SILICON CHIP

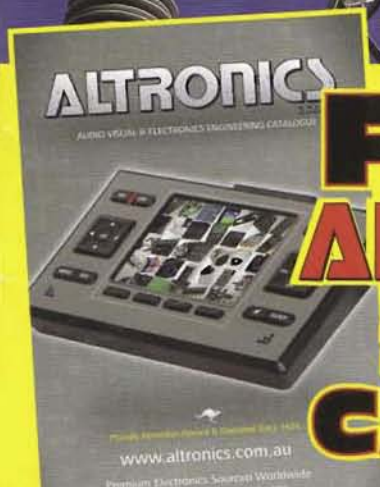
SEPTEMBER 2008
ISSN 1030-2662
09
9 771030 266001
PRINT POST APPROVED
- PP255003/01272
$8.50* INC GST NZ$9.90 INC GST

Basslink

HOW THEY MOVE 400,000V DC ACROSS BASS STRAIT

ELECTRICIAN'S AS3017 TEST SET

ALL-NEW RAILPOWER CONTROLLER



FREE! ALTRONICS 2008-9 CATALOG

AUSTRALIA ONLY



with infrared remote!

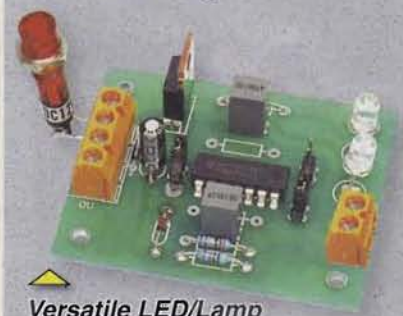
Contents

SILICON CHIP

Vol.21, No.9; September 2008 www.siliconchip.com.au



Railpower Model Train Controller – Page 22.



Versatile LED/Lamp Flasher – Page 34.



Ultra-LD Mk.2 Amplifier Power Supply Module – Page 58.



DSP Musicolour Remote Control – Page 72.

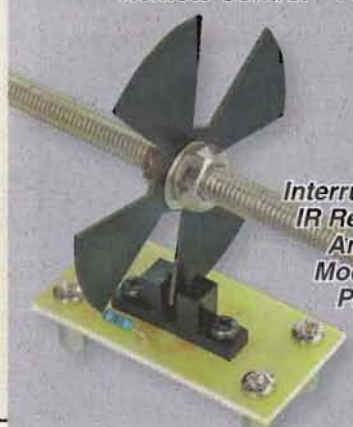


Photo-Interruptor & IR Reflector Amplifier Modules – Page 76.

Features

13 The Basslink High-Voltage DC Power Link
How do you get 500,000V DC across 300km of wild water? Basslink is the longest undersea HVDC power link in the world – by Michael Goebel

31 Review: Metrel Instaltest 3017
It not only prompts you through all the compulsory AS/NZS3017 electrical tests but also allows you to print out a report for the client as is now mandatory – by Leo Simpson

Projects To Build

22 Railpower Model Train Controller
It features infrared remote control, variable inertia and a pulse power output to ensure smooth control of your locomotives – by John Clarke

34 Versatile LED/Lamp Flasher
Looking for a replacement for the LM3909 LED flasher/oscillator IC? This versatile LED/lamp flasher module will do the job – by Thomas Scarborough

58 Ultra-LD Mk.2 200W Power Amplifier Module, Pt.2
Pt.2 this month gives the assembly details for this new high-performance module & describes a suitable power supply – by John Clarke & Greg Swain

72 DSP Musicolour Light Show; Pt.4
Simple add-on circuit lets you drive your new DSP Musicolour using a standard infrared remote control handpiece – by Mauro Grassi

76 LED Strobe & Contactless Tachometer, Pt.2
Pt.2 has the assembly details for the photo-interruptor and IR reflector amplifier modules. We also describe how the unit is used – by John Clarke

Special Columns

40 Serviceman's Log
One man's trash is another man's treasure – by the TV Serviceman

53 Circuit Notebook
(1) Kill Those Adverts Quickly With The Supermute; (2) 4017 Counter Tester; (3) Water Tank Level Indicator; (4) PICAXE-Based Star 5W LED Control Unit; (5) Low-Power Class-A Valve Amplifier; (6) Sweep Frequency Generator For Audio Testing

80 Vintage Radio
The Raycophone "Pee Wee" Midget – by Rodney Champness

Departments

2 Publisher's Letter
4 Mailbag
38 Product Showcase
92 Order Form
88 Ask Silicon Chip
91 Notes & Errata
93 Market Centre

SILICON CHIP
www.siliconchip.com.au

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

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

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

Technical Staff
Ross Tester
Jim Rowe, B.A., B.Sc, VK2ZLO
Mauro Grassi, B.Sc.(Hons.)

Photography
Ross Tester

Reader Services
Ann Morris

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

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

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

Digital TV is being wasted



Anyone who watched the opening ceremony of the Beijing Olympics on a large-screen high-definition TV set or projector could not fail to have been impressed. Not only was the sweep and pageantry of the ceremony itself a wonderful showcase for Chinese civilisation and culture, the HDTV medium added to the gorgeous spectacle.

In subsequent days, the competition has been inspiring and the HDTV pictures have given wonderful close-ups of the athletes in their all-out efforts. In watching this programming, it is very easy to conclude that HDTV is fantastic technology which everyone can enjoy. This is no doubt great for the Seven network and to a lesser extent, the SBS network which chose to cover certain events in full.

This editorial is written just a few days after the opening ceremony so I don't know how the Olympic Games will eventually pan out. No doubt it will be a great success for China but there is considerable doubt that any country staging the Olympics in future will decide to spend so much money.

But after the Olympics, what is the future for HDTV programming? From my perspective, it looks pretty barren. Take away sport and there is not much to watch in HDTV. Sure, there is the occasional documentary which takes full advantage of the medium but the rest of network programming is just as good (or bad) as in standard definition. In fact, the extra channels provided by the introduction of digital TV are simply going to waste. In the case of the commercial channels, most of the time the broadcasts are exactly the same or maybe just time-shifted. And in the case of the ABC2 network, the programming is either puerile or a repeat of the previous day's programs.

If you were to give a mark out of ten for the benefits brought about by digital TV programming, all the networks except SBS would get a failing mark.

Surely, digital TV can be put to better use than that! Even repeats of old movies (presently available in PayTV) would be better than much of the dross that is currently being served up. Why not put it to some real use? How about some educational programming?

Surely there must be thousands of hours of educational programming available for the asking and the range of topics must be very wide. Wouldn't it be wonderful, for example, if you could see a series on astronomy? Carl Sagan's *Cosmos* comes to mind, as does the American series *The Astronomers*. In fact, I see the possibility of regular programming on astronomy forever. The field is infinite (pun intended). Or what about ballroom dancing (a subject close to my heart)? There is plenty of flashy programming along the lines of "So you think you can dance?" but nothing on actually learning to dance. There is great potential for such broadcasts, especially since the popular TV series and films on dancing have made it so popular.

Or why not, perish the thought, some programming on electronics and a whole range of science-related topics? How about a detailed series on nuclear power? Such a series could not only explain how nuclear power is generated in great detail but would also give a better perspective on the storage of waste products. It could dispel a lot of the ill-informed paranoia that currently exists.

You can see the potential. Digital TV, whether in standard definition or high definition, is a wonderful resource. Currently it is simply being wasted.

Leo Simpson

MAILBAG



Letters and emails should contain complete name, address and daytime phone number. Letters to the Editor are submitted on the condition that Silicon Chip Publications Pty Ltd may edit and has the right to reproduce in electronic form and communicate these letters. This also applies to submissions to "Ask SILICON CHIP" and "Circuit Notebook".

Power meter reveals all

I read the article debunking the claims of the Enersonic Power Saver (SILICON CHIP, May 2008) and chuckled with amusement. But another thing I gained from reading it was your mention of the Mains Energy Meter available from Jaycar (MS6115). I've often thought about doing a "power audit", especially with all the talk about greenhouse emissions and energy use, etc.

A few issues back, I read an article about being "greener" and one thing that was mentioned was the bad habit Australians have of keeping an extra "beer fridge" in the garage. Well, I have one such drink's fridge and have been considering getting rid of it after reading that article. However, the power meter has revealed all.

My drinks fridge is only about 1m high and gets opened on average about once per week. When the fridge is running it draws 43W. As it cycles on/off, in total over a week it uses 2kWh of electricity.

This means that, at the current cost of 12 cents per unit, according to my last bill, that fridge is costing me 24 cents a week to run, which is a whopping $12.48 per year! If I get rid of my drink's fridge, I'll need a bigger fridge in the kitchen to hold the drinks, and since the kitchen fridge gets opened several times a day, I reckon this would end up using more power.

To add to this, when I examine my electricity bill I see there is a fixed "supply charge" as well as the cost of actual consumption. The price per unit is so low that there's little, if any, incentive to reduce consumption.

If governments want to get serious about reducing emissions, then as part of that, they need to encourage us to reduce energy consumption. The fixed component of the bill should be significantly lower and the price per unit should be significantly increased. I notice the situation is much the same with water – a high fixed cost and a low consumption cost. This tells me the suppliers are not interested in us reducing consumption of anything.

Greg Newton,
via email.

Comment: we really think you just wanted an excuse to keep your beer fridge! Seriously, it is a good analysis. The current billing schemes do not encourage economy.

USB power injector is the right solution

I was reading your article on the USB Power Injector and your problems operating an external hard drive with a "Y" cable (SILICON CHIP, June 2008). I'm pretty sure I can explain things.

The USB specification says that devices can only draw up to 100mA by default. Any more and the device needs to ask for it, up to a maximum of 500mA. Even with a "Y" cable, a device can only talk to one USB port to reconfigure it. This means the maximum power a device with a "Y" cable can be guaranteed to get is 600mA.

Not all computers enforce power supply limits but it would seem that your "troublesome" computer is one of them! As a reliable way of satisfying power-hungry devices, a "Y" cable is next to worthless and your USB Power Injector really is the right way to go.

Andrew Gregory,
Duncraig, WA.

Easy fuel consumption conversion

Ray Smith seems to have "shot himself in the foot" with his letter published in the July 2008 issue. If I was going to drive 900km with a car using 9l/100km, I would only use 81 litres, which at $1.50/l would cost me $121.50.

A conversion that readers might be interested in is that to convert MPG to l/100km or vice versa, simply divide 282 by the given number. For example, 9l/100 km converts to 282/9 = 31.33 MPG, or 25 MPG converts to 282/25 = 11.28l/100km.

Alan Torrens,
Hornsby, NSW.

House rewiring is expensive

Congratulations on providing information on sites to get information on the correct wiring of household electrical circuits (SILICON CHIP, June 2008).

I am very poor and live in a house

www.furzy.com
We Create Electronic Controllers

Old wiring should not be disturbed

I have some comments regarding the article on DIY wiring in the June 2008 edition, based on some knowledge of the situation.

I personally have no problem with anyone removing switches or power points so that walls may be more easily painted, or replacing faulty lamp holders, etc. Who would know anyway? Most electricians wouldn't care – they already have too much work.

If the house is old and has rubber-insulated cables it would be better not to remove any fittings at all because the slightest movement of the wires may cause the insulation to fall off. Get the house rewired in this case.

Running cables and having an inspector connect them just could not happen in Victoria. Cables must first be adequate for the current carried and run properly so that they won't be damaged by people walking around in roofs and they have to be de-rated if enclosed in insulation or conduit. This takes a certain amount of experience to ensure a conforming installation. Inspectors are self-employed here and are used to inspect, not finish off, other people's wiring.

The NZ guide implies that they could add lighting fittings. Much attention has been given in Australia recently to ensuring that ceiling down-lights don't set fire to the house. Where does the amateur installer get this knowledge, unless he studies AS/NZS:3000 intently and reads the trade magazines?

In regard to the press release on page 17 of the June 2008 issue, this was issued by the electrical safety organisation of WA and is in line with what is mandated or intended in other states. That is, live work is prohibited except in exceptional circumstances.

The possibility of electric shock is bad enough but on an industrial switchboard the fault current could well vaporise tools or other metalwork in close proximity to the electrician in the event of a fault occurring, resulting in serious burns at least.

In summary, I think that the status quo will remain and that your readers will do what they feel comfortable doing on their house wiring but it won't be strictly legal, though generally safe.

Name supplied but withheld at writer's request.

that has old cotton-covered wiring that at times catches on fire. My son had six down-lights installed by a licensed electrician and it cost him $1300. Ridiculous!

Given the information you provided in the June issue, I can now make my home safe, at a reasonable price. I do not want to see electricians out of work but in my old fibro home I feel that is safer for all if I do the work. It is not a choice thing but a cost thing. If I could afford a sparkie I would choose to have the work done by one and stick to my own areas of expertise.

I must say that I have been to every library I could around Sydney and have been unable to get any information on doing your own wiring. It is uncanny.

I also think that it is strange that the manufacturers of power points and switches often fail to provide a circuit diagram. Every other electrical device I buy has information on safe usage. Why not power points and switches?

Name and address supplied but withheld at writer's request.

Comment: as pointed out in the Publisher's Letter in the August 2008 issue, many people cannot afford the charges of electricians and certainly not for a complete rewire, as in your case. If you are going to proceed with new wiring, you would be wise to at least purchase a copy of AS/NZS 3018. It costs over $90.00 but where people need to do extensive re-wiring, we would strongly recommend it.

To purchase it on-line, go to ***http://www.saiglobal.com/shop***

Australians should not do their own wiring

I wish to comment on the recent SILICON CHIP push for Australians to be able to do their own in house wiring. I completely disagree. These rules are

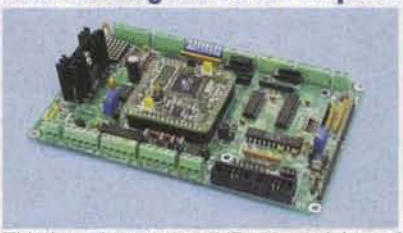
Atmel's AVR, from JED in Australia

JED has designed a range of single board computers and modules as a way of using the AVR without SMT board design



The AVR570 module (above) is a way of using an ATmega128 CPU on a user base board without having to lay out the intricate, surface-mounted surrounds of the CPU, and then having to manufacture your board on an SMT robot line. Instead you simply layout a square for four 0.1" spaced socket strips and plug in our pre-tested module. The module has the crystal, resetter, AVR-ISP programming header (and an optional JTAG ICE pad), as well as programming signal switching. For a little extra, we load a DS1305 RTC, crystal and Li battery underneath, which uses SPI and port G.
See JED's www site for a datasheet.

AVR573 Single Board Computer



This board uses the AVR570 module and adds 20 An./Dig. inputs, 12 FET outputs, LCD/Kbd, 2xRS232, 1xRS485, 1-Wire, power reg. etc. See www.jedmicro.com.au/avr.htm

$330 PC-PROM Programmer

This programmer plugs into a PC printer port and reads, writes and edits any 28 or 32-pin PROM. Comes with plug-pack, cable and software.



Also available is a multi-PROM UV eraser with timer, and a 32/32 PLCC converter.

JED Microprocessors Pty Ltd
173 Boronia Rd, Boronia, Victoria, 3155
Ph. 03 9762 3588, Fax 03 9762 5499
www.jedmicro.com.au

DEAD DEVICE UNDER TEST?
NO PROBLEM!
ABI BoardMaster 8000 Plus

Features:
• 64 to 128 Channels Digital V-I Tester
• Analogue/ Digital as wired in-circuit testers
• Power On/Off testing
THE MOST COMPREHENSIVE TEST SET FOR FAULT-FINDING ON ALMOST ANY KIND OF PCB
TM TekMark
TekMark Australia Pty Ltd
Suite 302, Level 3, 18-20 Orion Road
Lane Cove - NSW 2066 - Australia
Ph: 02 9911 3888 Fax: 02 9418 8485
enquiries@tekmarkgroup.com
www.tekmark.net.au

there to protect innocent people from dodgy wiring. Being allowed to hack at your own wiring sounds good in theory but what happens when you sell your house?

The new owners' kids might get killed by the previous owner's bad wiring. The new owner has NO way of knowing what the history of the house wiring is. By letting non-experienced people play with 240VAC wiring we are going to reduce the standard of wiring throughout Australia which will eventually lead to deaths.

Now I have done my own wiring but I accept that it is not technically legal for me to do so. If I ever sell my place I will probably get a qualified electrician to look over it and give it the nod so I can feel comfortable that someone won't die in the future because of something I did wrong.

David Ferguson,
Kincumber NSW.

Comment: there are two problems with your point of view. First, as alluded to in the letter above, there are vast numbers of older homes in Australia which have dodgy wiring which really is a hazard and many people simply cannot afford to have it fixed by an electrician. That is why we think that electrical energy authorities should look at offering a subsidy to have the wiring fixed.

Second, as will be obvious from the story on AS3017 testing on page 31 of this issue, electricians cannot simply "give the nod" to a house's wiring. If they are asked to do a report, it will not be cheap.

We also think that anyone purchasing an old house should have a full wiring safety report. If the report points up problems, this can be part of the sale price negotiation.

Nuclear power should use molten salt reactors

With regard to the Publisher's Letter in the July 2008 issue, I would agree with using nuclear power generation but not utilising the types of reactors installed around the world now. In general, they are very wasteful of the fuel.

In the 1950s and 1960s Oak Ridge National Labs (ORNL) developed the Molten Salt Reactor (MSR) which was dropped due to politics, just as they were about to build their third experimental MSR, the Molten Salt Breeder Reactor Experiment. This would have converted Thorium 232 to uranium for its fuel.

