistors had been improved sufficiently to make valves redundant and the hybrid sets were replaced by full-transistor designs.

An interesting innovation

Many vintage radio buffs will be unaware of hybrid car radios, due mainly to the relatively short period of time that they were made. However, they were quite an interesting innovation and demonstrated how two different technologies could be successfully married together.

In my case, I had been bemoaning the fact that I had been unable to obtain a hybrid car radio for some time – both for my collection and to prepare a column in Vintage Radio. However, when I mentioned this on one of the amateur bands recently, an amateur I'd not heard from for many years came on and said that he did have such a set – an AWA 976A, in fact. He also offered to lend it to me, along with a service manual, and I quickly took him up on his offer.



This version of the AWA 976A was made to fit Ford Falcon cars made during that era. The chassis is rather large for a car radio.

Circuit details

During this transitional time when transistors were finding their way into car radios, vehicles could be either positive or negative to chassis. European vehicles tended to be positive earth and American vehicles were negative earth.

Most vibrator-powered car radios were not polarity sensitive, so it didn't matter whether the active line from the vehicle battery was positive or negative. However, some car radios were polarity sensitive and had to be designed to operate with either earthing situation. This was achieved by fully floating the circuit inside the cabinet, which made life more difficult for both designers and servicemen alike.

By contrast, the AWA 976A was designed to be used only with negative-earth vehicles. The valve section of the set follows the normal valve line-up, with an RF stage (12BL6), a converter stage (12AD6), a single 455kHz intermediate frequency (IF) amplifier and finally a duo-diode-triode (12FK6) as a detector, AGC detector and low-level audio amplifier.

Fig.1 shows the circuit details. The antenna input is typical of most car radios from the early 1950s until the end of the valve era. The tuning is not done with a variable ganged tuning capacitor but with a variable-inductance (permeability) tuning mechanism. What is different about the input circuit is that the antenna and its cable form part of the tuned circuit at the input. Final tuning of the antenna circuit is required when the receiver is installed in the vehicle.

As usual, a telescopic antenna is used and the signal is fed to the receiver's input via a coaxial cable. In effect, the coaxial cable is in parallel with trimmer capacitor C1 and forms part of the tuned circuit. Their combined capacitance is intended to tune the antenna circuit to a peak at around 1500kHz.

During installation, C1 is adjusted to compensate for variations in the coaxial cable capacitance. The coaxial cable is not just any old coaxial cable, being usually around 110Ω in impedance and with air spacing to keep the capacitance between the centre conductor and the shield to a minimum.

Note that coaxial cable is necessary for the antenna lead, otherwise electrical noise from the vehicle would drown out all but the nearest and strongest radio stations. The coaxial cable provides shielding which prevents noise pick-up and externally mounting the antenna also significantly reduces noise.

The 12BL6 is coupled to the 12AD6 (V2) via tuned circuit L4, C5 & C6 and coupling capacitor C7. V2 is a pentagrid converter and works much the same as a 6BE6.

IF stages

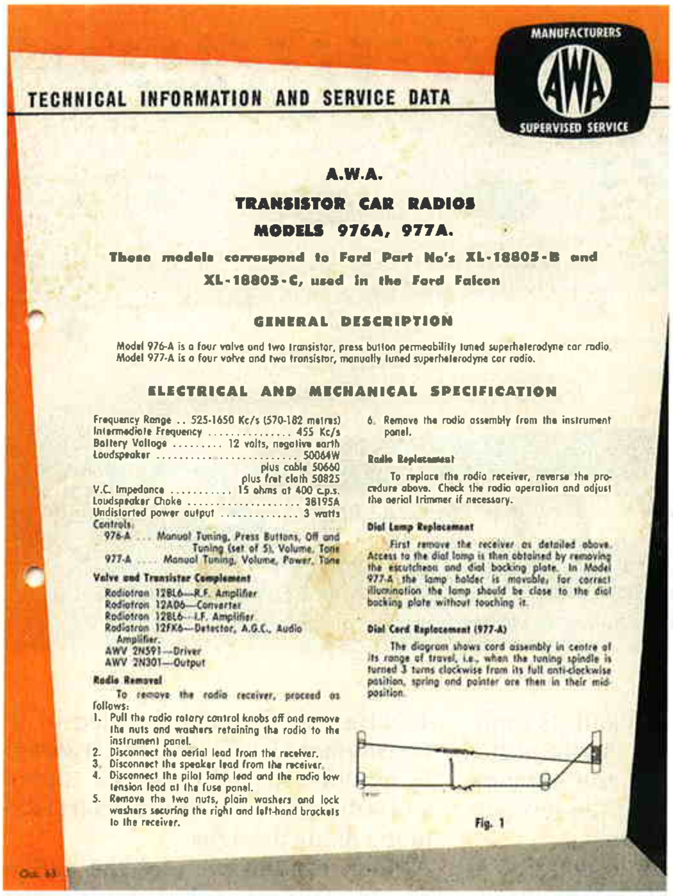
The output of the 12AD6 is at 455kHz and this signal is fed to IF transformer TR1. From there, it goes to IF amplifier stage V3 (another 12BL6) and is then fed via IF transformer (TR2) to the diode detector.

Note that the plate of the 12BL6 goes to a tapping on the IF transformer primary. This is not common practice and was probably done to match the output impedance of the valve with the dynamic impedance of the tuned circuit, to ensure maximum gain and minimum loading.

Next, the IF signal is applied to the detector diode (pin 6) of the 12FK6 (V4), where it is detected. The recovered audio is then applied to the grid of the valve, with C16, C17 & R8 filtering out the IF signal. In addition, a tone control (RV2) and a tuning mute switch (SW1) are included in the grid input to this valve.

V4 provides a modest degree of amplification, after which the audio signal is fed to the transistor output stage.

The AGC diode (pin 5) of the 12FK6 is supplied with signal from the top of the plate winding of the IF amplifier. This means that the AGC voltage is greater than it otherwise would be if derived from the signal that's fed to the detector. The selectivity of the IF amplifier is lower here too, which means that as the set is tuned, the AGC starts reducing the gain of the receiver before it is right on station. This reduces any blasting as the tuning approaches the optimum position.



TECHNICAL INFORMATION AND SERVICE DATA

MANUFACTURERS AWA SUPERVISED SERVICE

A.W.A.

TRANSISTOR CAR RADIOS

MODELS 976A, 977A.

These models correspond to Ford Part No's XL-18805-B and XL-18805-C, used in the Ford Falcon

GENERAL DESCRIPTION

Model 976-A is a four valve and two transistor, press button permeability tuned superheterodyne car radio. Model 977-A is a four valve and two transistor, manually tuned superheterodyne car radio.

ELECTRICAL AND MECHANICAL SPECIFICATION

Frequency Range .. 525-1650 Kc/s (570-182 metres)
Intermediate Frequency .... 455 Kc/s
Battery Voltage .... 12 volts, negative earth
Loudspeaker 50064W
plus cable 50660
plus fret cloth 50825
V.C. Impedance .... 15 ohms at 400 c.p.s.
Loudspeaker Choke 38195A
Undistorted power output .... 3 watts
Controls:
976-A ... Manual Tuning, Press Buttons, Off and Tuning (set of 5), Volume, Tone
977-A ..... Manual Tuning, Volume, Power, Tone

Valve and Transistor Complement

Radiotron 12BL6—R.F. Amplifier
Radiotron 12AD6—Converter
Radiotron 12BL6—I.F. Amplifier
Radiotron 12FK6—Detector, A.G.C., Audio Amplifier.
AWV 2N591—Driver
AWV 2N301—Output

Radio Removal

To remove the radio receiver, proceed as follows:

1. Pull the radio rotary control knobs off and remove the nuts and washers retaining the radio to the instrument panel.
2. Disconnect the aerial lead from the receiver.
3. Disconnect the speaker lead from the receiver.
4. Disconnect the pilot lamp lead and the radio low tension lead at the fuse panel.
5. Remove the two nuts, plain washers and lock washers securing the right and left-hand brackets to the receiver.
6. Remove the radio assembly from the instrument panel.

Radio Replacement

To replace the radio receiver, reverse the procedure above. Check the radio operation and adjust the aerial trimmer if necessary.

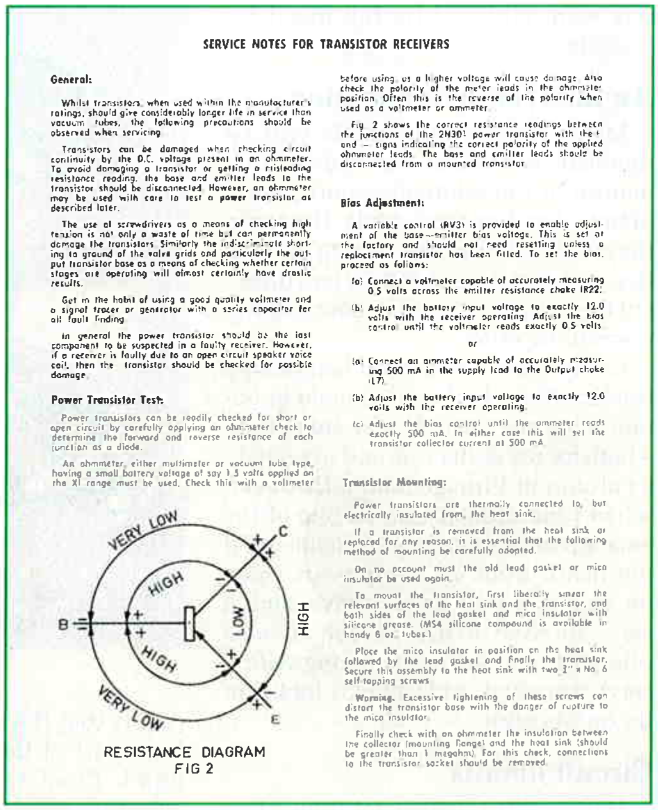
Dial Lamp Replacement

First remove the receiver as detailed above. Access to the dial lamp is then obtained by removing the escutcheon and dial backing plate. In Model 977-A the lamp holder is movable; for correct illumination the lamp should be close to the dial backing plate without touching it.

Dial Cord Replacement (977-A)

The diagram shows cord assembly in centre of its range of travel, i.e., when the tuning spindle is turned 3 turns clockwise from its full anti-clockwise position, spring and pointer are then in their mid-position.

Fig. 1



SERVICE NOTES FOR TRANSISTOR RECEIVERS

General:

Whilst transistors, when used within the manufacturer's ratings, should give considerably longer life in service than vacuum tubes, the following precautions should be observed when servicing.

Transistors can be damaged when checking circuit continuity by the D.C. voltage present in an ohmmeter. To avoid damaging a transistor or getting a misleading resistance reading, the base and emitter leads to the transistor should be disconnected. However, an ohmmeter may be used with care to test a power transistor as described later.

The use of screwdrivers as a means of checking high tension is not only a waste of time but can permanently damage the transistors. Similarly the indiscriminate shorting to ground of the valve grids and particularly the output transistor base as a means of checking whether certain stages are operating will almost certainly have drastic results.

Get in the habit of using a good quality voltmeter and a signal tracer or generator with a series capacitor for all fault finding.

In general the power transistor should be the last component to be suspected in a faulty receiver. However, if a receiver is faulty due to an open circuit speaker voice coil, then the transistor should be checked for possible damage.

Power Transistor Test:

Power transistors can be readily checked for short or open circuit by carefully applying an ohmmeter check to determine the forward and reverse resistance of each junction as a diode.

An ohmmeter, either multimeter or vacuum tube type, having a small battery voltage of say 1.5 volts applied on the X1 range must be used. Check this with a voltmeter before using, as a higher voltage will cause damage. Also check the polarity of the meter leads in the ohmmeter position. Often this is the reverse of the polarity when used as a voltmeter or ammeter.

Fig. 2 shows the correct resistance readings between the junctions of the 2N301 power transistor with the + and − signs indicating the correct polarity of the applied ohmmeter leads. The base and emitter leads should be disconnected from a mounted transistor.

RESISTANCE DIAGRAM
FIG 2

Bias Adjustment:

A variable control (RV3) is provided to enable adjustment of the base—emitter bias voltage. This is set at the factory and should not need resetting unless a replacement transistor has been fitted. To set the bias, proceed as follows:

(a) Connect a voltmeter capable of accurately measuring 0.5 volts across the emitter resistance choke (R22).

(b) Adjust the battery input voltage to exactly 12.0 volts with the receiver operating. Adjust the bias control until the voltmeter reads exactly 0.5 volts.

or

(a) Connect an ammeter capable of accurately measuring 500 mA in the supply lead to the Output choke (L7).

(b) Adjust the battery input voltage to exactly 12.0 volts with the receiver operating.

(c) Adjust the bias control until the ammeter reads exactly 500 mA. In either case this will set the transistor collector current at 500 mA.

Transistor Mounting:

Power transistors are thermally connected to, but electrically insulated from, the heat sink.

If a transistor is removed from the heat sink or replaced for any reason, it is essential that the following method of mounting be carefully adopted.

On no account must the old lead gasket or mica insulator be used again.

To mount the transistor, first liberally smear the relevant surfaces of the heat sink and the transistor, and both sides of the lead gasket and mica insulator with silicone grease. (MS4 silicone compound is available in handy 8 oz. tubes.)