The biggest advantage of MSRs is that the fuel is present as a hot liquid salt of about 0.9% uranium tetrafluoride, in a mixture of other fluoride salts. All other advantages flow from this such as a thin-wall reactor vessel that is not pressurised and easy removal of reaction products.

Molten Salt Reactors are stable if the reaction rate increases. There is a lot of information on the internet about MSRs. Currently there are no working MSRs as the last one, ORNL's MSRE, was shut down in 1969.

Derrick Watson,
via email.

Electrical engineers' wiring course no longer available

It would seem that New Zealand has more going for it than just Sauvignon Blanc. Wouldn't it be nice if some sense prevailed in Australian electrical wiring regulations?

Several years ago, I attempted to enrol in a TAFE course "Electrical Wiring for Electrical Engineers". This 6-month course allowed electrical engineers to do their own domestic wiring. I finally tracked down the (ex) course coordinator who informed me that the course was no longer available due to lobbying by the ETU.

I believe it was electrical engineers that wrote the wiring rules but we, like every non-electrician in Australia, are apparently not capable of applying them. Isn't it time we changed this ludicrous situation?

Craig Alexander B.E. (Elect),
Wagga Wagga, NSW.

Nuclear waste is a problem

The Publisher's Letter on nuclear power stations (July 2008) was right

The Audio Component Specialists


• Speaker drivers - tweeters to 18" subwoofers - plus kits
• Capacitors, terminals, wire, coils and parts
• Specialist electronic audio components
• Home hifi and car audio
• Public address and DJ equipment
• Industrial and commercial audio parts
• Much more online or phone (02) 4627-8766




soundlabs GROUP
www.soundlabsgroup.com.au

JOIN THE TECHNOLOGY AGE NOW
with
PICAXE



Developed as a teaching tool, the PICAXE is a low-cost "brain" for almost any project

Easy to use and understand, professionals & hobbyists can be productive within minutes.
Free software development system and low-cost in-circuit programming.
Variety of hardware, project boards and kits to suit your application.
Digital, analog, RS232, 1-Wire™, SPI and I²C.
PC connectivity.

Applications include:
Datalogging
Robotics
Measurement & instruments
Motor & lighting control
Farming & agriculture
Internet server
Wireless links
Colour sensing
Fun games



Distributed in Australia by
Microzed Computers Pty Limited
Phone 1300 735 420
Fax 1300 735 421
www.microzed.com.au

Mailbag: continued

More detail on applying solder paste to SMDs

I found myself reading and re-reading the March 2008 issue. It really is a gem, probably reflecting the fact that the lead items on SMDs and the DDS VFO are both areas of my current project work.

I wonder whether Jim Rowe could be persuaded to provide a little more detail on his solder-paste applying "mini-spatula"? I would particularly like to know the material he used for its blade. Similarly, could he provide details on his very narrow roller applicator that he mentions having also constructed?

As to the use of the toaster oven, I have been meaning to try this method after first seeing it described in "Amateur Radio" magazine some 3-4 years ago. Jim's detailed description of its use begs an immediate question though. How much more useful would the oven be if it had a suitable microcontroller to manage the temperature and timing?

Indeed, two such controllers have appeared in "Elektor" magazine, most recently in the December 2007 issue. The first design was complex and used some rather esoteric components, meaning the project was expensive. The latter offering has been simplified design wise but is complicated by the fact that "Elektor" chose to make the project available only as a largely pre-assembled, bolt-together kit, at a price of 75 pounds.

So how about a SILICON CHIP SMD Toaster Oven Controller? This would seem to be a relatively easy application, perhaps one that would require only moderate reprogramming of an existing microcontroller project so that it can monitor the temperature on the target PC board near the chip in question and then control the switching to match the ideal temperature curve described in the March 2008 article. A useful extension though would be to also include switching software to allow the oven to also be used for the baking process to achieve MSL ratings. I believe the December "Elektor" design does have this added feature.

Bill Maxwell,
Powranna, Tas.

Jim Rowe comments: the material used for the blade of the mini spatula was phosphor bronze: a strip 0.3mm thick, salvaged from one of the contact strips on an old relay. It was about 7mm wide and I cut off a 32mm length, leaving one of the original mounting holes near one end to allow mounting in a slot at the end of the "handle" (a 150mm length of 8mm diameter aluminium rod) using a single 2mm screw and nut. The outer end was then narrowed to a tapering rounded point, using tin snips and then a small grinder.

The wheel for the narrow roller applicator was turned from 10mm diameter acetal rod, which was drilled with a 3mm centre hole and then cut off to give a disc 1mm thick. This was then mounted in a 1.1mm wide slot cut in the end of another 150mm length of 8mm aluminium rod, using a 3mm screw as the axle. The hole for the screw was tapped with an M3 thread.

I just smeared out a quantity of the solder paste on a glass plate, and then picked up a small quantity on the spatula to smear it over the SMD pads. This seemed to make it easier to produce a reasonably even smear but you may find the alternative a bit easier for you. Whichever way you choose though, it's not easy – a bit like trying to spread caviar in a stripe that is even in both width and thickness.

to the point. However, as I understand it, there is one major hitch in that it seems to be uneconomic to dispose of the highly toxic waste from the process.

I also laud your stand on DIY wiring. One circumstance where people should take care though is where there is little room to negotiate a good job. This is where an experienced electrician perhaps should be used. There are many power points and light switches

where the installer left a minimal amount of slack and that makes it difficult for us mortals to make a good firm contact.

George Briansky,
Emerald, Vic.

Comment: storage of nuclear waste is a problem but ultimately, it should be possible to process spent nuclear fuel rods for re-use in power stations.

Slide scanner is a winner

My mouth fell open when I saw the article on a slide scanner in the June 2008 issue because I had just "scanned" over 400 of my grandmother's colour slides using a similar technique. The transparencies were up to 44 years old and were mostly in good shape, with only a few spoiled by mould, but their cardboard frames were delaminating and jamming in the projector.

The lack of mould is probably because my grandmother lives in the UK; the house has been centrally heated since the early 1970s and I imagine that would keep the humidity low. It took me four hours to do the job and that included setting up. I did it with a very crude set-up due to time and materials constraints. My camera is a 3.2MP Canon Powershot A410.

I tried two set-ups. My first attempt used a 20W compact fluorescent tube for illumination. I positioned a passive slide previewer with its viewing lens right next to the end of the CFL tube so that the light uniformly illuminated the translucent screen. Slides were simply propped against the translucent screen of the slide previewer (which in this application is being used back-to-front).

I found that with this arrangement a lot of stray light from the CFL tube reflected from the front of the camera onto the front of the slide, so that a ghost of the camera was visible in the images. To solve this, I simply threw a towel over the CFL tube and slide previewer and tucked it tightly around the edges of the translucent screen but after only 10 minutes it all got so hot that the lens on the slide previewer melted and sagged!

After that little accident I changed the light source to a single-AA-cell/single-LED torch I happened to have with me. I unclipped the unharmed translucent screen from the slide previewer and sticky-taped it to the end of a tube of aluminium foil, placing the LED torch in the other end of the foil tube. The illumination of the translucent screen using this method wasn't quite as uniform as using the lens on the slide previewer but you'd have to examine the images pretty closely to notice.

I kept the room dark to avoid reflections from the viewing side of the slides. I took each shot with the camera balanced on my thumbs, to enable me to frame the shot to suit each slide, and pressed the shutter release between heartbeats and with my breath still – there is no obvious blurring in the resulting images. My camera was set to auto white balance, and the colour balance on the resulting images looks fine. Many of the older slides were in a 1:1 aspect ratio, with the transparency both wider and higher than in 35mm slides and I mostly chose to crop them (my camera has a 4:3 aspect ratio), concentrating on just getting all the people into the frame.

With group shots, in addition to snapping the full slide I moved the camera closer to the slide to get more

HOPERF



Digital Sensors



RF IC & Modules



Semiconductor Devices



SAW Devices

Distributed in Australia by
Microzed Computers Pty. Limited
Phone: 1300 735 420 Fax: 1300 735 421
www.microzed.com.au

OCEAN CONTROLS
Helping to put you in Control
Peripheral Devices
We have a selection of peripheral devices for your controller

New Relay Cards
Each relay can be operated by 0 -5V, NPN and PNP open collector signals. 12V or 24V powered. Cards available with 2,4 and 8 relays. Can be fitted with DIN rail Mount. **Prices from $21.50+GST.**



RS232 To TTL Interface
Convert RS232 to TTL and vice versa (TX and RX). This will allow your microcontroller to communicate with a computer. **$15+GST**



Annemometer
Our KTA-250 interface allows you to connect a Davis Instruments anemometer to a PLC, Data Acquisition system or SCADA system. 4-20mA, Modbus and alarm outputs **$159+GST**



DIN Rail Terminals
Paying too much for Din Rail Terminals, Fuse Terminals, Test Switch Terminals and Earth Terminals. Great quality at a low price **From $1.60+GST**



Accelerometers
Accelerometer Breakout boards range from +/-2G to +/-10G. Available as 2 and 3 axis.
From $39+GST



Nylon Cable Glands
IP68 rating. Sizes PG7 to PG29
Prices from $1.50+GST



Contact Ocean Controls
Ph: 03 9782 5882
www.oceancontrols.com.au

Mailbag: continued

Loudspeaker protector is desirable for Bridge Adaptor

The Bridge Adaptor for Power Amplifiers featured in the July 2008 issue looks useful. You use an SC480 amplifier as an example, which uses a Polyswitch for speaker protection.

For whatever reason, some people do not like Polyswitches wired into their amplifiers. Some amplifiers use other means of speaker protection which as a rule use transistors or ICs plus a relay for this purpose. This type of speaker protection has often been featured in SILICON CHIP projects as well.

Glen King,
via email.

Comment: you make a good point. And as you point out, we have featured speaker protectors and how they should be wired into a stereo amplifier on a number of occasions. The most recent was in the July 2007 issue, involving the Speaker Protector for the 20W Class-A Stereo Amplifier. The method of installation is exactly the same for a stereo amplifier used in bridge mode.

detailed shots of individuals. I found that I had to manually adjust the aperture for a small proportion of the shots where the background was either significantly lighter or darker than the faces – a newer camera with face detection would make this unnecessary.

I did the whole shoot on a single charge of a pair of 2500mAH NiMH AA cells in the camera and the OEM single AA cell in the LED torch. I have burned the images onto a DVD so that my grandmother can show them by just popping the disk into her DVD player. But I have cautioned her to hang onto the original slides, as the image quality of the slides is far superior to that of the digital copies.

Andrew Partridge,
Toowoomba East, Qld.

2.4GHz airways museum project

I am working on a 1:72 scale model of a 33MHz airways navigational aid for our museum (see **www.airwaysmuseum.com**). This is to be a working model with the wavelength to scale, requiring a frequency of 2.4GHz.

The aid was based on a German development and was used in Australia between 1939 and 1952. It was called "flying on the beam" and its proper name was a "Radio Range" (a history of radio ranges is at the above website at site search, key word "radio range").

I have two problems for which I would like assistance but first I need to describe how the full-size system works. It has a ground-based transmitter, with a compatible receiver in the aircraft. The transmitter antennas consist of a vertical ½-wave active dipole, with >½-wave dipoles ¼-wave away on each side. The side dipoles have relays at their centres which are open or closed alternately. When closed, the dipole acts as a reflector; when open the dipole cannot affect the radiation pattern.

The 33MHz carrier is amplitude modulated with a 1kHz tone. The side relays are opened and closed alternately, one for 7/8 second and the other for 1/8 second. Thus the radiation pattern is thrown from side to side, one side for 7/8 second and the other for 1/8 second. When "on course" the patterns are of equal amplitude and the aircraft pilot hears a steady tone, ie, he is "flying the beam".

Note that the aircraft radio must receive amplitude modulation and must not have a fast AGC action; only a slow one to allow for the relatively slow aircraft progress to or from the ground station (the model will not need even slow AGC).

For the model to simulate this at 2.4GHz we can use an AWM630 transmitter module but the AWM630 receiver module is of no use as it has a fast AGC action and does not produce audio tones with a level proportional to the incoming carrier strength. The AWM630 TX is amplitude-modulated by feeding its power input with a 1kHz square wave of 5V amplitude.

To provide the necessary gain I have

Tips on light switches

The article in the June 2008 edition on doing your own electrical work contained a few surprises. In New Zealand, I believed all the home handyman could do was to repair corded devices and replace wall plugs and light fittings. Thanks for the clarification.

I feel sorry for my Australian counterparts. The situation highlights the often wide disparity between the law and commonsense.

I work as a mechanical engineer and have routinely done all my own electrical work in my home. It's neither difficult nor particularly dangerous if you understand what it is you are dealing with and simple precautions are taken.

I've spent a lot of time on industrial sites where electrical work was being carried out. I've always claimed electricians are the messiest tradesmen of the lot and if they are involved in any fitting work, they are shockers.

Before you think Australia is all bad, we now have a situation with our building regulations that parallels your electrical situation. A spate of residential housing that developed serious water leaks, in combination with untreated timber framing, poor architectural and regulatory practices, poor quality building work and the use of monolithic wall cladding systems has led to a clamp down on permitted owner modifications. It is now almost a crime for the house owner to pick up a hammer. The irony is that it wasn't the fault of the good builders or the home handyman.

As for light switches and their removal for painting or whatever, I have a couple of tips. When the light switch is pulled from the fitting, put a plastic bread bag over it, and put a piece of masking tape around the neck to hold it in place. This has the advantage that there will be no paint splashes on the switch and it can still be used.

To get out the little plastic plugs over the screws out without damage, I use a piece of duct tape to stick to the buttons and pull them out. It will take more than one go to do it, you need a super sticky tape and I recommend when you install the buttons not to push them in too hard.

What does concern me about doing my own electrical work at home are the insurance implications. I'm not talking about my own work but about the attitude of insurance companies to unlicensed work. Would this affect a claim in some other area? Insurance companies can be slippery.

Andrew Buchanan,
Tawa, NZ.

Comment: spare plastic plugs can often be found on the rear of light switches and power points and are available from hardware stores.

hooked up a DEM 13LNA 2.4GHz preamplifier, a germanium point-contact diode, an audio preamp and an audio amplifier, all small enough to fit in a 1:72 model DC3 aircraft. Antennas are BC7048 coaxial dipoles (Google if details are required).

Now to the problems: first, we obtain about 0.5-metre range without the RF preamp and no more with it in circuit! To make a working model display for the museum I need about at least a 3- metre range. The 2.4GHz preamplifier was specially imported from the USA and I am not sure that it works. (I need to borrow a microwave signal generator or take the gear to where there is one).

I am looking for a person who would like to participate in this project, which is interesting, challenging, and useful to our museum.

Ron Rye,
Heidelberg West, Vic.
ronrye@optusnet.com.au

Modification to IR remote tester

With regard to the story on repairing an industrial microwave oven (Serviceman's Log, June 2008) I should point out that running diodes in parallel doesn't work; the weakest one always blows first.

On another subject, I wanted to test a TV remote control and remembered seeing a circuit in a previous issue (Circuit Notebook, September 2007). I

PRIME ELECTRONICS
Est. 1987

FLUKE

115 Compact DMM



True RMS
AC/DC Volts 600V
AC/DC Amps 10A
Resistance
Continuity
Frequency
Capacitance
Diode Test
Analog Bar Graph
Backlight
Min/Max/Avg
Display Hold
Auto/Manual Range
Holster

List Price ~~$245.00~~ **Our Price $199.00**

179/EDA2 Combo Kit



Kit Contains

- Fluke 179 True RMS DMM
- TL224 SureGrip™ Silcone Test Lead Set
- TL910 Electronic Test Probe Set
- AC280 SureGrip™ Hook Clip Set
- TPAK Magnetic Hanger
- 80BK Intergrated DMM Temp Probe
- C35 Soft Meter Case

List Price ~~$585.00~~ **Our Price $499.00**

Prices exclude GST

Call for a 2008 Fluke Catalogue

www.prime-electronics.com.au
Brisbane (07) 3252 7466
Sydney (02) 9704 9000

Mailbag: continued

Tiny URLs eliminate long URLs

I have a tip on easier computing with long URLs. For example, the address on soldering SMDs is rather long: **http://www.curiousinventor.com/guides/surface_mount_soldering/101**

Instead, try this: **http://tinyurl.com/5ngmpl**

This gives the same result. Tiny URLs work by shortening a long web address which can be either typed in or "cut and pasted" in the shortened format. Result: fewer mistakes when entering web addresses.

If you set it up correctly, all that's required to change an address to a tiny URL is to click on the tinyURL tab set up in either Firefox, Internet Explorer or the new Flock browser – see **www.flock.com/**

John Vance,
Bundoora, Vic.

collected the parts and made a circuit board, put it all together and found that it didn't work. I came to the conclusion that the TLC 7555CP was not as sensitive as the Intersil version so I replaced the IR LED with a Jaycar ZD-1952 IR LED receiver using a 5.6kΩ resistor to reduce the voltage to it. It now works beautifully.

Ted Irving,
Heathcote, NSW.

Safe disposal of used fluorescent lamps

I watched the ABC's 7:30 Report on July 1st, 2008. The lead topic was on the phasing out of incandescents and the safe disposal of compact fluorescent lamps. I was disturbed at its lack of thoroughness.

There seem to be at least two widely-held misconceptions, or a general failure to acknowledge that (1) the tubular fluorescents we have been using for decades also require safe disposal and (2) the very popular low-voltage halogen down-lights are also not only incandescent but even less efficient than ordinary 240V bulbs. There is an even stronger case for them to be replaced, particularly if very efficient high-brightness LED fixtures can replace them.