Place the mica insulator in position on the heat sink followed by the lead gasket and finally the transistor. Secure this assembly to the heat sink with two ½" x No. 6 self-tapping screws.

Warning. Excessive tightening of these screws can distort the transistor base with the danger of rupture to the mica insulator.

Finally check with an ohmmeter the insulation between the collector (mounting flange) and the heat sink (should be greater than 1 megohm). For this check, connections to the transistor socket should be removed.

These two pages from the service manual give the general specifications (left) and provide useful service data, including a test procedure for the transistors.

Note that the resistors in the AGC lines have very high values, which means that any leakage in C4 or C8 cannot be tolerated. The full AGC voltage is applied to both the signal and suppressor grids of V1, while V2 and V3 both have about a quarter of the AGC voltage applied to them compared to the RF stage.

Transistor stages

Let's now take a look at the transistor stages in the audio amplifier.

As shown in Fig.1, the triode audio amplifier's plate is directly connected to the base of VT1 (2N591), the first transistor audio stage. The amplified output from VT1 is then fed via audio transformer TR3 to the base of audio output transistor VT2 (2N301).

In this circuit, the 2N301 is used as a class-A audio amplifier. Its forward bias is set to give a standing current of 0.5A and this is achieved by adjusting RV3. Note that there is very little collector current flowing through the speaker when it is connected via socket SK2. This is because inductor L7's DC resistance is extremely low, so most current flows through this inductor.

The audio output from the 2N301 output stage is around 3W, which is sufficient to drive the speaker to good volume.

The receiver's total current drain is around 1.4A which was less than half that drawn by a comparable vibrator-powered receiver operating from a 12V supply. In practice, the hybrid valve and transistor combination worked quite well and these receivers were good performers.

Cleaning up

The AWA 976A and its manually tuned brother – the 977A – were designed for use in the Ford Falcons of the era. The case is quite large and that makes it a relatively easy set to service. With no pushbutton tuning mechanism, the manual model was even easier.

As with any set, its appearance some 40 years later depends on the quality of the material used; ie, the metal plating, the timber and veneers, and plastics and bakelite. It also depends on how well the set has been looked after and where it has been stored.

The top and bottom covers are easily removed, with just three self-tapping screws holding each cover in place. The heatsink and the 2N301 transistor can then be removed by undoing three screws along the front edge of the receiver case. The transistor and heatsink are then left "swinging" but still attached by the three transistor leads – well not quite, as the collector lead broke off in this particular set. The lead was single conductor and had fatigued and broken, so I replaced it with a multi-strand lead.

However, that was a minor fault. The most obvious problem was that someone in the distant past had applied lots of heavy oil to the pushbutton tuning mechanism. Over the years, with dust, heat and vibration, this oil had worked its way into many other areas of the receiver. The oil/dust combination had then congealed and much of the set had become a black "mucky" mess.

I attached this muck using a small paintbrush dipped in kerosene, after which most of it could be removed using a rag wrapped around the end of a screwdriver. However, it was so bad in some places that I had to scrape it off. This isn't easy when there is little spare room, despite the good access for service.

In the end, the clean-up was reasonably successful but there is still some muck there. They only way to completely get rid of this would be to strip the whole set down but I'm not quite that keen. Unfortunately, the hardened oil gunk had also upset the inductance tuning mechanism and one slug has broken free.

The case itself is all metal, as is usual with car radios. This effectively shields the circuitry from the electrical interference generated by the car's electrical and ignition systems.

In this instance, the quality of the plating left something to be desired but then the manufacturer would not have expected the set to still be around some 45 years after it was made! The plating is quite pitted but it cleaned up quite well using a kerosene-soaked kitchen-scouring pad.

The control knobs on the set are not the originals according the photographs in the service data. Instead, they appear to from an AWA mantel set of around the same vintage.

Circuit checks

As usual, I began by checking the most critical capacitors for electrical leakage and found that they were all faulty. As a result, I replaced AGC bypass capacitors C4 & C8 with 50V disc ceramics, as well as audio coupling capacitor C22.

Nothing else appeared to be defective other than that the oscillator coil slug had come adrift from the tuning mechanism. The slug adjustment shaft had a bright area on it, which indicated that it had been shielded from corrosion in the tuning adjustment mechanism. As a result, I slid the adjustment shaft into the mechanism so that the bright area disappeared and then glued it into position using contact adhesive. Once dry, it appeared to work well and the slug moved freely in and out of the coil when the tuning mechanism was operated.

Sticky mechanism

This check also revealed that the tuning mechanism was rather "sticky" and wouldn't tune across the whole broadcast band. This problem was fixed by judiciously cleaning the sliding mechanism and lubricating it (sparingly) with Inox. It's quite possible that the original owner had trouble with the tuning mechanism sticking and consequently oiled it quite heav-