David Pulford,
Forestville, NSW.

Valve circuit errata 78 years too late?

I noticed that the circuit you published for the AWA C103/43 shortwave converter from the 1930s (SILICON CHIP, April 2008) shows an internal connection from the screen grid in V1 and V2 to a mysterious grid connected between the cathode and the normal grid. This obviously doesn't make any sense in terms of a valve's operation.

I was wondering if this was an error in the original circuit diagram or is it a transcription error?

Roger Forsey,
Seaholme, Vic.

Rodney Champness comments: I would say that this was one of the funny ways in which valve elements and their order in a valve were shown in earlier days. It's not incorrect but strange compared to the more sensible ways that valve layouts were drawn in later years.

Easy way to reverse a fan

In reply to the question about reversing a brushless DC fan motor (Ask SILICON CHIP, May 2008) it could be added that the easiest way to reverse the airflow is to simply physically reverse the fan assembly; four screws and it's done. Usually it has an arrow on the side to confirm orientation.

Also worth mentioning is that for maximum fan efficiency and airflow, an equal area of inlet or exhaust is required on the opposite side of the cabinet, otherwise you are trying to partially pressurise or depressurise the cabinet.

John Williamson,
Cheltenham, Vic. SC

Australia's Lowest Priced DSO!



Now you've got no excuse ... update your old analogue scopes!

Whether you're a hobbyist, TAFE college or university workshop, the GW GDS-1022 has the price and performance for you.

GW GDS-1022 25MHz

- 25MHz Bandwidth, 2 Ch
- 250MS/s Real Time Sampling
- 4k Memory Per Channel
- TFT Colour Display
- 19 Auto Measurements
- Built-in USB & SD Card Slot
- **GW Brand - 28 years in Australia**

ONLY $499 inc GST

SAVE $50

Sydney Tel 02 9519 3933 Fax 02 9550 1378
Melbourne Tel 03 9889 0427 Fax 03 9889 0715
Brisbane Tel 07 3275 2183 Fax 07 3275 2196
Adelaide Tel 08 8363 5733 Fax 08 83635799
Perth Tel 08 9361 4200 Fax 08 9361 4300
email testinst@emona.com.au
web www.emona.com.au

EMONA

Basslink

the high voltage DC power link between Victoria & Tasmania – the longest undersea power link in the world



by Michael Goebel

Back in February 2000 a tender was granted for building a high voltage DC power link between Victoria and Tasmania. It was finally commissioned in April 2006 and now feeds power in both directions between Victoria and Tasmania, depending on demand in those states.



Victoria and Tasmania have different power supply problems. Victoria has Australia's most inefficient thermal power stations, burning brown coal – Loy Yang power station and mine is shown above. So it makes sense to use Tasmania's hydo-electricity when it is available, especially during peak power periods.

On the other hand, when Tasmania suffers droughts they often do not have enough hydro-electric power capacity to meet their own demand. When that happens, Tasmania can draw power from Victoria's grid.

But there is a problem – the 300km-wide stretch of often-wild water between the two called Bass Strait. And connecting them is not quite as easy as erecting a couple of giant pylons and stringing some cable over the water.

Enter Basslink

Basslink is a 400kV DC bi-directional, undersea electricity interconnector, rated to transmit 500MW continuously and 630MW peak from Tasmania. The link can operate at up to 600MW for up to 10 hours, providing that it is 'pre-cooled' (six hours at no more than 300MW). In the other direction, up to 480MW can be sent to the relatively small Tasmanian grid.

Basslink consists of:

- a 290km-long submarine power cable, the longest of its type in the world, from McGaurans Beach near Giffard in Victoria's Gippsland, to Four Mile Bluff, above George Town on Tasmania's north coast.
- a 60.8km overhead power line to the Victorian coast.
- a 6.6km underground cable in Victoria.
- an 11km overhead line section to the Tasmanian coast.
- a 1.7km underground cable in Tasmania.

The high voltage cable used for the Basslink is 15cm thick. The undersea cable alone weighs 17,400 tonnes. From McGauran Beach it runs for a few kilometres as an underground cable and finally emerges as an above-ground line running 70km to Loy Yang power station.

There, the high voltage DC from Tasmania is converted into AC with the help of thyristor "converter valves" so it can be fed into the 3-phase power system. These valves have nothing to do with thermionics or vacuum tubes but are entirely solid state. The thyristors are made of pure mono crystalline silicon and are effectively used as switches.

When Victorian power is being fed to Tasmania, a similar station in Tasmania transforms the DC into AC. So power transmission can be made in both directions, with similar conversion equipment for AC to DC and DC to AC at each end.

Why DC?

In an AC distribution system, voltage conversion is simple – just use a transformer. However, above certain power levels and over long distances, for submarine cables, high voltage AC transmission links have significant disadvantages compared to DC, despite DC having to be converted twice.

For a long transmission path, the smaller losses and

reduced construction cost of a DC line can offset the additional cost of converter stations at each end of the line. Also, at high AC voltages significant amounts of energy are lost due to corona discharge, the capacitance between phases or in the case of buried cables, between phases and the soil or water in which the cable is buried.

Long undersea cables have a high capacitance. While this has minimal effect for DC transmission, the current required to charge and discharge the capacitance of the cable causes additional I^2R power losses when the cable is carrying AC. In addition, some AC power is lost in the dielectric.

HVDC can carry more power per conductor, because for a given power rating the constant voltage in a DC line is lower than the peak voltage in an AC line. This voltage determines the insulation thickness and conductor spacing.

Therefore DC transmission line corridors can be used to carry more power into an area of high power consumption, which can again lower costs.

Another advantage of HVDC systems is that they require only two cables as opposed to the three needed for three phase current transmission. As a result, an HVDC overhead line also requires less space.

So the key advantages of a DC link over an AC link are:

- It allows power transmission between AC networks with different frequencies, or networks which cannot be synchronised. A good example of this is Japan which has 50Hz and 60Hz power grids.
- Inductive and capacitive parameters do not limit the transmission capacity or the maximum length of a DC overhead line or cable.
- In addition, the full conductor cross section is utilised because there is no "skin effect" at DC.

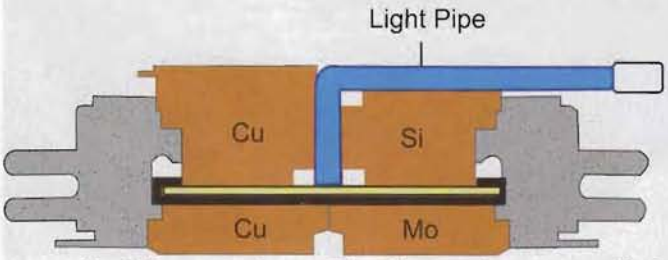
Thyristor "valves"

The outdoor valves for earlier systems were designed with oil-immersed thyristors with parallel/series connection of thyristors and an electromagnetic firing system. Further development went via air-insulated, air-cooled valves to the air-insulated, water cooled design, which is the state-of-the-art in HVDC valve design.

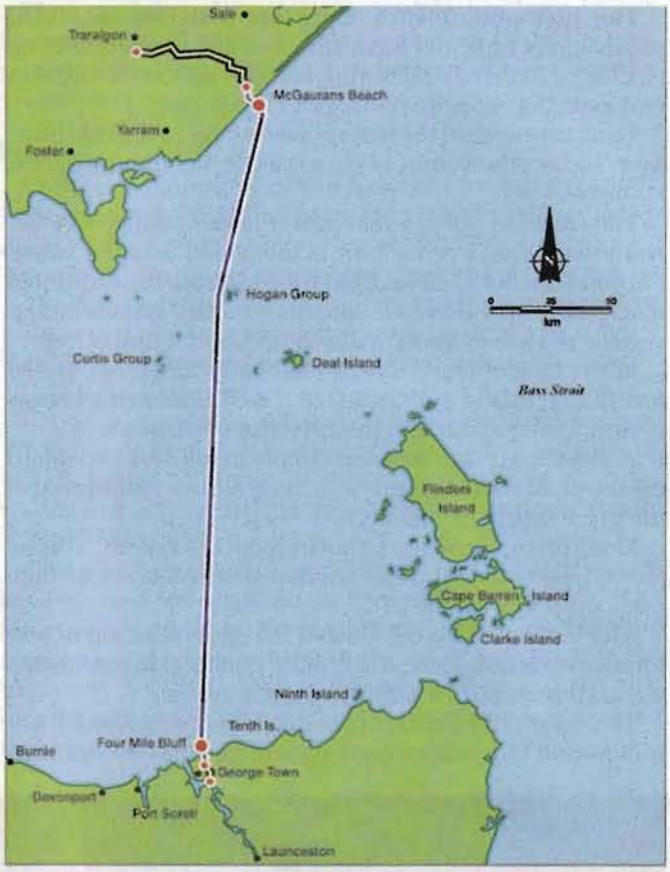
The development of thyristors with higher current and voltage ratings has eliminated the need for parallel connection and reduced the number of series-connected thyristors per valve.

Light triggered thyristors

It has long been known that injecting photons into the gate instead of electrons can turn on thyristors. See Fig 5.



A graphical diagram of one of the Siemens laser-controlled LTT thyristors which make up the "valve" used in the AC/DC and DC/AC conversion in Basslink, with an exploded photo of the device at right.

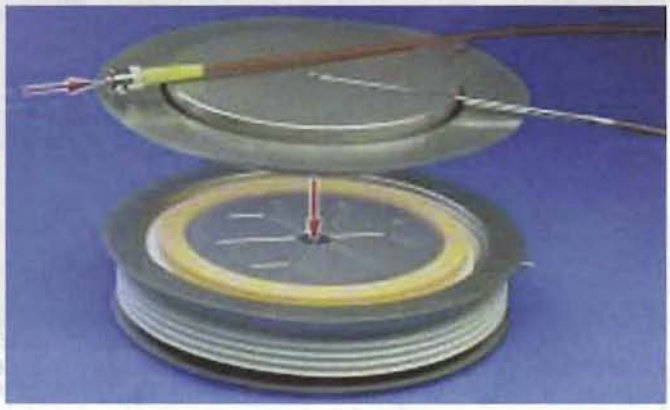


The route of the predominantly-undersea HVDC interconnect between the Loy Yang power station in Victoria's Gippsland and the Tasmanian hydro grid connection at George Town, near Launceston in northern Tasmania.

This is known as LTT (Light triggered thyristor) technology and reduces the number of components in the thyristor control by up to 80%.

This simplification results in increased reliability and availability of the transmission system. With LTT technology, the gating light pulse is transmitted via fibre-optic cable (itself providing high isolation), through the thyristor housing directly to the thyristor wafer. Therefore no elaborate electronics, including auxiliary supplies, are needed to control the high potential.

Innovations in almost every other area of HVDC have been constantly adding to the reliability of this technology with economic benefits for users throughout the world.



The high-performance thyristors installed in HVDC plants today typically have silicon wafer diameters of up to 125mm (6 inches), blocking voltages up to 8kV and current carrying capacity up to 4kA DC.

Thus no parallel thyristors need to be installed, however, series connection is necessary to handle the HVDC voltages.

The required optical gate power is just 10mW. The forward overvoltage protection is integrated into the wafer. Further benefits of direct light triggering are the unlimited black start capability and operation during system undervoltage or system faults without traditional limitations.

In the case of convential (electrically triggered) thyristors (ETT), this is only possible if sufficient firing energy is stored long enough in the thyristor electronics.

A simple voltage divider circuit made from standard off-the-shelf resistors and capacitors allows monitoring of the thyristors performance.

Monitoring signals are transmitted at very-much-safer ground potential through another dedicated set of fibre optic cables as for the LTT.

All electronic circuits needed for the evaluation of performance are now located at ground potential in a protected environment, further simplifying the system.

The extent of monitoring is the same as for the ETT. It is expected that this technology will become the industry standard in HVDC thyristor valves of the 21st century, paving the way towards maintenance-free thyristor valves.

Laser control

The thyristors in the Basslink project are controlled by 10mW laser flashes, transmitted via glass fibres. These thyristors, which have a diameter of 100mm, were produced by Infineon and are made of silicon, molybdenum and copper. To achieve a DC voltage of 400kV, several dozen thyristors per converter valve are connected in series.

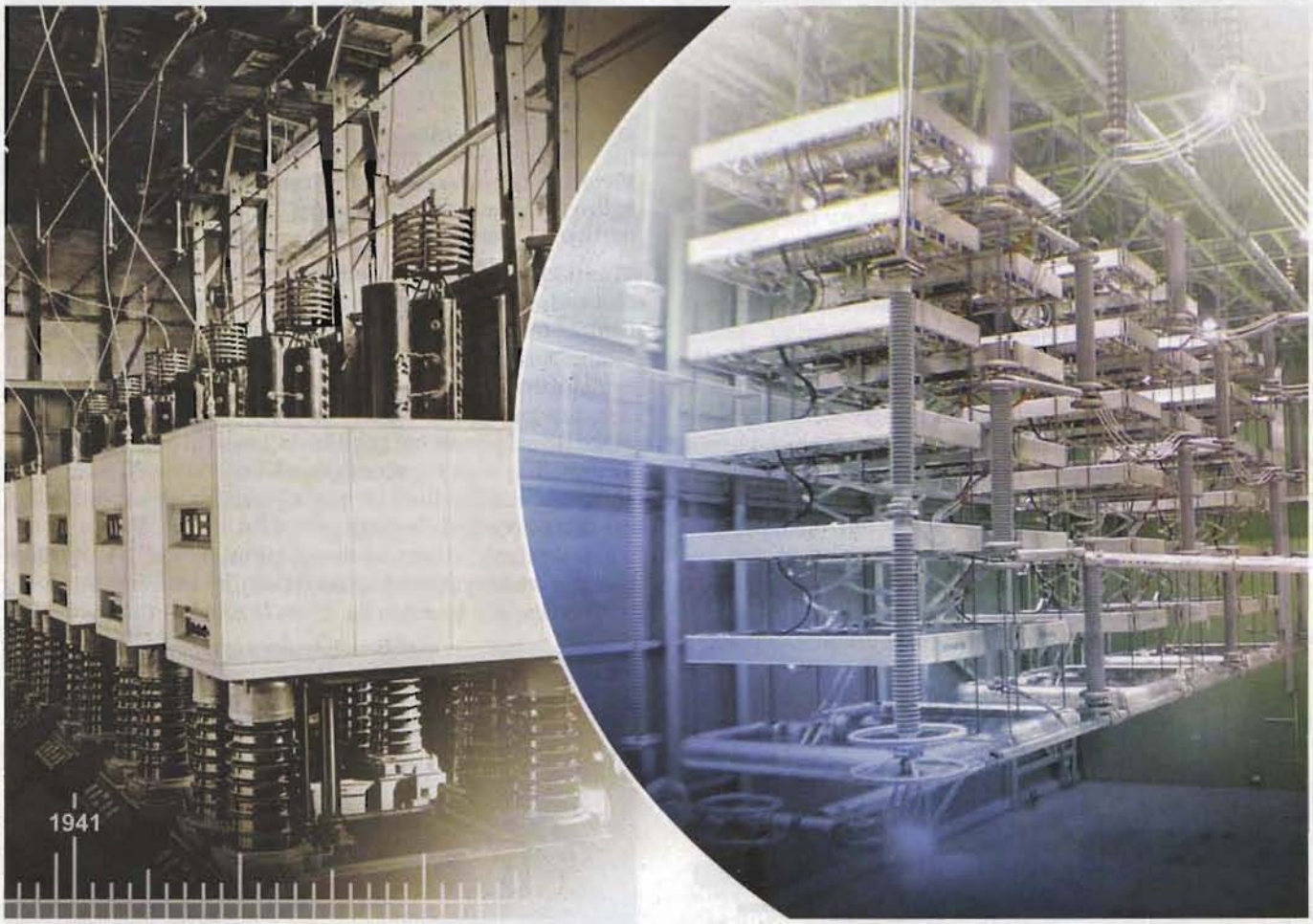
All of these thyristors must trigger within 1µs in order to ensure that none are overloaded or damaged.

Valve Design

The modular concept of the Siemens thyristor valves permits different mechanical setups to best suit each application: single, double, quadruple valves or complete six-pulse bridges, either free standing or suspended from the building structure.

The standard Siemens valves for long distance transmission are suspended from the ceiling of the valve hall to allow them to withstand earthquakes, especially important in areas prone to seismic activity such as Japan and New Zealand.

The suspension insulators are designed to carry the weight and additional loads originating for example from



The old and the new: at left is a bank of six mercury-arc rectifiers for a 100kV, 140A high-voltage DC supply from around 1942. At right are the HVDC valve towers in the 3000MW. ±500kV, 1000km HVDC transmission link between Guizhou and Guangdong in China. Basslink is a smaller distance but is predominantly under water, which brings in a whole new set of problems to overcome (photo courtesy Siemens).

an unbalanced weight distribution due to insulator failure, an earthquake or during maintenance.

Connections between modules (piping of cooling circuit, fibre optic ducts, buswork and suspension insulator fixtures) are flexible in order to allow stress-free deflections of the modules inside an MVU (multiple valve unit) structure.

Each valve is made up of three modules. Four arresters, each related to one valve, are located on one side of the valve tower. Ease of access for maintenance purposes, if required, is another benefit of the Siemens valve design. By varying the number of thyristors per module and the number of modules per valve, the same design can be used for all transmission voltages that may be required.

Thyristor cooling

The thyristors are stacked in the module with a heatsink on either side. The water connection to the heatsinks can be designed in parallel or series.

The parallel cooling circuit provides all thyristors with the same water temperature. This allows a better utilisation of the thyristor capability and offers the additional advantage that electrolytic currents through the heatsinks – the cause for electrolytic corrosion – can be avoided by placing grading electrodes at strategic locations in the water circuit.

The parallel wafer cooling principle has been in use for more than 25 years, with no corrosion problems ever encountered. Water cooling also does not require any de-oxygenising equipment.

Fire!

With such enormous power involved, arcing and fire is a constant risk. This has been minimised through many steps:

- All oil has been eliminated from the valve and its components. Snubber capacitors and grading capacitors use SF6 as a replacement for impregnating oil.
- Only flame-retardant and self-extinguishing plastic materials are used.
- A wide separation between the modular units ensures that any local overheating will not affect neighbouring units.
- Careful design of the electrical connections avoids loose contacts.

The past has shown that Siemens HVDC installations have never been exposed to a hazardous fire risk. The tests performed on actual components and samples in the actual configuration as used in the valve indicate that the improved design indeed is flame retardant and the risk of a major fire following a fault is extremely low or even non existent.



One end of BassLink – the 400kV DC valve hall near the Loy Yang power station in Victoria's Gippsland. The valves hang from the ceiling, predominantly to allow them to move, protecting them from damage in case of earthquake.

High Voltage DC: how it works

As noted elsewhere in this article, the basic element in all HVDC conversion is the light triggered thyristor (LTT) or SCR (silicon controlled rectifier). These are connected in series banks of a hundred or more SCRs, to give a total rating which may be 500kV DC or more and hundreds of Amps.

When connected in such a way, they are referred to as "valves" and each valve can be regarded as a single device. In reality, to function in this way, all the SCRs in a valve must be triggered on within one microsecond of each other. This is achieved by a laser light pulse fed to the every SCR in the valve.

Once an SCR is triggered, it breaks into conduction and it continues to conduct until the load current falls to a very low value (below the "holding" current) or the voltage across it is reversed in polarity. So in effect, once an SCR or valve is triggered into conduction, it behaves just like a conventional diode, albeit a very large diode!

So how are these banks of LTTs, or valves, connected to perform the conversion from AC to DC or DC to AC? And how does the same setup perform either AC/DC or DC/AC without altering the connections?

To keep it simple, let's first consider the conversion of AC to DC. Consider that all power grids are 3-phase systems, with the difference between respective AC phases being 120°.

Fig.1 shows a 3-phase transformer connected to a 6-SCR bridge rectifier. Incidentally, this is exactly the same connection as used in a standard car alternator (it has six large diodes pressed into its casing.)

Each diode (or LTT) conducts when it has a forward voltage across it and so each diode conducts for a maximum of 60°. The result is a DC voltage with a superimposed 300Hz AC ripple (for a 50Hz grid), as shown in Fig.2.

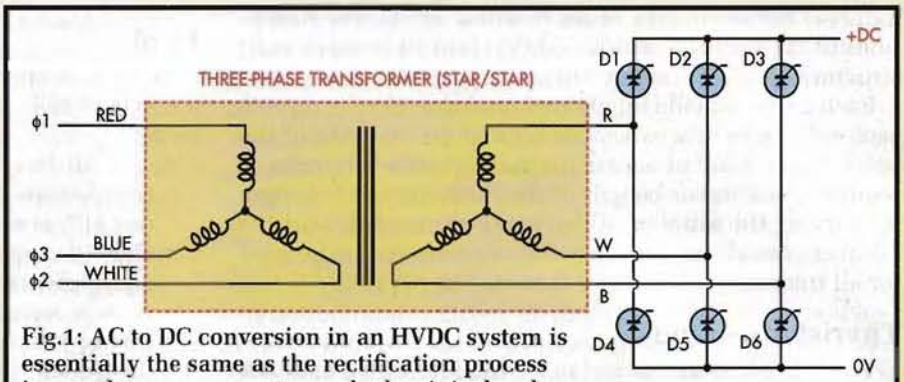


Fig.1: AC to DC conversion in an HVDC system is essentially the same as the rectification process in a 3-phase power system, whether it is the alternator of a car or in a country's electric power grid. Six diodes (or SCRs) are required and two diodes will be conducting at any one time. Note that while we show a star-connected transformer in this case, it could just as easily be a delta-connected system.

At any one time, only two diodes will be conducting, for example, D1 & D5 or D6, D2 & D4 or D6 and so on. The result is that there are six diode-conduction periods providing the AC to DC conversion which is more familiarly known as rectification.

Exactly the same setup can be used to convert the DC back to AC except that the power flow is in the other direction. In DC/AC conversion, only two SCRs conduct at any one time (as in rectification) but they need to be triggered into conduction at the right time to energise the particular transformer windings.

However, the resultant waveforms on the output side of 3-phase transformers are anything but a clean sine wave. Hence quite heavy filtering is required in order to prevent large harmonics in the distribution grid.

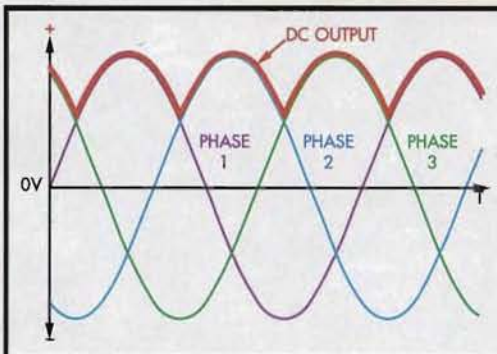


Fig.2: This set of waveforms shows how a 3-phase system is converted to DC using the schematic of Fig.1. The three voltage phases are separated by a phase difference of 120° and the resultant DC from the rectifiers has a superimposed ripple at six times the mains frequency, ie, 300Hz for a 50Hz grid.

Because there are six periods (or combinations) of SCR conduction in this DC/AC conversion process, this is referred to as a 6-pulse converter; six trigger pulses are required for one cycle of AC which will be 50Hz or 60Hz, depending on the country where it is used.

In reality, the setup outlined in Fi.g.1 is not used now. Instead, we have a more complicated system, shown in Fig.3. This uses a 3-phase transformer with star and delta-connected secondaries feeding a set of 12 SCRs or valves.

This makes use of the fact that while the three phases are separated by 120°, when the outputs of a star and delta system are connected together, you effectively have six phases separated by 60°.

When used for AC/DC conversion (ie, rectification), the resultant DC has 600Hz ripple (for a 50Hz grid) and there are 12 combinations of SCR conduction. To consider just one 30° conduction period, when D1 conducts, so will D5, D8 & D11 or D6, D9 & D12.

Since there are 12 conduction periods, this is referred to as a 12-pulse converter. The six voltage waveforms from the star and delta windings are depicted in Fig.4.

Note that we have shown the Star and Delta winding outputs with their normal amplitude relationship, whereby the phase-to-phase (delta) voltage is $\sqrt{3}$ times the phase to neutral (star) voltage, to highlight how the 6-phase system comes about.

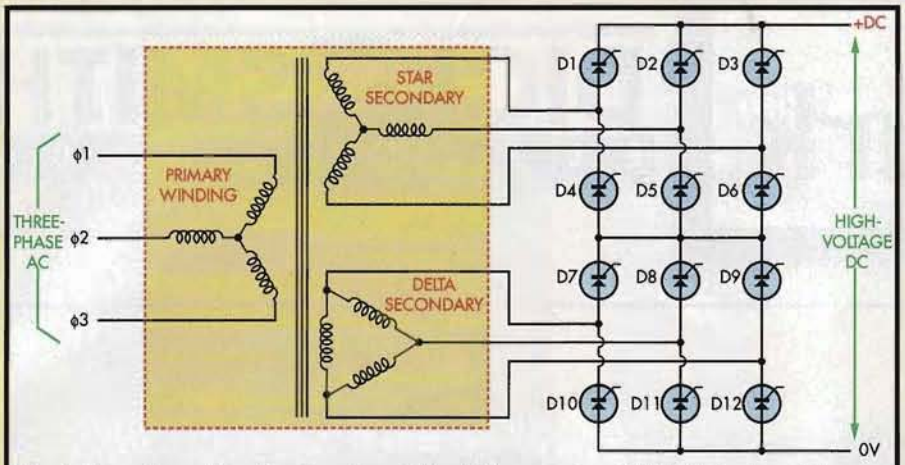


Fig.3: the schematic of a 12-pulse AC to DC converter. While this circuit is ostensibly an AC to DC converter, it can just as easily be run in the opposite direction, converting DC to 3-phase AC by triggering the SCRs at appropriate times to energise the relevant transformer windings.

In reality, we assume that their amplitudes will be the same.

For DC/AC conversion, the process is exactly the same as for a 6-pulse system except that we now have 12 SCRs (or valves) which are triggered at 12 points in the waveform to energise the star and delta windings. Because the harmonics in a 12-pulse converter are twice as high in frequency and reducing in amplitude by the same amount, it is much easier to filter them out and prevent them being fed into the distribution grid.

Note that the schematic of Fig.3 is much simplified compared to reality and does not show all the filtering, protection and ancillary components.

Note also that the DC/AC conversion process assumes that there is already 3-phase power available on the AC grid, to provide the essential triggering and synchonisation of the SCR valves.

In a complete HVDC system there is an AC/DC converter at each end of the transmission line and in the case of the Basslink system and others throughout the world, they can transfer power in both directions. See Fig.5.

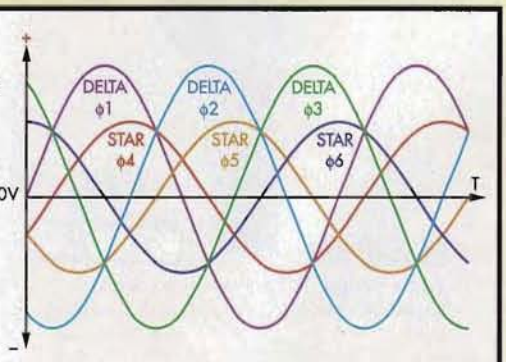


Fig.4: the phase relationship in a 3-phase system using star and delta waveforms together, to drive the converter circuit of Fig.3. The resultant phase waveforms are separated by only 60° and the resultant DC from rectification has ripple at 12 times the mains frequency, ie, 600Hz for a 50Hz system. Note that the harmonics produced in conversion can run as high as the 30th or higher and require elaborate filtering.

So was Edison right all along?



Anyone familiar with the history of electrical energy will know that Thomas Edison was a very strong proponent of DC and many early systems in towns and cities were based on DC.

Ultimately though, the sheer advantages of the AC system, as promoted by Westinghouse and largely invented by Nicola Tesla, won out and now AC generation and transmission of power are universal, usually at 50Hz or 60Hz.

So why is high voltage DC now being promoted? In fact, the advantages of AC over DC are still manifest. However, for power transmission over very long distances, say 800km or more or for distances of 50km or more undersea, DC has advantages in that usually only one cable instead of three, in the case of 3-phase AC transmission, is involved.

By transmitting electrical power at very high voltages, eg, 400kV or higher, the resistance losses are reduced, as are the weight of the cable, its supporting structure and so on.

Furthermore, DC transmission makes it possible to transfer power between two electrical grids that operate at different frequencies (50Hz & 60Hz), as happens in Japan.

So Edison did not get it right. High voltage DC power transmission is the solution to problems that Edison is unlikely to ever have foreseen. SC

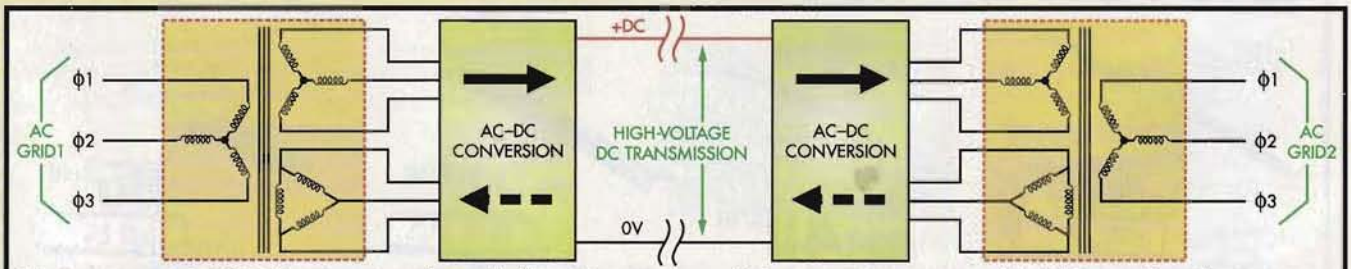
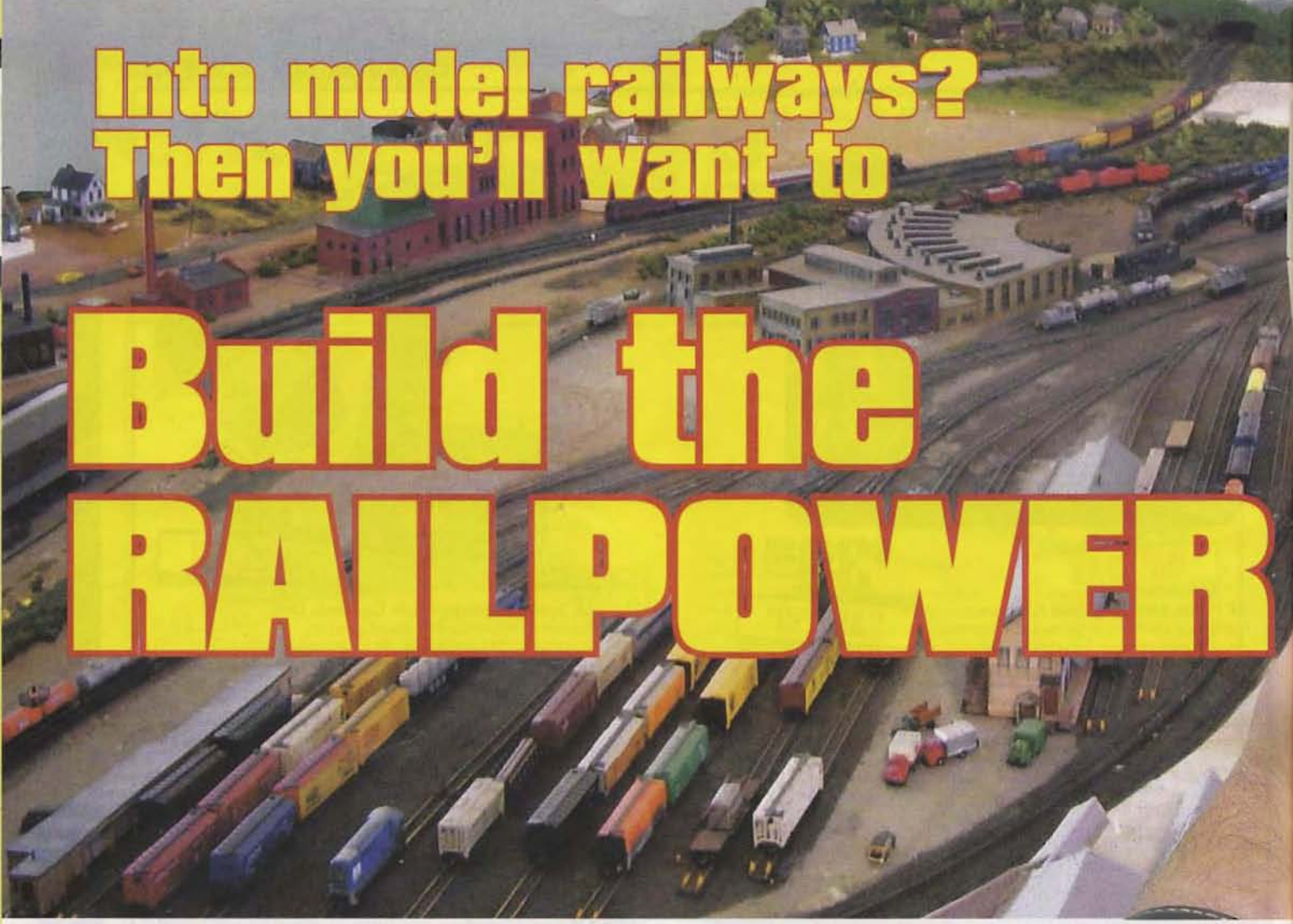


Fig.5: a complete HVDC system in schematic form. In very long distance systems, as used in China or Brazil, power transmission is usually in one direction only but a complete AC to DC and DC to AC converter is required at the start and finish of the transmission line.



Into model railways? Then you'll want to Build the RAILPOWER

This ultra-high performance model train controller features infrared remote control. We believe it's the best build-it-yourself train controller ever published!

Once upon a time model trains were every kid's dream hobby – but nowadays they are much more likely to be the province of their dads and grand-dads.

To a true model railway enthusiast, realism of rolling stock, track layout, scenery and train operation is paramount – and it's not hard to spend up to a thousand dollars or more on a good loco. (Some model railway "widows" insist it's the spender that's loco!)

Many model railway enthusiasts have permanent setups occupying vast areas of their homes – inside and out! We've heard of model railway enthusiasts who have bought a new house simply on the basis that it lends itself to their hobby. Bedrooms? Bathrooms? Kitchen? Who cares, as long as there is room for his "trains"!

One thing that every enthusiast understands is that the old-fashioned rheostat-type controller is simply not up to the task – to achieve that realism we mentioned earlier, they must have a high-performance train controller, one that can vary the speed, direction and be able to simulate the inertia of a full-size train. And one with switch-mode (pulse power) operation for really good low speed control.