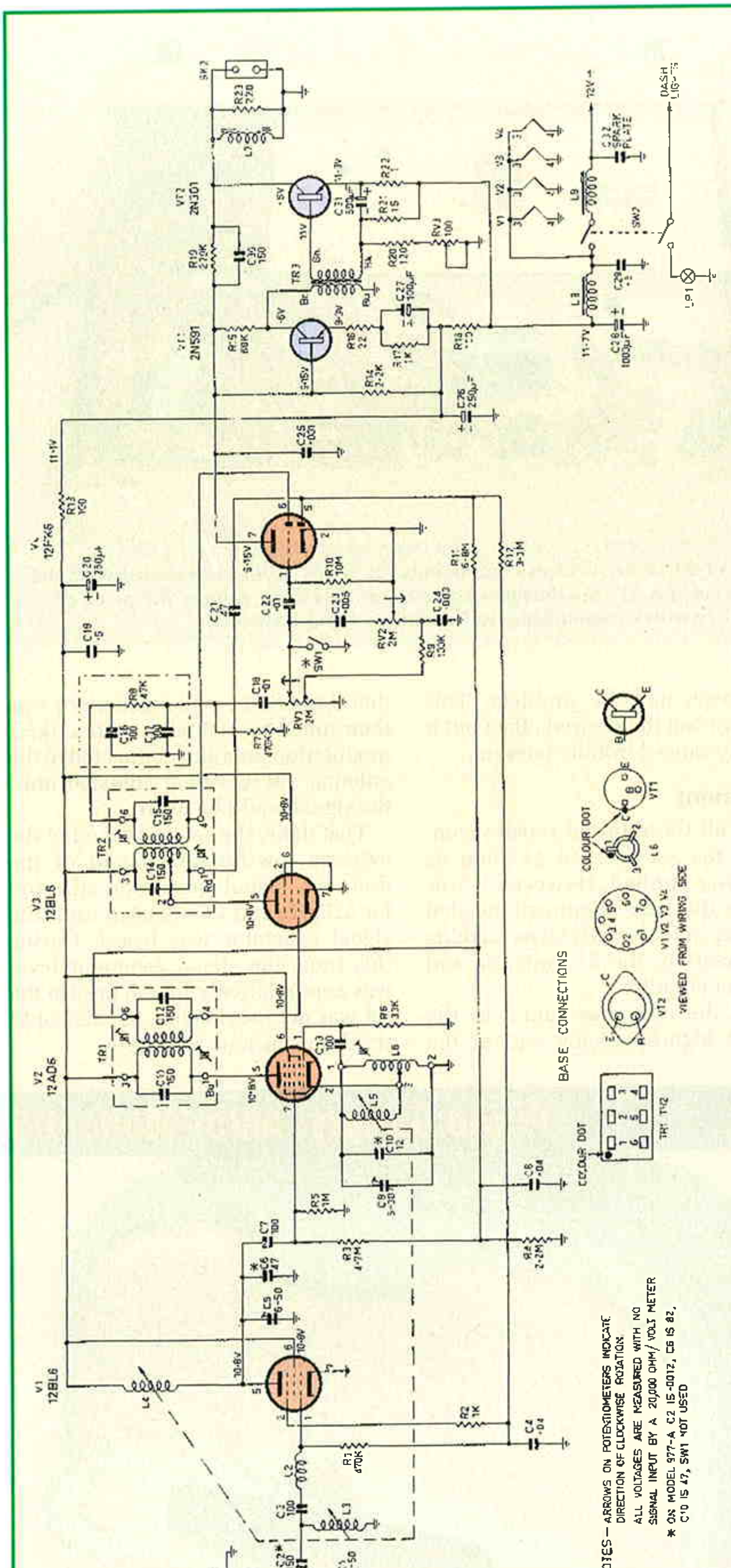
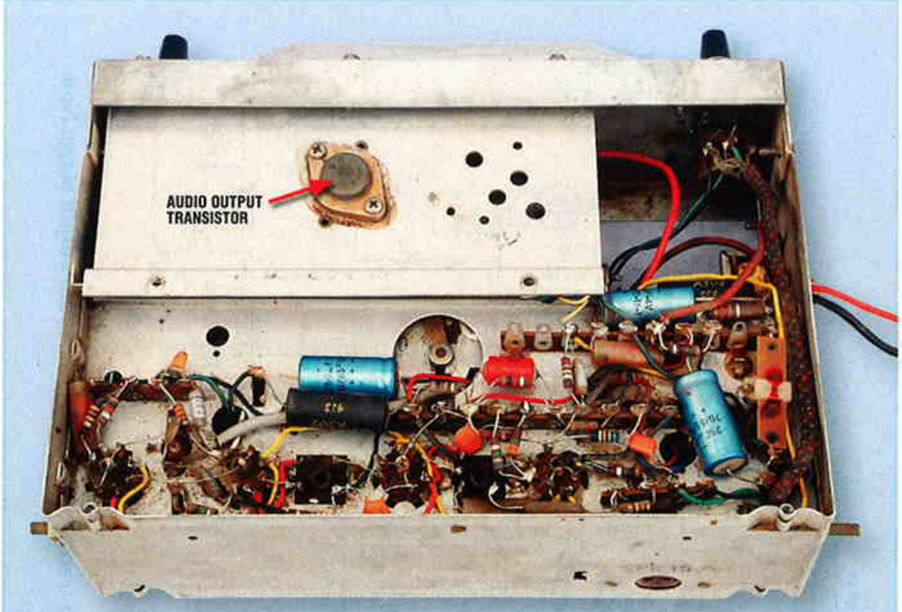


Fig.1: the AWA 976A hybrid car radio used four valves in the RF and IF stages, plus two PNP germanium transistors to form the audio output stage. Note that the output transistor (VT2) operates as a class-A amplifier.



Most of the under-chassis components are wired point-to-point between the valve sockets, IF transformers and several tag strips. A large flat piece of metal provides heatsinking for the audio output transistor.

ily to overcome the problem. This may have had the desired effect but it certainly caused trouble later on.

Alignment

With all those initial repairs completed, the set worked as soon as power was applied. However, it was obvious that the alignment needed tweaking and this involves making adjustments in the RF, antenna and oscillator circuits.

First, the unit was tuned to the extreme high-frequency end of the dial. My LSG11 signal generator was then tuned to 1650kHz with a 1kHz modulation tone and connected to the antenna. C9 was then adjusted until the signal could be heard.

That done, the set was tuned to the extreme low-frequency end of the dial, the signal generator adjusted for 525kHz and L6 adjusted until the signal generator was heard. During this time, the signal generator level was kept relatively low to ensure the set was not overloaded, as this could result in spurious responses.

These two adjustments were done a couple of times, as they interact with each other to some extent. The actual adjustments required were small, as I had obviously managed to get the oscillator slug into the right position on the tuning mechanism when I glued it into place.

The antenna and RF slugs had not been interfered with, so I simply peaked C5 at around 1500kHz. The antenna circuit is tuned up with the set in the car. First, the set is tuned to around 1500kHz with the antenna fully extended and then C1 is adjusted for best performance. This adjustment is accessible from the outside of the case.

The IF amplifier stages seemed to be correctly tuned and the set was now performing normally, so no attempt was made to peak the IF stages. In fact, it is rare for the IF stages in car radios to drift in alignment due to the sticky core-locking compound used.

In summary, there wasn't a lot wrong with this set – a few leaky capacitors, a very gunky chassis, one tuning slug not operating and 40 years of corrosion just about complete the list.

Summary

This is the only hybrid car radio I've seen in recent years, as they are now quite rare. If you come across one, grab it. I would be more than happy to have one in my own collection, as they were an interesting type of radio that was quite popular, if only for a short time. **SC**

Photo Gallery: Astor Model GS (1949)

MANUFACTURED BY Radio Corporation, Melbourne, in 1949, the Astor Model GS was housed in a stylish bakelite cabinet and was available in a range of colours. This blue example was rare and is now very collectable.

This set used the same basic reflex circuitry that was common to a number of 4-valve Astor models. The valve line-up was as follows: 6A8-G frequency changer; 6B8-G reflexed IF amplifier/1st audio amplifier/detector/AVC rectifier; 6V6-GT audio output; and 5Y3-GT rectifier.

Photo: Historical Radio Society of Australia, Inc.

A Christmas Gift for one lucky SILICON CHIP subscriber...

YES!

Simply take out a new subscription (or renew an existing one) and you'll go into the Christmas Eve draw for a pair of these M6 bass-reflex kit speakers, valued at $599 – as described in the November 2006 issue of SILICON CHIP, . Australian and New Zealand subscribers are eligible to win this superb prize, courtesy of theloudspeakerkit.com

Speakers will be supplied in flat (kit) form and raw finish, ready for you to assemble. Only PVA glue and a Phillips screwdriver required.

All subscriptions and renewals received from now until 5pm on Friday, December 22 will be included in the computerised draw.

DON'T MISS OUT! COMMENCE OR RENEW YOUR SUBSCRIPTION NOW!

If your subscription is not due for renewal until after Christmas, you can renew now to enter and the renewal will commence at your due date

Phone/Fax order form & Tax Invoice
Silicon Chip Publications Pty Ltd ABN 49 003 205 490

Your name:...
PLEASE PRINT

Address:...

.... Postcode ....

Daytime Phone No:...

email (if applicable) ....

METHOD OF PAYMENT:

☐ Cheque/Money Order ☐ Mastercard ☐ Visa card

Card No: |_|_|_|_| |_|_|_|_| |_|_|_|_| |_|_|_|_|

Expiry: |_|_/_|_| Signature:.............................

YOUR SUBSCRIPTION ORDER:
All subscription prices include pack and post. Australian prices include GST.

☐ 1 Year Subscription with binder (Aust $105, NZ$AU119)

☐ 1 Year Subscription without binder (Aust $89.50, NZ [air] $AU96)

☐ 2 Year Subscription with 2 binders (Aust $203, NZ $AU233)

☐ 2 Year Subscription without binders (Aust $172, NZ [air] $AU190.00)

NEW SUBSCRIPTIONS: Start with ☐ November 2006
☐ December 2006
or ☐ .... issue

Would you like to order anything else (books, special publications, etc)?
Subscribers qualify for 10% discount on other SILICON CHIP merchandise.

.... $....... P&P....... $......

.... $....... P&P....... $......

.... $....... P&P....... $......

Order Total: $......

163

4 easy ways to order your subscription or renewal:

BY PHONE:* (02) 9939 3295 9-4 Mon-Fri

BY FAX:# (02) 9939 2648 24 Hours 7 Days

BY EMAIL:# silchip@siliconchip.com.au 24 Hours 7 Days

BY MAIL:# PO Box 139, Collaroy NSW 2097

BY INTERNET:^ siliconchip.com.au 24 Hours 7 Days

* Please have your credit card handy! # Don't forget to include your name, address, phone no and credit card details. ^ You will be prompted for required information

ASK SILICON CHIP

Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Write to: Ask Silicon Chip, PO Box 139, Collaroy Beach, NSW 2097 or send an email to silchip@siliconchip.com.au

Model train controller

I have built the Model Train Controller from the November 1995 issue of "Electronics Australia" and have a question regarding its operation.

The controller works OK on a resistive load, with the voltage slowly rising and falling as designed but on a train motor, the back-EMF seems to be triggering the SCR continually. The train goes into "cruise control" and the throttle (VR1) no longer controls the speed.

Can you please suggest a fix for this? Are there any more recent or more advanced train controller designs published by SILICON CHIP? (J. Y., via email).

• In our experience, SCR controllers do not do a good job with model locomotive motors. Having said that, check diode D7 and capacitor C3 as they should be filtering hash on the lines.

For a really smooth and realistic controller, have a look at any of SILICON CHIP's switchmode transistor designs such as the "L'il Pulser" from the February 2001 issue.

Spark generator wanted

I am looking for a spark generator circuit that will produce a nice spark at the press of a switch; battery-powered would be preferable. Has SILICON CHIP done such a circuit? (Y. M., via email).

• Have a look at the Jacobs Ladder project described in the September 1995 issue. It uses an ignition coil to generate a healthy column of fat sparks.

Query About UHF Prescaler Capacitors

What wonderful projects are possible with modern components. A few years ago, a project such as the UHF prescaler described in the October 2006 edition of SILICON CHIP would have hardly been possible for the average constructor, or at least not with the confidence that it would work without any hassles or a bench equipped with equipment worth as much as one's home. I shall be building one for use with 23cm and 13cm ATV Tx design and construction.

The reason for this letter is to query the value of the two 10nF capacitors for the input and output of IC1. The reactance of the two capacitors is only 0.31Ω at 50MHz. 100pF with a lower self-resonant frequency would still have a reactance of only 31Ω and even 10pF would operate quite effectively with its 310Ω of reactance.

At microwave frequencies of around 3GHz, for 10pF the reactance would be insignificant but their reduced inductance and self-resonant frequency would be a decided advantage as well as reducing the possibility of lower frequency instability. I have noted the excellent supply decoupling technique employed. Perhaps the 10nF values were typographic errors?

I do not intend this letter to be taken as a criticism for I am genuinely interested in the design philosophy, having designed pro and non-pro projects over many years. (V. B., via email).

• The value of the coupling capacitors on either side of IC1 may seem a little high but we found that the sensitivity of the prescaler dropped significantly at 50MHz if they were reduced much below 10nF, at least with the X7R dielectric capacitors being used. However, if you are not too concerned about the sensitivity at 50MHz, you could use lower values for these capacitors.

We would suggest either 1nF or 470pF.

Digital clocks do not keep good time

Can you explain why it is that identical radio clocks gain time at vastly differing rates when they all use ICs clocked by AC from a common household supply? Is it possible for control tones to cause false triggering of the counters, perhaps to a different degree? (H. M., via email).

• Are you sure that the clocks are controlled by the 50Hz mains? They could be crystal-controlled, which would explain the differing time gains. If they are crystal controlled, there is sometimes a trimmer, which can be adjusted for better time-keeping.

We would not expect mains control tones to affect time-keeping since they are reduced in amplitude compared to the mains voltage and so should not trigger the counter inputs.

Damping factor of class-A amplifier

I am in the process of putting together a stereo set-up of the 15W class-A amplifier and would like to know how much better the damping factor is compared to most top brands. I'm also curious as to how its damping compares to your other amplifiers, especially the 100W class-AB Ultra-LD amplifier. By the way, would you know the gain dB of the 15W class-A unit? (N. N., via email).

• If you have the articles for these amplifiers, you will see the damping factor quoted in the specification panels. For the 15W unit, it is greater than 200 at 100Hz & 1kHz, while for the Ultra-LD it is better than 170 for the same frequencies.

In other words, both amplifiers are so good that the damping factor is academic. The voltage gain for both amplifiers is also identical, as set by the 18kΩ and 1.2kΩ feedback resistors. The voltage gain is x16 or +24dB.

Further mods to Battery Zapper

I recently built the "Deluxe Lead-Acid Battery Zapper Mk.2" featured in the May 2006 issue and uncovered several problems:

(1) When connected to a 12V battery, the Zapper circuit would usually operate as intended with an audible 1kHz tone but every now and then would refuse to start properly. No tone would be audible and the 3A fuse would open after a few seconds.