Finally, infrared remote control (so you can direct operations from anywhere on your layout) is practically essential – and not just on larger layouts.

Railpower Mk IV

Our latest Railpower train controller (actually the fourth one we've published in our 20+ years) is simply outstanding. The completely new design, based on a PIC microcontroller, provides all those wanted features and more.

Those who have had a chance to try it out reckon it's right up there with the best commercial controllers costing hundreds of dollars more.

This latest Railpower design is packed full of features to enable a locomotive to be driven smoothly over its full speed range.

And while all of the control features can be accessed from the handheld remote, there is also a large knob on the front panel to control the speed – for those who like to feel "in control"! There are also four pushbuttons on the



Features

- Pulse power for extra smooth low speed operation
- Back-EMF detection for speed regulation
- Infrared remote control
- Front panel speed control
- Speed setting displayed as bargraph and percentage value
- Actual speed bargraph display
- Adjustable simulated inertia with on/off control
- Adjustable braking (stop) inertia
- Forward and reverse lockout
- Indication of stop, direction, inertia and lockout
- Overload protection with visual and audible indication

Design by JOHN CLARKE

front panel to adjust all the settings as well as providing Direction, Stop and Inertia on/off.

Infrared remote control

A standard pre-programmed remote is used to access all the standard features such as speed, direction, braking (stop) and inertia on/off.

And since we are using a standard remote control, we have allocated the standard buttons to control particular functions.

For example, the volume up and down buttons control the speed, the mute button is used for braking (stop) while the channel up and down buttons select forward or reverse, respectively.

Just like the real world, the direction of the locomotive cannot be changed if it is running above a certain speed (which we call the "lockout" speed). So if you want to change direction you have to slow down the locomotive before the Railpower will let you change the direction.

This prevents derailments which can be catastrophic if you are using a locomotive (or two/three) ahead of a long train.

Using the Stop (Mute) function brings the locomotive to a stop when pressed and lets the train return to its original speed setting when pressed again.

Just like in TV operation, if you have pressed the Stop (mute) button, pressing the Speed (volume up) button, returns the train to its original setting. However, if you have Stop pressed, you can also use the Volume Down button to reduce the speed setting while the train is stationary.

Inertia

Real trains have huge amounts of inertia. A big coal drag or iron ore train may be 20,000 tonnes or more and you can bet that when the driver calls for an increase in speed, nothing happens quickly. In fact, the driver of a real train must not apply full power quickly otherwise the train couplings can be easily broken.

In the modelling situation we wish to simulate that huge inertia so that changes in speed setting are not immediately reflected by a change in actual train speed. We can adjust the

Specifications

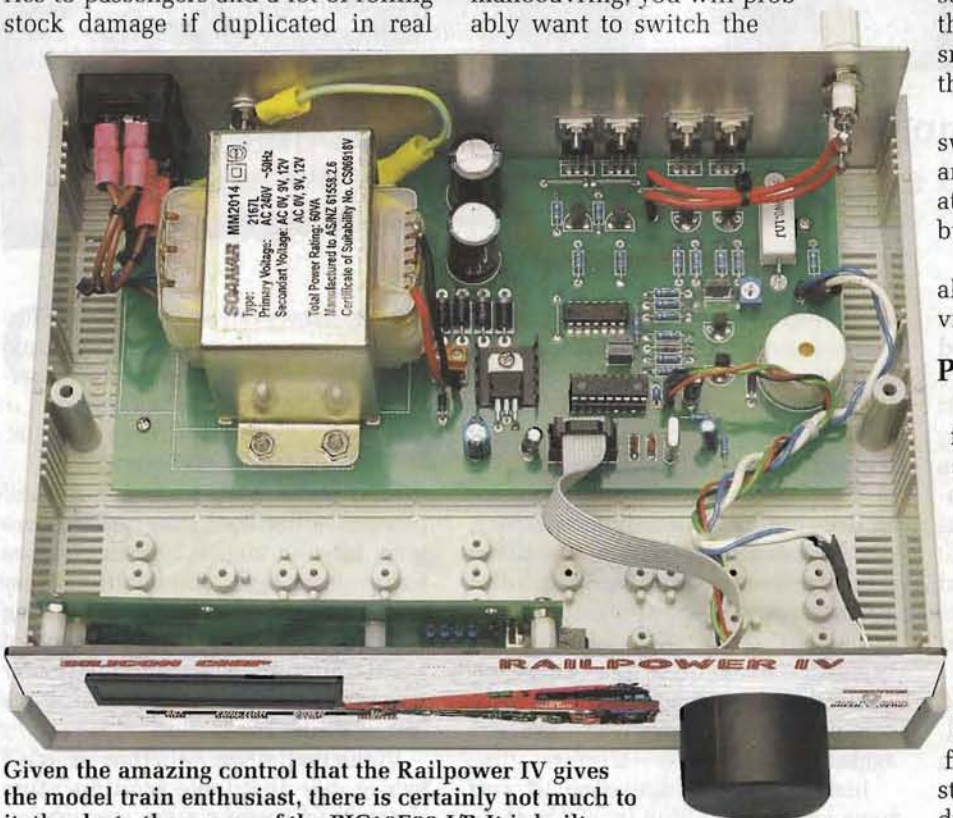
Output Voltage	16-17V pulse width modulated in 819 steps up to 80% duty cycle
Output current	up to 6A
Pulse Frequency	122Hz, 488Hz or 1953Hz
Speed setting display	60-step bargraph and percentage from 0-100%.
Actual speed display	60-step bargraph
Minimum speed setting	adjustable
Lockout speed setting	adjustable
Default speed setting	adjustable
Infrared remote codes	Philips RC5; TV, SAT1 and SAT2
Infrared remote range	8m (indoors)
Inertia adjustment	From 0-100 corresponding to about 1 to 100s (dependent on minimum and maximum settings)
Stop adjustment	From 0-100 corresponding to about 1 to 100s (dependent on minimum and maximum speed settings)
Back EMF Feedback control	Adjustable from 0 to 100 corresponding to no back-EMF control through to a maximum
Speed ramp rate	From 0 to 255 corresponding to the rate of speed setting change with remote control
Bi-colour LED	Shows track voltage and direction

amount of simulated inertia over a wide range, to simulate the effect of locomotive running in "light engine" (ie, no carriages or wagons) to that large coal drag we mentioned above.

Simulating train inertia adds greatly to the operation of model trains. Instead of trains accelerating like jack rabbits or coming to a screeching halt (which surely would cause fatal injuries to passengers and a lot of rolling stock damage if duplicated in real life operation!) they move off slowly, or even ponderously, in case of long freight trains.

Inertia can be toggled on or off with the remote control's On/Off switch (normally used to turn the TV on or off).

When you are running a train along a layout you will want inertia switched on but when shunting or other delicate manoeuvring, you will probably want to switch the inertia off. When inertia is set to off, the locomotive motor responds almost instantly to speed setting changes.



Given the amazing control that the Railpower IV gives the model train enthusiast, there is certainly not much to it, thanks to the power of the PIC16F88-I/P. It is built on two PC boards (one for the display) and mounts in a 260 x 85 x 180mm ABS case. It offers both local and infrared control.

Run & braking inertia

Actually, the Railpower IV provides for two inertia settings. The first is for running a train, giving very gradual increase or decreases in train speed in response to a given setting. The second is braking inertia which means that the train can be brought to a stop smoothly and quickly when you press the Stop button.

However, if you have the Inertia switched off, there is no braking inertia and the train will come to an immediate jarring stop if you press the Stop button.

As we mentioned before, these and all the other settings can be adjusted via the front panel buttons.

Pulse power

Having realistic inertia counts for nothing if the train controller cannot provide smooth reliable acceleration from a standing start. To provide smooth low speed control and very smooth starts, you cannot use smooth DC or unfiltered DC operation.

It just will not work properly and the result can be a locomotive which is stalled until you wind up the voltage to such a level that when the loco finally does move, it takes off like a startled rabbit and may even spin its driving wheels furiously.

The only way to ensure reliable low speed operation, apart from hav-

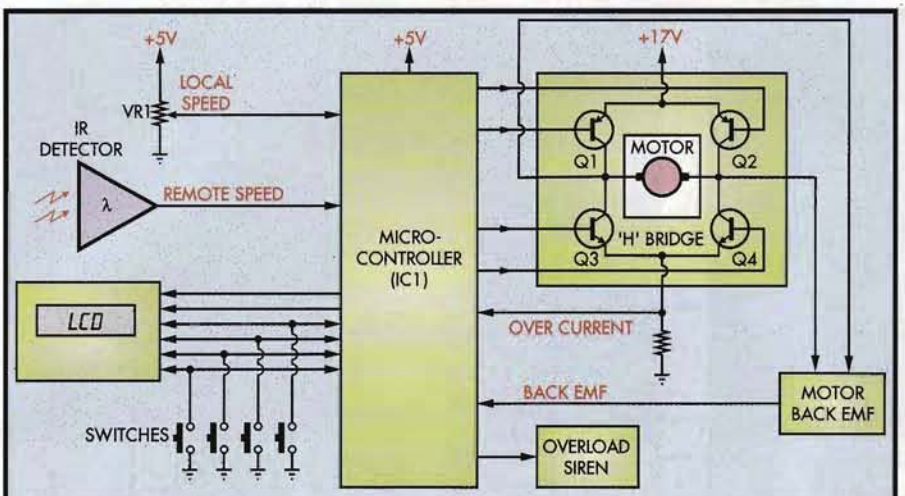


Fig.1: the block diagram of the Railpower IV belies just how powerful this new train controller is. It's by far the best we have ever published and is only made possible through the use of a PIC microcontroller.

ing clean track and regularly cleaned locomotive wheels, is to use what railway modellers refer to as "pulse power" and what electronics people call switchmode or pulse width modulation (PWM).

Whatever it is called, it involves driving the locomotive with high amplitude (typically 16-17V) pulses which easily overcome track/wheel contact resistance and motor stiction (static friction) to ensure smooth starting and low speed running.

Speed regulation

The other way to ensure good low speed operation is to monitor the back-EMF of the locomotive motor. This is the voltage which opposes current flow through the motor due to the applied voltage.

In permanent magnet DC motors, as used in most model locomotives, back-EMF is directly proportional to speed.

Therefore, if we want the controller to maintain a set speed, we monitor back-EMF to provide a feedback signal to the circuit. It works very well.

Liquid crystal display

A 2-line Liquid Crystal Display (LCD) indicates train speed and speed settings, as well as direction, stop and whether inertia is switched on or off. The train and speed settings are shown as horizontal bargraphs. The speed setting is also shown as a percentage from 0 to 100%. The lower bargraph shows the speed setting while the upper bargraph shows the actual train speed.

If the Railpower IV is overloaded or the output is shorted, the top line of the LCD shows 'OVER' in place of the direction arrow, padlock icon (lockout), S and I indicators. An internal overload siren also sounds and power to the motor is stopped until the current overload is ended.

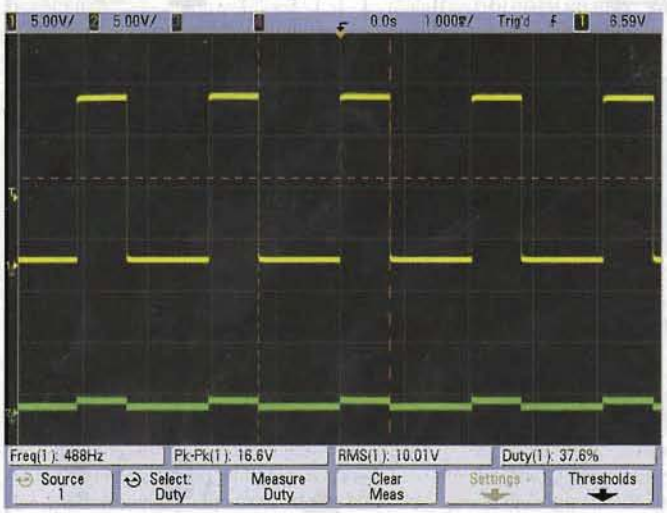
As already mentioned, you can change all the settings with the front panel switches below the LCD panel. We will discuss those details next month.

The Railpower IV is presented in a large instrument case that houses the power transformer and circuitry. At the rear panel is the mains input and power switch and two terminals for connection to the track layout.

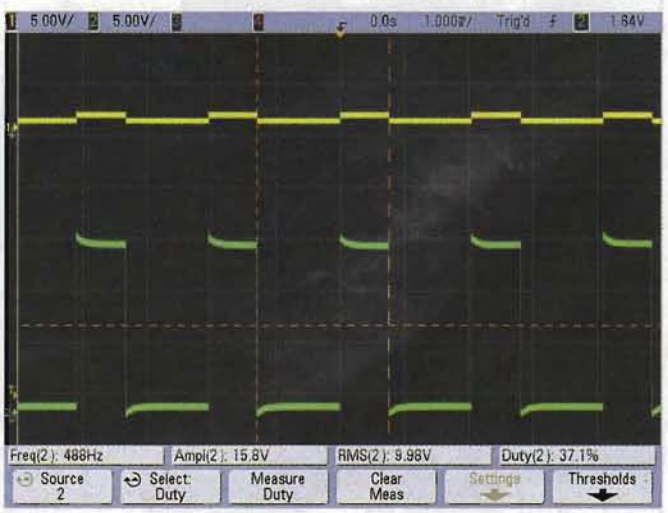
Circuit details

A block diagram of the circuit is shown in Fig.1. It comprises the PIC microcontroller and this drives the LCD module, the H-bridge and overload siren. It also monitors signal from the infrared detector, the front panel switches, the over-current monitor and the back-EMF from the locomotive motor.

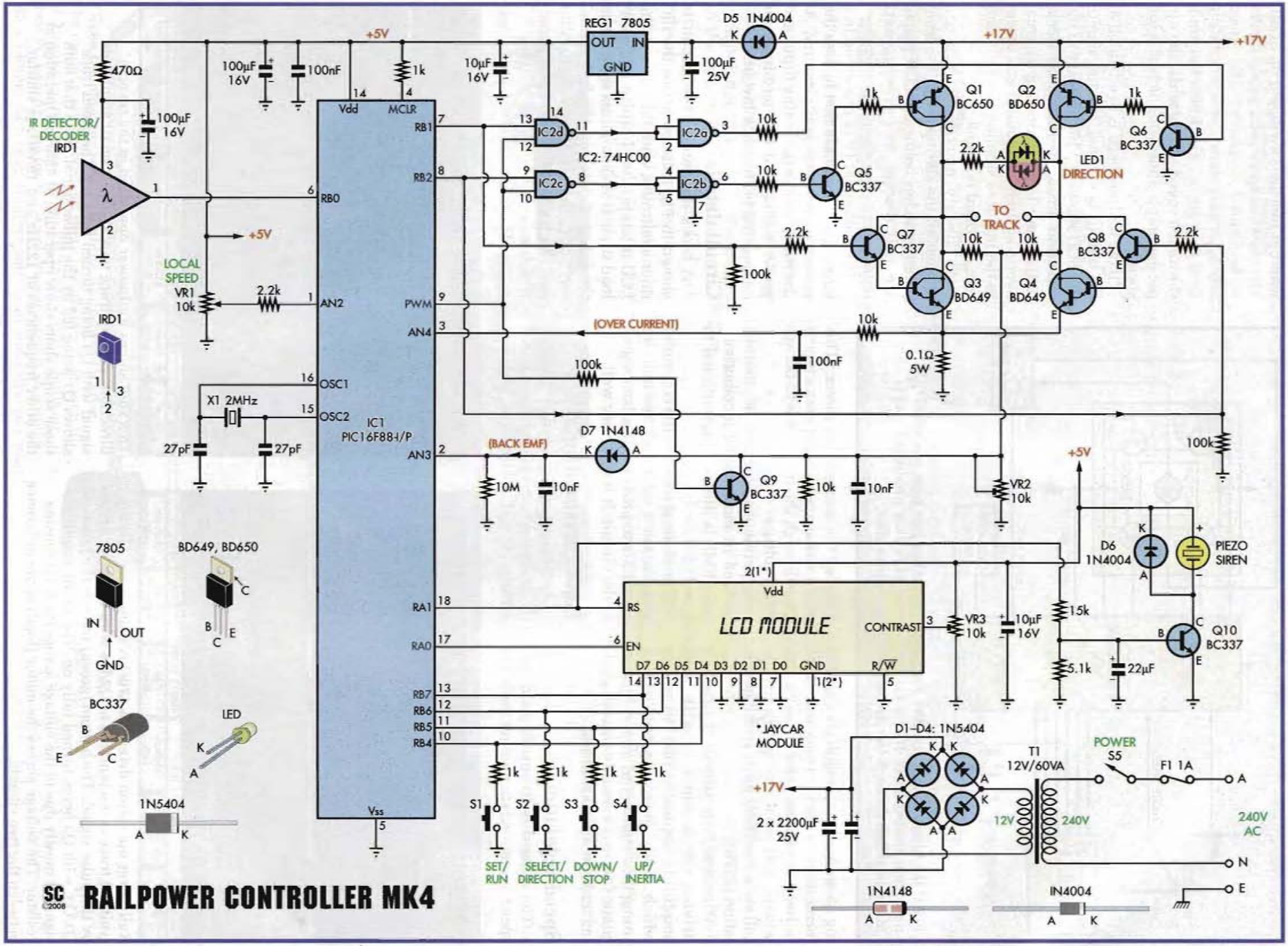
The H-bridge drive circuit com-



Railpower operation driving a 470Ω resistor load. The top (yellow) trace is the junction of Q2/Q4 with Q2 being driven by the pulse signal. The bottom (green) trace is the junction of Q1/Q3, with Q3 being turned fully on. The small amplitude signal is mostly due to the voltage across the 0.1Ω sensing resistor. The voltage across the motor (load) is the difference between the two signals.

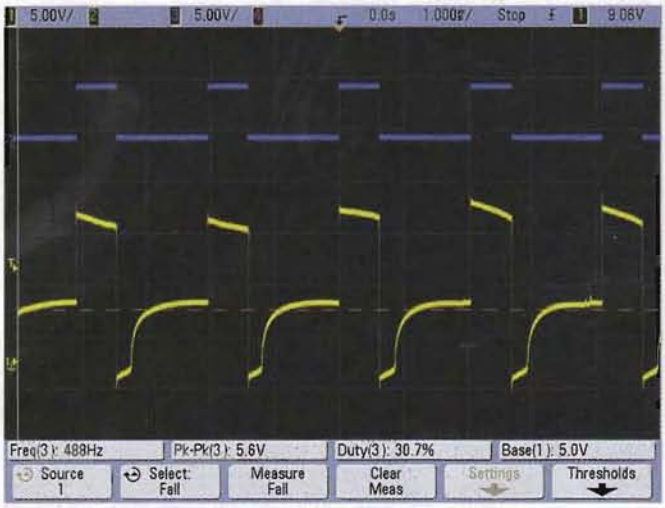


This shot shows Railpower operation in the reverse direction. The top trace now shows a small amplitude signal with Q4 being turned fully on. The green trace shows Q1 being fed by the pulse signal. Note that both these scope shots show operation at 488Hz. Operation at the other frequencies of 122Hz and 1953Hz is similar.

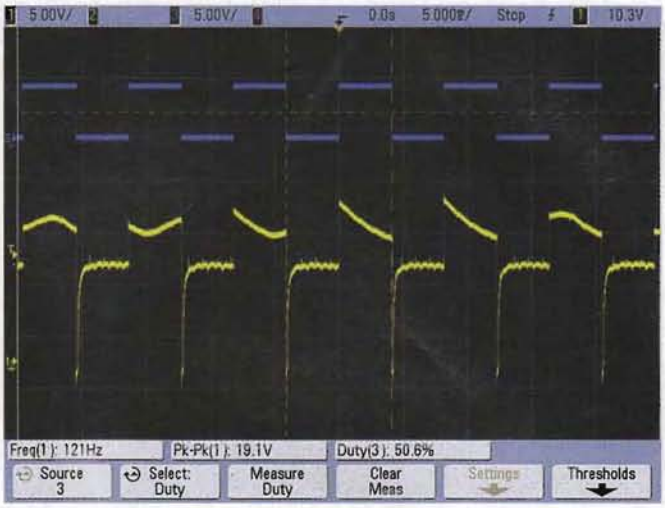


SC RAILPOWER CONTROLLER MK4

©2008



Railpower operation with a 12V permanent magnet motor. The top (blue) trace is the pulse (PWM) signal from IC2a which drives Q6 and Q2. The yellow trace shows the voltage across the motor for a duty cycle of 30.7%. The back-EMF is the shelf part of the waveform corresponding to the low (off) times of the blue trace. In this case the back-EMF is being measured by the horizontal cursor at 5V.



The same set-up as previously but with a PWM frequency of 122Hz instead of 488Hz. The PWM duty cycle is 50%. In this case the motor back-EMF is much higher, as would be expected with a high average driving voltage. In general, permanent magnet motors work better with lower pulse frequencies as their inductance has less effect. The uneven tops of the yellow trace are caused by 100Hz ripple on the 17V supply.

prises four power transistors Q1, Q2, Q3 and Q4 which drive the motor (ie, locomotive) in switchmode as well as providing for forward or reverse operation.

For forward operation, Q1 & Q4 are switched on while Q2 & Q3 are switched off, to provide current in one direction through the motor. Similarly, for reverse operation, Q2 & Q3 are switched on while Q1 & Q4 are switched off, providing current through the motor in the opposite direction.

At same time, to provide the switchmode operation (pulse power), Q1 is pulsed on and off at the preset rate (which may be 122Hz, 488Hz or 1953Hz) while Q4 is switched fully on (forward operation). Similarly, for reverse operation, Q2 is pulsed at 122Hz etc while Q3 is fully on.

A common sensing resistor, connected to the emitters of Q3 & Q4 is used to monitor the current drain by the locomotive motor. We also monitor the motor when all transistors are off (ie, in the off periods of the switchmode signal) to determine the back-EMF of the motor and thereby its loading.

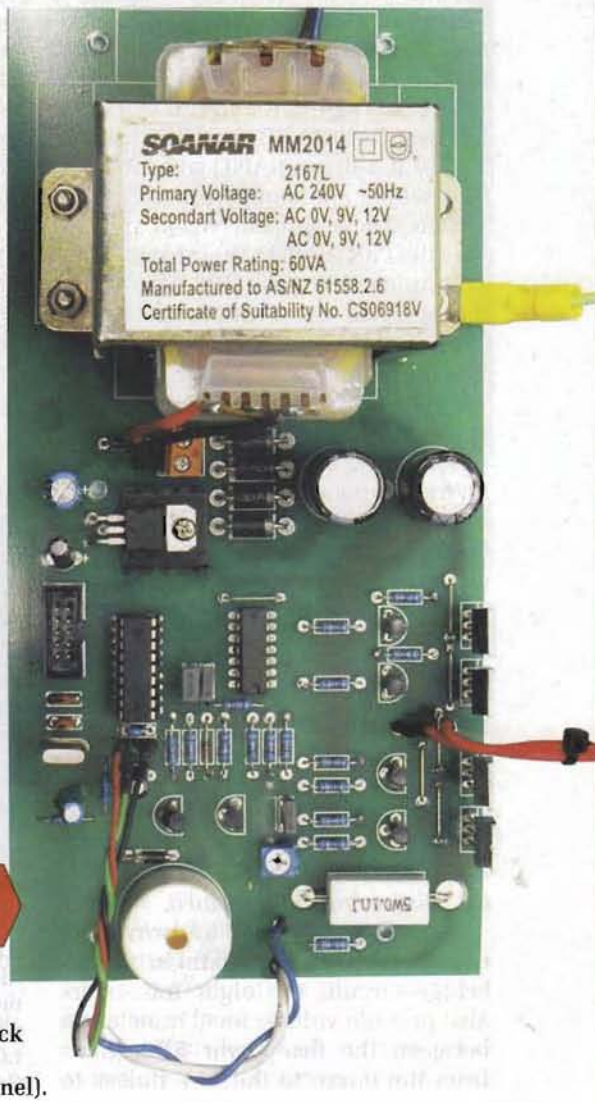
The full circuit is shown in Fig.2. IC1 is a PIC16F88-I/P microcontroller. We are using its PWM (pulse width modulation) output at pin 9 and three analog inputs to monitor the signals for over-current, back-EMF and the front panel speed potentiometer VR1.

The remaining input/output pins are used to monitor the infrared detector (IRD1), drive the LCD panel and piezo siren and to monitor the four front panel switches.

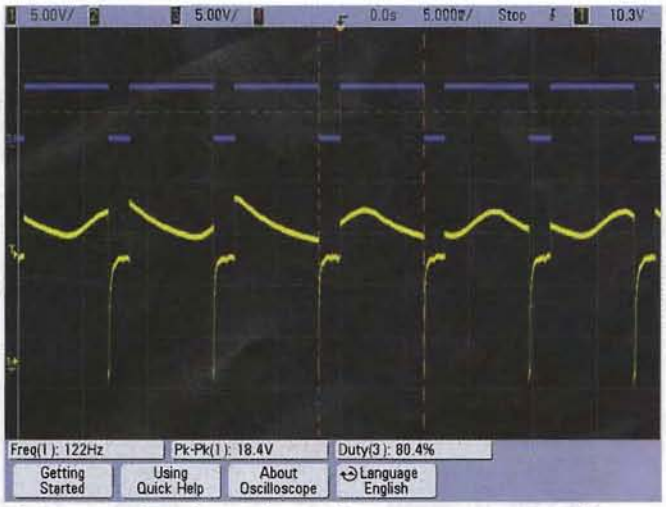
H-bridge drive

IC2, a 74HC00 quad CMOS NAND gate and transistors Q1-Q8 provide the H-bridge drive. This is somewhat more

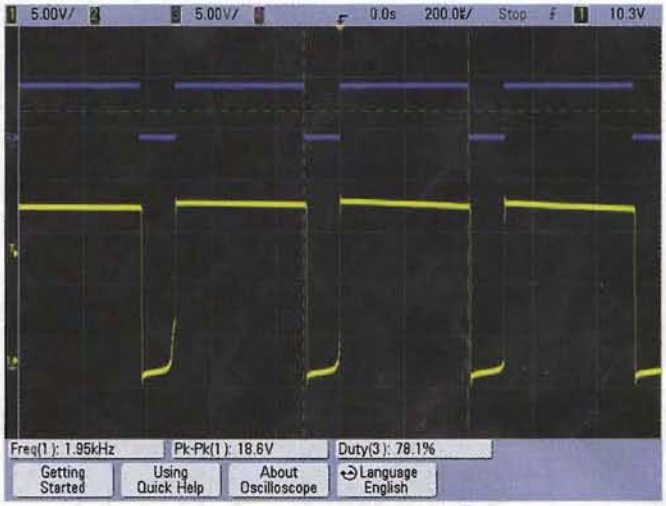
Fig.2 (opposite): the circuit of the Railpower IV consists mainly of a PIC microcontroller and an H-bridge motor driver. The PIC also drives the LCD module directly. With the exception of the local speed control and direction LED, everything is mounted on two PC boards. You have the choice of complete remote control (with a range of up to 8m indoors) or "local" control with a speed pot and push-buttons on the front panel.



Just to whet your appetites, here's the Railpower IV mainboard which we will fully describe next month. Almost everything is mounted on this or the display board. The connections to this board are (clockwise from top right) 230V power from the mains input socket/fuse/switch, earth connection to back panel, output to terminals on back panel, track direction LED and local speed potentiometer (both on front panel).



This scope shot shows the Railpower operating at full power, with a pulse duty cycle of 80.4% and pulse frequency of 122Hz. The back-EMF, measured in the off periods, can be seen to be quite high, as the motor will be running at full speed.



Operation at the highest frequency of 1953Hz and with a duty cycle of close to 80% gives an apparently smoother waveform, since motor hash and power supply ripple are not evident. However, typical motors will run more slowly at this high pulse rate.

complicated than the simplified schematic of Fig.1 but you can see the similarity, with Q1 to Q4 being the heavy-duty Darlington power transistors. The high gain of these transistors is further boosted by Q5 to Q8.

The H-bridge drive circuit works as follows. Outputs RB1 and RB2 (pins 7 & 8) of IC1 drive NAND gates IC2d & IC2c which are then inverted by IC2a & IC2b. These gates drive Q5 and Q6 via 10kΩ resistors to their bases.

Outputs RB1 and RB2 also drive the bases of Q7 & Q8, respectively. These outputs (ie, RB1 & RB2) work in complementary fashion so that when RB1 is high, RB2 is low and vice versa. So when RB1 is high, Q6 turns on Q2 and Q7 turns on Q3, giving the forward operation described previously. Similarly, when RB2 is high, Q5 turns on Q1 and Q8 turns on Q4, giving reverse operation.

So RB1 selects forward operation while RB2 selects reverse operation. At the same time, the PWM output of IC1 (pin 9) is gated through IC2d and IC2c, depending on the state of RB1 and RB2. So the PWM signal provides switchmode operation of Q1 and Q2, as previously described.

Note that, as well as providing considerable current gain in the H-bridge circuit, the eight transistors also provide voltage level translation between the flea-power 5V signals from the micro to the 17V pulses to the locomotive motor.

Over-current monitoring

The 0.1Ω 5W resistor provides motor current sensing. The voltage across this resistor is fed to the AN4 input (pin 3) of IC1 via a 10kΩ resistor while a 100nF capacitor filters the signal preventing transients from being detected.

IC1 converts the voltage to a digital value and switches off power to the motor should the current exceed 6A. 6A corresponds to 0.6V at AN4. Power is switched off by taking both the RB1 and RB2 outputs low so that none of the transistors are on to drive the motor.

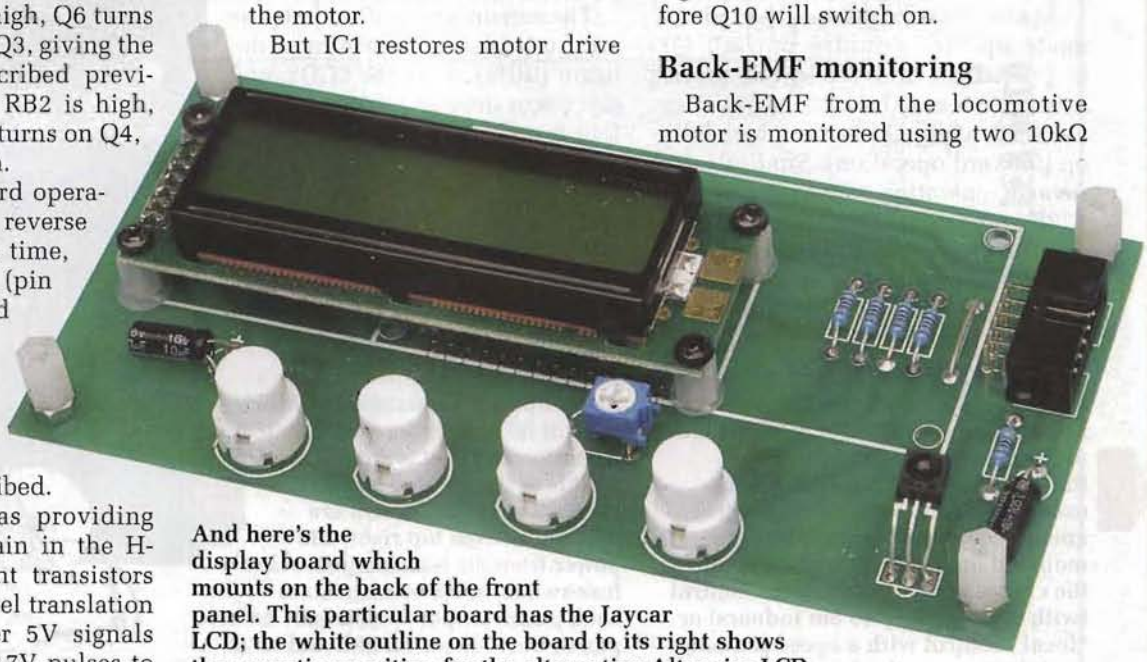
But IC1 restores motor drive momentarily every 0.2s and if the sensed current is below the 6A, the motor is again allowed to run. If current is still over 6A, then the power to the motor is removed again.

At the same time as an overload is detected, output RA1 (pin 18) drives transistor Q10 to sound the piezo siren which has an inbuilt oscillator.

The RA1 output is also used to send data to the LCD module. To avoid turning on Q10 with the data signal, a 22µF capacitor at its base filters out the short periods of high data signal from RA1. So when we want to drive the transistor we must apply the high signal from RA1 for about 100ms before Q10 will switch on.

Back-EMF monitoring

Back-EMF from the locomotive motor is monitored using two 10kΩ



And here's the display board which mounts on the back of the front panel. This particular board has the Jaycar LCD; the white outline on the board to its right shows the mounting position for the alternative Altronics LCD.

Parts List – Railpower IV

1 PC board coded 09109081, 217 x 102mm
1 PC board coded 09109082, 141 x 71mm
1 12V 60VA mains transformer (2167L type) (T1)
1 LCD module, Altronics Z-7001or Jaycar QP-5516
1 front panel label, 243 x 76mm
1 plastic instrument case, 260 x 190 x 80mm
1 aluminium rear panel, 243 x 76 x 1.5mm
1 chassis-mount male IEC connector with fuse and switch
1 M205 1A fuse (F1)
1 IEC 3-core 240VAC mains lead with 3-pin plug
1 universal infrared remote control (see text)
1 PC mount piezo buzzer (Jaycar AB3458 or equivalent)
1 DIP18 IC socket for IC1
1 DIP14 socket cut to suit LCD connector
1 14-pin DIL header strip for Jaycar LCD module or 1 SIL 14-pin header strip for Altronics LCD module with 2.54mm pin spacing
1 3-way header strip with 2.54mm pin spacings
1 mini heatsink 19 x 19 x 9.5mm
1 2MHz crystal (X1)
1 2-way PC-mount screw terminals with 5.08mm pin spacing
2 binding posts
1 10kΩ linear potentiometer (VR1)
1 knob to suit VR1
4 SPST PC-mount tactile snap action switches (S1-S4)
2 10-pin IDC line sockets
1 10-pin IDC vertical header
1 10-pin IDC right angled header
1 200mm length of 10-way IDC cable
1 200mm length of 7.5A green/yellow mains wire
1 100mm length of 7.5A brown mains wire
1 150mm length of black hookup wire
1 150mm length of red hookup wire
1 150mm length of green hookup wire
1 150mm length of 0.8mm tinned copper wire
5 4.8mm female insulated quick connect spade connectors
1 6.4mm female insulated quick connect spade connector
1 chassis mount quick connect spade terminal (6.4mm)
2 5.3mm ID eyelet quick connector
6 100mm cable ties
4 M3 x 10mm screws
4 TO-220 insulating kits (silicone washer and bush)
5 M3 nuts
5 M4 x 10mm screws
5 M4 nuts
3 4mm star washers
6 No.4 self-tapping screws
4 M3 tapped x 6mm Nylon spacers
4 M3 tapped x 12mm spacers
4 3mm Nylon washers
12 M3 x 6mm screws
4 M3 x 6mm countersunk screws
4 PC stakes

Semiconductors
1 PIC16F88-I/P programmed with 0910908A.hex (IC1)
1 74HC00 quad NAND gate (IC2)
1 infrared detector/decoder (IRD1)
2 BD650 PNP Darlington power transistors (Q1,Q2)
2 BD649 NPN Darlington power transistors (Q3,Q4)
6 BC337 NPN transistors (Q5-Q10)
4 1N5404 3A rectifier diodes (D1-D4)
2 1N4004 1A rectifier diodes (D5,D6)
1 1N4148 switching diode (D7)
1 dual colour LED with two leads (LED1)

Capacitors
2 2200μF 25V PC electrolytic
1 100μF 25V PC electrolytic
1 100μF 16V PC electrolytic
1 22μF 16V PC electrolytic
2 10μF 16V PC electrolytic
2 100nF MKT polyester
2 10nF MKT polyester
2 27pF ceramic

Resistors (0.25W 1%)

1 10MΩ	3 100kΩ	1 15kΩ	4 10kΩ
1 5.1kΩ	4 2.2kΩ	7 1kΩ	1 470Ω
1 0.1Ω 5W			

2 10kΩ horizontal trimpots (code 103) (VR2,VR3)

resistors connected to the collectors of Q3 and Q4. Depending on which direction the motor is running, the back-EMF will come from the collector of Q3 or Q4, whichever transistor happens to be off at the time.