This problem was rare at first, but after a week of continuous operation it occurred much more frequently. Further investigation revealed the supply to IC1 was oscillating wildly at around 200kHz. This was the result of the LC power filter interacting with the output of the zapping circuit. Replacing RFC1 with a link cured this problem without adversely affecting the regulation of IC1's supply.

(2) When zapping a 24V chain of batteries while connected to a 2-stage smart charger, the battery voltage held steady at 28.5V. This caused 2W of power to be dissipated by the 1W-rated ZD1. This also applies to the checker regulator diode ZD4.

While this may not matter for short periods of time, the Zapper is expected to run continuously for days. This will result in an unacceptable load on the zener regulators. There are several possible solutions. I chose to replace the two 100Ω 5W resistors with 180Ω parts and replaced both ZD1 and ZD4 with two 6.8V 1W zeners in series.

(3) When zapping 24V batteries, the circuit generates a large amount of heat. I decided to drill a large quantity of ventilation holes in the sides and lid in the top half of the case before sealing the lid, but even then the circuit board became discoloured and the plastic formers of L1 & L2 deformed.

Perhaps most importantly, D3 becomes extremely hot. Even with a small heatsink fitted, it managed to char the insulation of a wire that happened to come into contact with it. I recommend that all constructors increase the ventilation and fit a heatsink to D3 if they intend to operate the zapper at 24V.

(4) The condition checker circuit would work fine at 12V but would destroy a Mosfet or two, as well as Q8, D10, D11 and the three 0.22Ω resistors, whenever an attempt was made to check a 24V battery. The Mosfets appeared to be failing short, taking out the other components due to the over-current condition.

I managed to reproduce the problem non-destructively by replacing the three 0.22Ω resistors with one 0.5Ω. This revealed that the current limiting would work perfectly at 12V but would break out into wild multi-MHz oscillations when connected to 24V.

After eliminating all other possibilities, I guessed that the MOS parasitic G-D and G-S capacitances were forming a feedback loop within the source-follower circuit configuration. This was confirmed when I inserted four 0.5Ω 5W resistors in parallel between the MOS drains and the battery positive, at which point the oscillations ceased.

I trust that you will test and publish these modifications, as they have

24V LED Drivers For Underwater Lights

I have built six underwater lights using the 3W Star LEDs (Jaycar ZD-0526). I am now looking for a suitable 24V driver for them.

The Jaycar catalog lists two units: AA-0580 rated at 1W, 11-30V and KC-5389 rated at 1-5W, 12V. Will the AA-0580 drive the 3W LEDs?

Alternatively, would the KC-5389 be a better choice if it can be modified to run at 30V? If the KC-5389 could be modified, should I use one driver for each LED or put two LEDs in series?

The LEDs are heatsinked and enclosed in a stainless steel housing. (J. N., via email).

• The Jaycar AA-0580 is suitable for driving 1W LEDs only. As described in the May 2004 issue of SILICON CHIP, the Luxeon LED Driver (Jaycar KC-5389) was designed for operation from a 12V DC supply. However, it can be modified to operate from 24-28V DC and drive two 3W stars in series with the following changes:

(1). Replace the 24V/5W zener diode (ZD1) with a 33V/5W type (available from **www.wiltronics.com.au** or **www.iinet.net.au/~worcom**)

(2). Install a 470pF ceramic capacitor for C1. As described in the article, resistor R1 should be 0.15Ω for 700mA of drive current (recommended) or 0.1Ω for 1000mA.

(3). If you don't need the low battery cutout function, then remove D2 from the circuit to disable it completely.

Conversely, if you do need this function, then replace the following parts in the circuit: 750Ω with 2.7kΩ; 18kΩ with 33kΩ; and 9.1kΩ with 6.8kΩ.

caused me several days of headaches and I would not want others to have to go through the same process. (R. F., via email).

• After further testing, we too have discovered the instability problem in the Zapper circuitry, which seems to occur only with a proportion of STP60NF06 Mosfets. As noted in Notes & Errata in the October 2006 issue, we recommend fitting a 100Ω stopper resistor in series with the gate of Q1, which prevents this instability without degrading the Zapper's performance.

We have not encountered the other problems you describe when checking the condition of 24V batteries. However your modifications would be very applicable for anyone who expects to use the project with 24V batteries. Thanks for providing the details.

6V to 12V radio conversion

M. S. asks in the September 2006 issue about running a 6V car radio on 12V in a 1953 Pontiac he is restoring. Perhaps he could salvage one of the old 6V headlamp bulbs and put that in series with the radio to act as a dropping resistor?

A 55W bulb would draw 9A at 6V, so it should be able to handle the current drawn by the radio. He could perhaps fit it inside the radio casing. (P. C., via email).

• That is an interesting suggestion but it could lead to damage in the radio, even if you did match the headlight bulb current with the radio current. Initially, the valves will not draw any HT current and so the HT voltage will be much higher than it should be. This could damage the electros and the vibrator itself. It might also blow the valve heaters.

The idea of installing a 55W bulb inside the radio casing would not work either – headlight bulbs get extremely hot.

DC-DC converter for vintage radio HT

I refer to the 12AX7 valve audio preamplifier published in the November 2003 issue. I wish to incorporate the DC-DC converter from this project into a vintage valve car radio, using it to supply HT to five valves instead on one. The current on the HT rail will need to be about 50mA.

Your article quotes the 12AX7 valve as needing only 2mA from the HT rail. How much current can the DC-DC converter provide? (C. S., via email).

• The unit should comfortably deliver 50mA. However, its hash may interfere with radio reception unless it is well shielded.

How to connect ultrasonic transducers

I have recently purchased a couple of Jaycar AU-5550 ultrasonic transducers. Although there is a data sheet on the Jaycar website, it doesn't give any other information. There are only two pins but how to use them? Is the body the earth?

The manufacturer's part number is T/R40-16B but I cannot find any practical information on the web. Can you assist me please? (T. U., via email).

• In essence, these piezoelectric transducers are capacitors. There is no polarity and you don't connect the case (although note that some transducers like the Murata MA40 series have one pin connected to the metal housing).

Have a look at the Ultrasonic Parking Radar in our February 2000 issue. It shows how to use them.

Additional outputs for remote control extender

I am looking at building your IR Remote Control Extender from the October 2006 issue. I was wondering what modifications, if any, would be required to add extra LEDs at the output so it could be used to control more than one device. (R. S., Ballarat, Vic).

• The circuit can drive more than one LED if you duplicate the 220Ω resistor and LED section for each additional output. In other words, use an additional 220Ω resistor and LED in series between the collector of Q1 and ground (0V).

Valve preamp loads power supply

I have assembled the valve preamp kit (November 2003) and the Jaycar KC5347 power supply kit intended for the SC480 amplifier. I am having trouble with certain voltages. With the preamp disconnected I get the proper voltages from the power supply. When

I connect the preamp, the +15V rail drops to +6V. The outputs from the inverter are 6V and 160V, respectively. (R. C., via email).

● The reason why the both the 15V and HT rails are dropping under load (ie, when the preamp is connected) is because the 15V outputs of the KC-5347 power supply are not designed to supply the current drain required for the valve preamp. They're designed to provide only a few tens of milliamps whereas the valve preamp needs about 300mA.

In fact, the 12AX7 valve heater alone needs around 150mA, while the DC-DC converter used to provide the HT requires almost the same amount.

So you'll need to power the valve preamp from a 12V power supply capable of providing the required current. When you do this, you should find that the voltages don't drop significantly when the preamp is connected.

TV choke magnet mystery

Could you please tell me what purpose a permanent magnet fitted to the top of a choke/transformer serves? I refer to part of the HV/EHT circuitry of an old TV (picture supplied) and I have also often found quite small chokes with strongly magnetic ferrite cores when salvaging bits and pieces from CRT monitors and TVs. I figure it modifies the components' inductive behaviour but can't get my head around exactly how. (B. J., via email).

● We passed this query to our Serviceman writer and here is his reply: as a guess, this looks like a transductor used in North South Correction circuits for old delta CRT sets like Sanyo (circa 1976). Rotating the magnet attempts to straighten the horizontal lines at the top (and bottom) of the screen. Vertical and Horizontal pulses are mixed together via this transductor to produce a butterfly waveform which is injected into the deflection yoke. This is always a compromise with other adjust pots nearby.

This particular board looks like it is from an EMI HMV/Healing C211 chassis. SC

Notes & Errata

LED Tachometer Pt.1, October 2006: the display reading in both Fig.1 and Fig.2 should be 1200 rather than 3200. The text describing the operation on page 27 is correct.

LED Tachometer Pt.2, November 2006: the overlay diagram for the DC Relay Switch board (Fig.9) shows D1 with reversed orientation. The cathode (striped end) of D1 should be to the right.

Mini Theremin Mk.2, July & August 2006: equalising coil L1 needs to be wound so that its self-capacitance is as low as possible. In practice, this means that the windings should be jumble-wound by hand without regard to neatness. Do not wind each layer with each turn placed adjacent to the next as would be done by a coil-winding machine.

Battery Zapper, May 2006: if readers intend to use this project with 24V batteries, the following changes are recommended:
(1) Increase the two 100Ω 5W resistors to 180Ω parts and replace both ZD1 and ZD4 with two 6.8V 1W zener diodes in series.
(2) Improve ventilation by drilling holes in the sides and top of the case and fit a heatsink to diode D3.
(3) Insert four 0.5Ω 5W resistors in parallel between the drains of Mosfets Q3 to Q6 and the battery positive to prevent oscillation when doing the "Condition" check.

DC Relay Switch, November 2006: the overlay diagram (Fig.2) shows D1 with reversed orientation. The cathode (striped end) of D1 should be to the right. In addition, the parts list should include:
- 1 1N4148 diode (D3)
- 4 M3 x 12mm countersunk Nylon screws
- 4 3mm Nylon washers
- 4 M3 nuts

SMS Controller, October & November 2004: in certain circumstances, user commands such as EN and DIS may operate on the wrong input or output port. A firmware update (v1.2) is available from the website to correct this problem.

Note that as this problem is only evident with certain combinations of long strings, there is no requirement to perform this update if your controller is operating satisfactorily.

SILICON CHIP REFERENCE

GREAT BOOKS FOR

ALL PRICES INCLUDE GST AND ARE

BACK IN STOCK

AUDIO POWER AMPLIFIER DESIGN HANDBOOK by Douglas Self 4th Edition 2006

Reduced in price from previous edition! From one of the world's most respected audio authorities. New 4th edition is more comprehensive than ever – now with new chapters on Class D amplifiers and DC servos. Now even bigger – 465 pages in paperback. ***See the review in September 2006 issue.***

$83

THE WIRELESS NETWORKING STARTER KIT by Engst & Fleishman.

2nd Edition, Published 2004.

If you've ever wanted to know the intricate details of setting up your own wireless network and the traps for young players, you'll find it here. (See review July 05 SILICON CHIP) 530+pages in paperback.

$48

Practical Variable Speed Drives and Power Electronics

by Malcolm Barnes. 1st Ed, Feb 2003.

An essential reference for engineers and anyone who wishes to design or use variable speed drives for induction motors. As reviewed in SILICON CHIP September 2003. 288 pages.

$85

AUDIO ELECTRONICS

By John Linsley Hood. First published 1995. Second edition 1999.

For anyone involved in designing, adapting and using analog and digital audio equipment. Covers tape recording, tuners and receivers, preamplifiers, voltage amplifiers, audio power amplifiers, compact disc technology & digital audio, test & measurement, loudspeaker crossover systems, power supplies and noise reduction systems. 375 pages in soft cover.

$92

Microcontroller Projects in C for the 8051 by Dogan Ibrahim. Published 2000.

Through graded projects introduces the fundamentals of microelectronics, the 8051 family, programming in C and the use of a C compiler. Provides an interesting, enjoyable and easily mastered alternative to more theoretical textbooks. 178 pages in paperback.

$73

ANALOG ELECTRONICS

By Ian Hickman. 2nd edition 1999.

Essential reading for electronics designers and students alike. It will answer questions about core analog theory and design principles as well as offering practical design ideas. Many of the circuits taken from Ian Hickman's magazine articles. 294 pages in soft cover.

$89

Servicing TV Satellite & Video Equipment

By Eugene Trundle. **Revised edition 2002.**

Written by a practising service engineer, emphasis is on practical business of fault diagnosis and repair. Covers TV power supplies, line timebases, video deck machines, test gear, intermittent faults, repair techniques and workshop practice. Features a completely new chapter on the latest digital equipment – DVD, set-top boxes, digital satellite TV and digital TV sets.

$70

Power Supply Cookbook

by Marty Brown. 2nd edition 2001.

An easy-to-follow, step-by-step text for a wide variety of power supplies. All described in simple language. Anyone with a basic knowledge of electronics can create a very complicated power supply design. 265 pages in paperback.

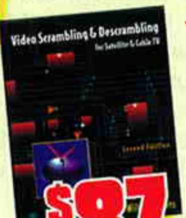
$99

Interfacing With C by Howard Hutchings

Revised by Mike James. 2nd edition 2001.

Anyone interested in ports, transducer interfacing, analog to digital conversion, convolution, filters or digital/analog conversion will benefit from reading this book. The principals precede the applications to provide genuine understanding and encourage further development. 302 pages in paperback.