Note that the back-EMF signal will be attenuated by the 10kΩ resistor connecting to the transistor which happens to be on but this does not matter as we need to further attenuate the signal with trimpot VR2 anyway. This is needed to limit the back-EMF signal so it is below the 5V maximum to the AN3 input for IC1.

However, there is a further condition to monitoring back-EMF and that is that it can only be done while the motor is not being energised, ie, in the times when the PWM signal from IC1 is off.

To that end, transistor Q9's base is switched by the PWM signal so that it is on when the PWM signal is high. This shunts the back-EMF signal to 0V so that we are only monitoring "pure" back-EMF and not a mix of back-EMF and applied voltage.

The signal from Q9 is fed via diode D7, filtered with a 10nF capacitor and passed to the AN3 input. D7 prevents the voltage at AN3 dropping to zero each time Q9 switches on. A 10MΩ resistor discharges the 10nF capacitor over a 100ms period so the input can respond to a falling back-EMF signal.

IC1 converts the back-EMF signal to a 10-bit digital value and this is used to modify the PWM signal to the motor. If the back-EMF is falling, the pulse width (duty cycle) is increased in order to maintain the motor speed. Similarly, if the back-EMF increases (maybe when going downhill) the pulse width is reduced.

Trimpot VR2 is adjusted to suit a range of locomotives that you might have on your layout.

Potentiometer VR1 is the front panel speed control. It varies the voltage



At left is the rear of the Railpower IV case. It looks pretty spartan – but that's deliberate. All you have is the switched and fused IEC mains input on the right and the two binding post terminals on the left which supply power to the track. Because the track polarity can be either way (as selected by the user) these are not colour coded. The bicolour LED on the front panel indicates direction.

to the AN2 input (pin 1) between 0 and 5V. Again, this voltage is converted to a 10-bit digital value and sets the speed of the motor when the Railpower is set to "local" (ie, front panel) control.

Switches and LCD drive

The four pushbutton switches S1 to S4 connect to the RB4 to RB7 lines for IC1. Normally, the RB4 to RB7 lines are set (by the software) as inputs, with internal pullup resistors. When a switch is pressed, then the corresponding input is pulled to 0V and IC1 detects this event.

The same RB4 to RB7 lines also drive the LCD and to do this they are set as outputs. 1kΩ resistors are included in series with the switches to prevent the RB4-RB7 lines becoming shorted to ground when a switch is pressed and when the lines are set as outputs. Driving the LCD occurs only momentarily at a slow repeat rate and so for most of the time the RB4-RB7 lines are ready to monitor the switches.

The LCD data is sent in 4-bit wide words. The DB0-DB3 data lines are not used. The RA1 output from IC1 drives the register select input to the LCD while the RA0 line provides the enable signal. The display contrast is set with trimpot VR3. Note that the supply pin numbering is different for the Jaycar and Altronics modules.

Infrared decoding

IRD1 detects the infrared signal from the handheld remote. This is encoded as bursts of 38kHz signal. The IR detector converts each burst as low (0V) and high (5V) in the absence of 38kHz. The decoded signal is sent to the RB0 input of IC1. IC1's software further decodes the signal sent by the IR remote and it will only accept encoding that is part of the Philips RC5 code.

This encoding is set on your handheld remote when you select a Philips or an affiliated company's brand of appliance. The software within IC1 will decode RC5 code for a TV, Satellite 1 and Satellite 2.

This means that you could use three separate Railpower controllers with their own IR remotes on the one layout, in conjunction with block switching. Furthermore, an additional Railpower could be employed with local (ie, non IR remote) to give four controllers on a large layout.

The Philips RC5 code for infrared transmission (also used with Marantz, Grundig and Loewe equipment) comprises 2-start bits and 1-toggle bit. The toggle bit alternates high and low on successive same key presses.

The code includes five system address bits and six command bits for a total of 14 bits. It uses bi-phase encoding with a high to low transition equal to a low signal and a low to high transition equal to a high signal. Each bit is transmitted at a 1.778ms rate. The entire code is 24.889ms in length and the code is repeated every 113.778ms.

IC1 operates at 2MHz using crystal X1. This frequency was chosen because it allowed the PWM frequency to be as low as 122Hz with 10-bit resolution. The crystal also provides an accurate source of timing so that the infrared RC5 code can be decoded at the correct rate.

Power supply

The Railpower uses a 12VAC 60VA transformer to drive a bridge rectifier comprising four 3A diodes. The rectifier output is filtered with two 2200µF capacitors to give about 17V DC (depending on the mains input voltage). This feeds the H-bridge driver for the motor. The 17V DC is also applied via diode D5 to 5V regulator REG1 which supplies IC1 and the rest of the circuit.

Next month we will complete the description of the Railpower with all the construction details and the set-up procedure. SC

Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑ 1	10MΩ	brown black blue brown	brown black black green brown
❑ 3	100kΩ	brown black yellow brown	brown black black orange brown
❑ 1	15kΩ	brown green orange brown	brown green black red brown
❑ 4	10kΩ	brown black orange brown	brown black black red brown
❑ 1	5.1kΩ	green brown red brown	green brown black brown brown
❑ 4	2.2kΩ	red red red brown	red red black brown brown
❑ 7	1kΩ	brown black red brown	brown black black brown brown
❑ 1	470Ω	yellow violet brown brown	yellow violet black black brown

Capacitor Codes

Value	µF Code	IEC Code	EIA Code
100nF	0.1µF	100n	104
10nF	0.01µF	10n	103
27pF	NA	27p	27

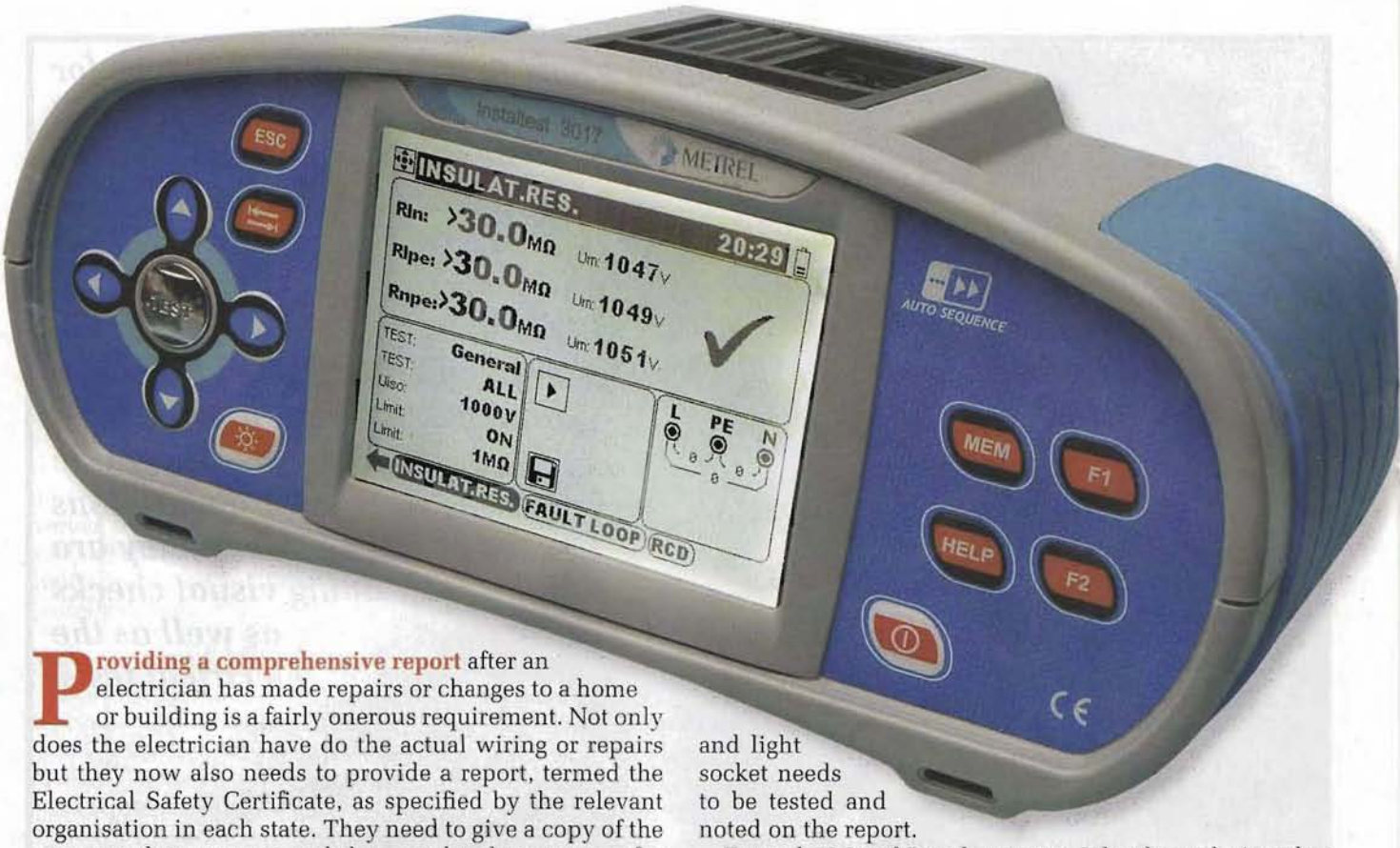


Did you know that it's now mandatory for electricians to provide a written safety test report when they install new wiring or do repairs to your home, office or factory? That is quite an onerous and time-consuming task but the Metrel Instaltest 3017 does all the tests specified in the AS/NZS3017 standard. As well, it provides a step-by-step guide for electricians when they are doing visual checks as well as the electrical tests.

A "must-have" for every electrician and contractor:

Metrel Instaltest 3017

By Leo Simpson



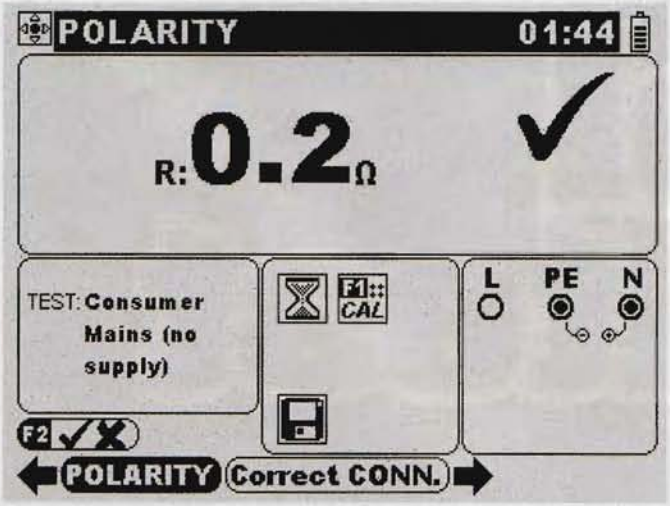
Providing a comprehensive report after an electrician has made repairs or changes to a home or building is a fairly onerous requirement. Not only does the electrician have do the actual wiring or repairs but they now also needs to provide a report, termed the Electrical Safety Certificate, as specified by the relevant organisation in each state. They need to give a copy of the report to the customer and they need to keep a copy for their own records.

Preparing this certificate is no simple task, as it must indicate that all required visual checks have been made and the electrical tests done, including the actual test readings where appropriate. All told, this can add up to quite a lot of work and it means that the electrician must be well organised to do the tests and then create the report for the customer, often after hours when all the "proper work" has been done.

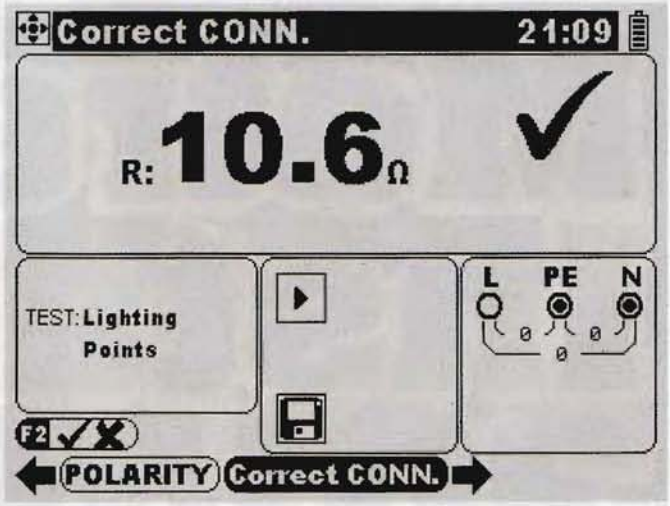
To indicate just how much work can be involved, consider a typical large home these days with multiple power and light circuits. If it is a complete wiring job, each power point and light socket needs to be tested and noted on the report.

Enter the Metrel Instaltest 3017. It has been designed to take the drudgery and much of the paper work out of the process. As well as compliance testing, the Instaltest 3017 can be used for trouble-shooting and also as a cable locator (with an optional kit).

The instrument itself is quite compact and measures about 230mm wide, 103mm high and 117mm deep. It has an LCD screen flanked by membrane switches on the front panel. At the top of the case is connector panel with a sliding door which allows access to a USB socket and a PS2 socket for serial communication to a computer and a DC socket for charging the internal batteries. The LCD can be illuminated for viewing in poor lighting conditions.



Tests are unambiguous and give a simple go/no go result. This one is for neutral line resistance to earth. The instrument was designed specifically for Australian/NZ conditions.



These are the actual screens shown to the electrician during testing. The Instaltest connects to the PC via a USB port, from where a printed report can be prepared for the customer, as is now required by law.

For visual checks of wiring, switchboards and so on, the Instaltest 3017 has a number of inbuilt procedures and as you step through them, you can tick the boxes as you go. There is no need to have separate paperwork. Then, you can do the actual tests such as electrical continuity & resistance, insulation resistance, polarity, correct connections, fault loop and RCD tests. Most of these tests, with the exception of polarity (testing whether Active is at 240VAC and Neutral is 0V with respect to earth) are done with no power in the system.

In order that the Instaltest can verify that the Active, Neutral and Earth connections in GPO (general purpose output, power point) are correct, a test box must be connected to the circuit at switchboard, with power disconnected via the circuit breaker. The test box connects a 10Ω resistor between Active & Earth and 5Ω resistor between Neutral and Earth. The Instaltest can then check for correct polarity and earth continuity.

Insulation tests are done at 1000V (internally generated). The test shows the insulation resistance (up to 30 megohms) and the test voltage. The instrument can also be used to test the insulation resistance of heating elements (in hot water tanks etc).

The Instaltest 3017 has a very good procedure for checking RCDs (residual current devices) and checks each one for six parameters. Having nominated the RCD type (ie, 10mA, 30mA, 100mA etc), the Instaltest tests at half, one and five times the rated current at normal and reverse polarity (180 degrees) and gives the trip times in milliseconds. Each time it trips the RCD, you need to reset it whereupon the Instaltest will do the next step, for all six test.

As each test is completed, you press the F2 button to commit the data to memory and then continuing through until all tests are done. After the job is complete and the electrician is able to do normal paperwork tasks such as invoicing, the Instaltest is connected via the USB or serial port to a computer and all the data downloaded to that reports can be compiled for the clients. The printed reports can then be presented to the customer, together with the invoice.

Using an optional transmitter box, the Instaltest can also be used for cable tracing in complex power systems.

All told, the Metrel Instaltest 3017 should be the answer to an electrician or contractor's prayers, providing fully documented reports to cater for all repairs and new installations.



Along with the AS3017 Instaltest instrument itself, the package contains a comprehensive set of test leads and add-ons to cover all tests required under AS/NZS3017. These include tests for voltage and frequency, insulation resistance, fault loop impedance, RCDs and phase rotation. Optional kits also allow earth resistance metering and cable locator/circuit tracing. Not shown here is the comprehensive instruction manual, also included.

For further information on performance and availability of the Instaltest 3017, contact the Australian distributors, Emona Instruments Pty Ltd, 86 Parramatta Road, Camperdown, NSW 2050. Phone (02) 9519 3933 or via their website, www.emona.com.au

SC



into MICROS OR PICS?