$63



VIDEO SCRAMBLING & DESCRAMBLING FOR SATELLITE & CABLE TV

by Graf & Sheets –2nd Edition

Ever wondered how they scramble video on cable and satellite TV? This book tells you! Encoding/decoding systems (analog and digital systems), encryption, even schematics and details of several encoder and decoder circuits for experimentation. For both the hobbyist and the professional. 290 pages in paperback.

$87

NEW NEW NEW NEW

PRACTICAL RF HANDBOOK

by Ian Hickman **NEW 4TH EDITION 2006**

The latest guide to RF design for engineers, technicians, students and enthusiasts. Covers key topics in RF: analog design principles, transmission lines, couplers, transformers, amplifiers, oscillators, modulation, transmitters and receivers, propagation & antennas. 279 pages in paperback.

$75

DVD PLAYERS AND DRIVES

by K.F. Ibrahim. Published 2003.

A guide to DVD technology and applications, with particular focus on design issues and pitfalls, maintenance and repair. Ideal for engineers, technicians, students of consumer electronics and sales and installation staff. As reviewed in Silicon Chip February 2004. 319 pages in paperback.

$79

Op Amps for Everyone

Edited by Ron Mancini Published 2003

Compiled by Texas Instruments, this is the closest thing to a "bible" on op amps. This is an engineer's reference with lots of theory, plenty of maths and right up-to-the-minute with modern devices. Not cheap but worth every cent. 478 pages, soft covers.

$119

WITH DVD

Complete Reference Red Hat

by Petersen and Haddad Published 2004

If you're into Linux you've got to have this latest omnibus reference covering Red Hat Enterprise Linux and Fedora. Great for internet server management, firewalls, encryption, authentication and more. Includes DVD. 832 pages, soft covers.

$89

MARKET CENTRE

Cash in your surplus gear. Advertise it here in Silicon Chip.

CLASSIFIED ADVERTISING RATES

Advertising rates for these pages: Classified ads: $27.00 (incl. GST) for up to 20 words plus 80 cents for each additional word. Display ads: $49.50 (incl. GST) per column centimetre (max. 10cm). Closing date: 5 weeks prior to month of sale.

To book your classified ad, email the text to **silicon@siliconchip.com.au** and include your credit card details, or fax (02) 9939 2648, or post to Silicon Chip Classifieds, PO Box 139, Collaroy, NSW, Australia 2097.

________ ________ ________ ________ ________

________ ________ ________ ________ ________

________ ________ ________ ________ ________

________ ________ ________ ________ ________

Enclosed is my cheque/money order for $________ or please debit my

❑ Bankcard ❑ Visa Card ❑ Master Card

Card No. ☐☐☐☐ ☐☐☐☐ ☐☐☐☐ ☐☐☐☐

Signature__________________ Card expiry date_____/_____

Name ________________________________

Street ________________________________

Suburb/town __________________ Postcode________

Phone:__________ Fax:__________ Email:__________

FOR SALE

More control solutions for you!
NEW K145Server: monitor temperatures in server rooms, hothouses etc remotely over the web for less than $100.
NEW 500oz-in plus Stepper Motor: may not be the fastest motor on the block but it has real grunt.
NEW DC Motor Controllers from Pololu: these motor controllers have been designed for robotic applications. Range from mini dual 1A controllers to 30A.
NEW Servo Motor Controllers from Pololu: control your R/C servo motors with our serial servo controllers Ideal for robotic applications. Control up to 8 servos with the one card.
Netiom Link: automatically transfer digital inputs and outputs between two cards over an Ethernet link.
Electronic Thermostats with digital temperature display; two control relays; can be used in heating and cooling. NTC thermistor or J T/C or Pt100 sensors.
Low Cost Mini Panel Meter Displays: programmable 4-20mA $155 and Tachometer $129.
Isolated RS232 to RS485 converters.
USB to RS422/RS485 converter with 1500V Isolation, RTS or Auto Data Flow control.
Signal Conditioners non isolated and isolated: convert thermocouples, RTDs to 4-20mA or 0-10V Fully programmable.
Stepper Motors: we have a selection of Stepper motors for hobby and high torque CNC applications.
DC Motors for both hobby and high torque applications.
DC, Stepper and Servo Motor controller kits.
Serial and Parallel Port relay controller cards.
PIC MicroProgrammers: serial and USB port operated.
Switch Mode, Battery Chargers and DC-DC converters.
Full details and credit card ordering available at **www.oceancontrols.com.au**
Helping to put you in control.

RCS RADIO/DESIGN is at 41 Arlewis

MicroByte
Electronics

Development / Training Board
For the PIC Micro

The Most Flexible Development board Around!
Based on the PIC16F877. The development board can be used with a wide variety of PIC Micro's including the PIC18F452. Adaptors available to use the 8,14,18 & 28 pin PIC Micro's. ICD 2 connector allows In circuit programming / Debugging with Microchips ICD 2. Uncommitted I/O ports allows for your own connection configuration to each device and also to external circuits. Onboard parallel port programmer allows programming of the PIC while still connected to the circuits. Other optional extras available. Connection to each circuit module or external circuit is made via 10 way IDC cables provided. CoreChart compatible - Program the PIC directly from CoreChart, the easy to use flow chart Icon based assembler.

For more information…
Visit: www.microbyte.com.au
Phone: (03) 9378 4288
Email: info@microbyte.com.au

Printed Circuit Board Manufacture
48-Hour service * High quality * Low prices
1 offs to any quantity
Artwork design if required
Call for obligation free quote…
INSTANT PCBs, POBox 448, Avalon 2107
Ph (02)9974 1189 Fax (02)9974 5491

St, Chester Hill 2162, NSW Australia and has all the published PC boards from SC, EA, ETI, HE, AEM & others. Ph (02) 9738 0330. **sales@rcsradio.com.au, www.rcsradio.com.au**

WEATHER STATIONS: windspeed & direction, inside temperature, outside temperature and windchill. Records highs and lows with time and date as they occur. Optional rainfall and PC interface. Used by government departments, farmers, pilots and weather enthusiasts. Other models with barometric pressure, humidity, dew point, solar radiation, UV, leaf wetness, etc. Just phone, fax or write for our FREE catalog and price list. Eco Watch: phone (03) 9761 7040; fax (03) 9761 7050; Unit 5, 17 Southfork Drive, Kilsyth, Victoria 3137. ABN 63 006 399 480. **www.davisinstruments.com.au**

Advertising Index

PC Boards

Printed circuit boards for SILICON CHIP designs can be obtained from RCS Radio Pty Ltd. Phone (02) 9738 0330. Fax (02) 9738 0334.