There's a reference to suit every microcontroller maestro in the SILICON CHIP reference bookshop: see the bookshop pages in this issue



Microcontroller Projects in C
– by Dogan Ibrahim
Graded projects introduce microelectronics, the 8051 and programming in C.
$81.00



Hands-On ZigBee
– by Fred Eady
An in-depth look at the clever little 2.4GHz wireless ZigBee chip that's now being found in a wide range of equipment from consumer to industrial.
$96.50



PIC Microcontroller – know it all (Newnes)
Newnes have put together the best of subjects their authors have written on over the past few years into this one handy volume!
$79.95



Programming 16-Bit Microcontrollers in C – by Luci Di Jasio
Learning to fly the PIC24. Includes a CD ROM with source code in C, Microchip C30 complier and MPLAB SIM.
$80.50



PIC in Practice – by DW Smith
Ideal introduction to PICs. Based on popular short courses for the PIC for professionals, techs, hobbyists, students and teachers.
$60



The PIC Micro – personal intro course – by John Morton
A very practical guide which assumes no prior knowledge. So it is an ideal introduction to the widely-used PIC micro.
$52

• Audio • RF • Digital • Analog • TV • Video • Power Control • Motors • Robots • Drives • Op Amps • Satellite



What do you do for a LED flasher now that the LM3909 is no more?

LM3909 Replacement Module: it's even more versatile!

by Thomas Scarborough

The LM3909 was a legendary IC, which the designers (National Semiconductor) modestly described as a "LED Flasher/Oscillator". Its popularity was surely due both to its great simplicity and versatility. It could flash a LED off a wide range of voltages, at a wide range of frequencies. It could also flash LEDs in parallel, could produce a tone in a loudspeaker, trigger a Triac or pulse an incandescent bulb – among other things. Sadly, though, the LM3909 has been discontinued and is now very difficult to find.

The module shown here is designed to do just about everything that the original LM3909 did – and more!

There are a couple of differences – the most obvious one is that the module is quite a bit larger than the DIP-sized LM3909.

Supply voltage is much more usable 3V-18V, compared to the LM3909's 1.15V to 6V. Current consumption may be as low as 100µA, rather than the LM3909's typical 0.55mA. Pulse width may be controlled more easily than it could with the LM3909.

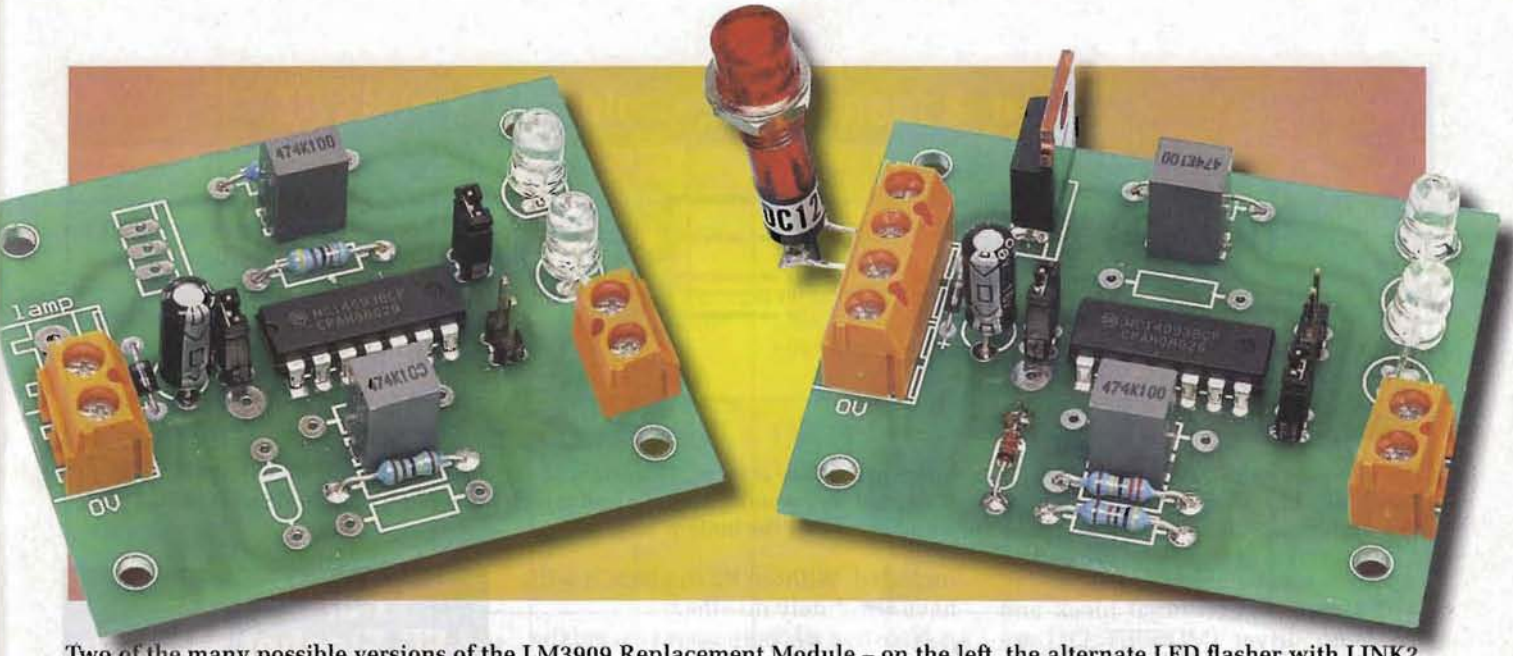
And not least, this circuit can pulse two LEDs alternately. It will also serve, among other things, as a quartz clock driver and continuity tester. Rather than present a host of similar circuits, however, a single module is shown here, along with a table showing how the module can be used in a variety of ways.

Circuit description

IC1a is a Schmitt RC oscillator or "clock generator". Only the capacitor, C1, can be regarded as a fixed part of the oscillator; R_1, R_2, R_X, R_Y and D_2 are all components which can be changed to allow the module to perform in different ways.

The output of the oscillator charges and discharges capacitor C2 through IC1b, connected as an inverting buffer. The charge on C2 then controls IC1c. When the output of IC1c is combined with the the output of IC1d (which is the inverted output of IC1a), brief pulses are sent in opposite directions between IC1c and IC1d.

Depending on their direction, these pulses cause either LED1 or LED2 to flash.



Two of the many possible versions of the LM3909 Replacement Module – on the left, the alternate LED flasher with LINK2, R_X at 4.7MΩ, R_B at 1kΩ, no R_2 and R_B (hidden behind capacitor at top) at 47kΩ. At right is the LED/bulb flasher, with LINK3, R_X at 2.2MΩ, R_2 at 470kΩ (in series with its diode), R_B at 1kΩ and no R_Y. Note the MOSFET lamp driver is also in place on this PC board. For most of the time, LINK1 stays in place (the circuits won't work without it).

R_X sets the frequency of the flash, while R_Y sets the pulse width (or "on" time) of one or both of the LEDs. Resistor R_B limits the current through the LEDs to safe values.

LINK1 is a switch which either enables (when connected to +V) or disables the oscillator (tying pin 1 to 0V via R1). In all except one case, LINK 1 stays in place unless you want to stop the circuit oscillating. In fact, LINK1 could be replaced by a switch if you want to make it even more convenient.

LINKS 2 and 3 can be changed to make their respective gates operate in different ways, in turn affecting the operation of the module. It is this which gives the module significantly more flexibility than the LM3909 it is replacing.

LINK2 is used where a short pulse width is required and LINK3 is used where a square wave is required.

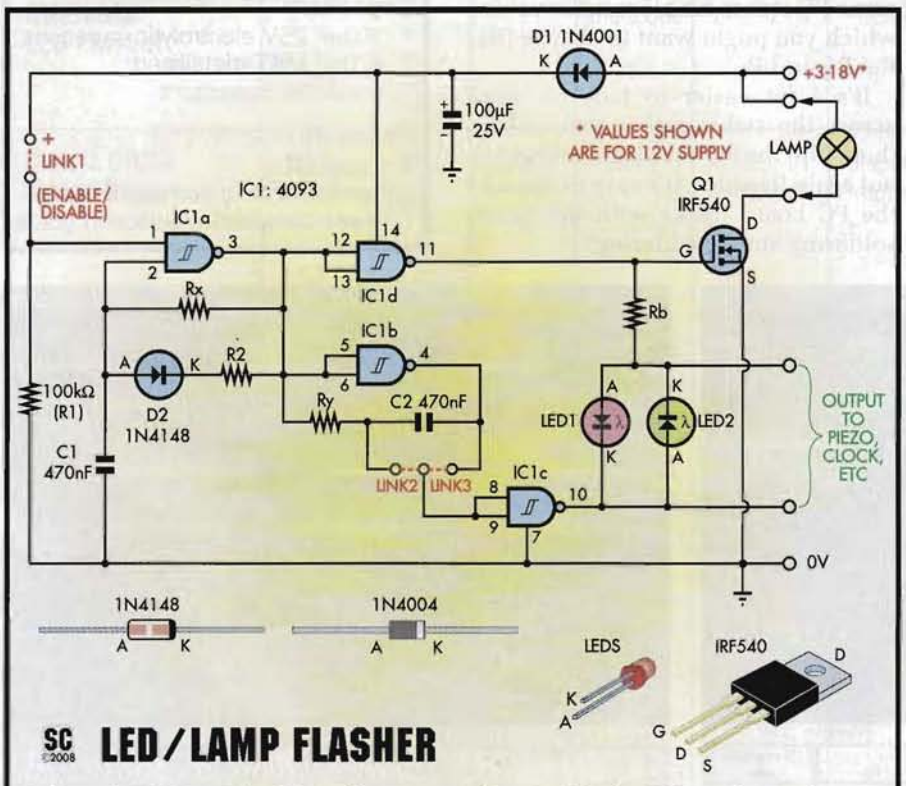
Various possibilities are shown in the table overleaf. Component values in this table are selected for 12V operation and will likely need to be modified for other supply voltages.

One of the other features of this module which you didn't get (as much) with the LM3909 is that it allows significant experimentation and modification of values. With the exception of R_B, changing any of the resistors (even going down to 0Ω) will not cause any damage to the module (R_B limits LED current through the LEDs and should never be less than about 470Ω).

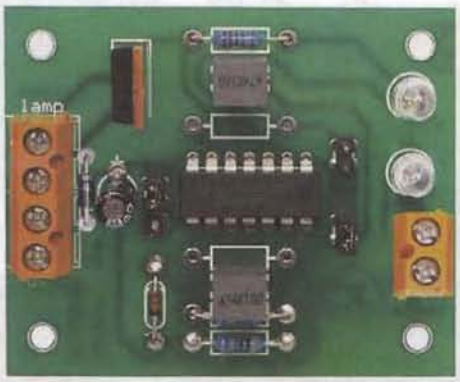
Finally, if LEDs are wired in parallel, these should best have individual current-limiting resistors, the combined resistance of which should not be less than about 330Ω.

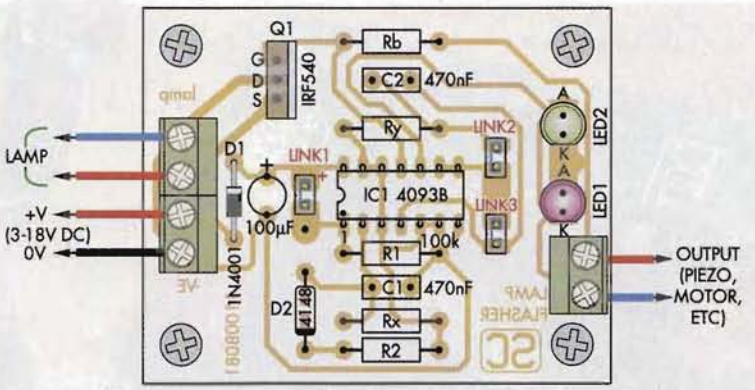
As mentioned earlier, one of the features of this module is its wide supply voltage range (3-18V). This is connected via a terminal block on the left side of the module which is in turn protected against incorrect polarity by diode D1 and is decoupled (smoothed) by the 100µF capacitor.

This capacitor is specified as 25V to allow up to an 18V supply; if you are ***never*** going to use a supply greater than 12V, a physically smaller 16V capacitor can be used.



Where the LM3909 had just about everything inside the DIP package, the replacement module requires a few more components – but it does more than the LM3909 ever did!





The same-size photo above matches the component overlay at right. The photo is of the Alternate LED Flasher. While this PC board might look like a double-sided type, it's not: it was produced in a panel which included a double-sided board so pads also appear on the top side, along with pads and tracks on the bottom side.

capacitor can be used.

The lamp, its terminal block and the lamp driver (MOSFET Q1) are optional – if you don't want to drive a lamp, simply leave them out.

Construction

This project could hardly be simpler – simply mount the components as shown on the overlay, also using the photograph as a guide.

Start with the terminal blocks. For most uses a two-way block will suffice on each side of the PC board (the four-way on the left side is only required for the incandescent lamp driver). Follow these with the three header pin sets (for LINKS 1, 2 and 3), then the resistors and capacitors, next the LEDs, the MOSFET (if required) and finally the diode D1 and IC1.

The diode D2 could be left out if you don't want to build the lamp driver or modified alternate LED flasher but given its low cost, it might as well be included. Without R2 in place, it will have absolutely no effect.

Note that all components except the resistors and the two "block" capacitors are polarised – the circuit won't work if you put them in the wrong way around (and you could damage them).

Also be very careful when soldering in components with close lead spacing (especially the IC). It's very easy to bridge across adjacent pads and once again, this will stop the project working and could cause damage.

And if you want to experiment with different values, here's a tip: solder in some PC stakes for all resistor values which you might want to change (R_2, R_B, R_X and R_Y).

It's a lot easier to tack resistors across the stakes rather than solder them into the PC board and take them out again (besides, it's easy to damage the PC board tracks with too much soldering and desoldering).

Parts List – LED Flasher Module

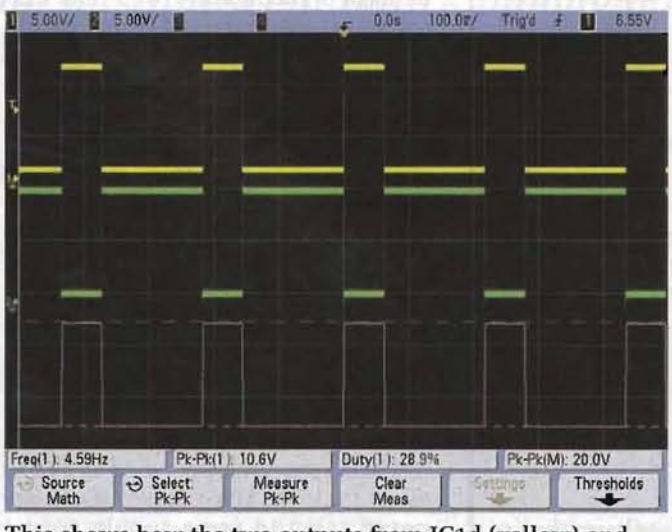
1 PC board, 62 x 50mm, code 11009081
3 2-way PC-mount terminal blocks
3 2-way header pin sets
1 4093 quad Schmitt NAND gate
1 IRF540 MOSFET (Q1 – optional)
1 1N4004 power diode (D1)
1 1N4148 small signal diode (D2)
2 5mm LEDs, colours as required
1 small incandescent lamp, voltage to suit supply voltage (optional)

Capacitors

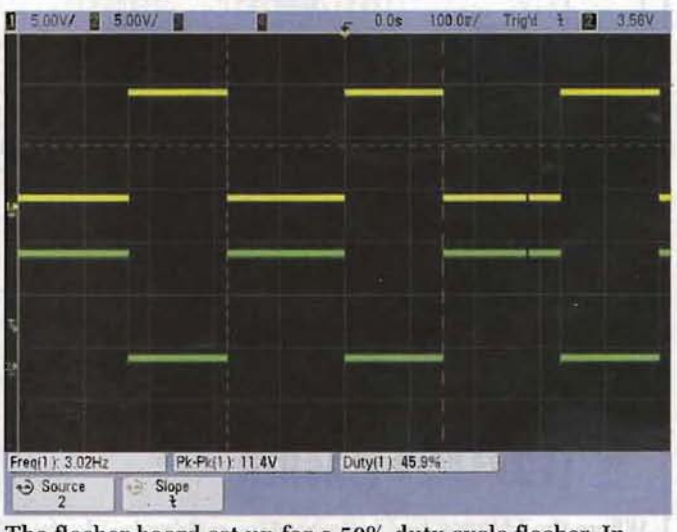
1 100µF 25V electrolytic capacitor
2 470nF MKT metallised polyester capacitors

Resistors (0.25W, 1%)

1 100kΩ (R1)
Other resistors to suit application – see component selection guide



This shows how the two outputs from IC1d (yellow) and IC1c (green) add to give double the drive signal to the LEDs (white trace).



The flasher board set up for a 50% duty cycle flasher. In fact, it is not quite 50%, due to the differing positive and negative switching thresholds in the gates.

LED Flasher Modules – Component Selection Guide

	R_X	R_Y	R_B	R_2	Links	LEDs	Notes:
LED Flasher	2.2MΩ	47kΩ	1kΩ	None	LINK 1 IN LINK 2 IN	LED1	
Alternate LED Flasher	4.7MΩ	47kΩ	1kΩ	None	LINK 1 IN LINK 2 IN	LED1 LED2	
Micropower Alternate LED Flasher	4.7MΩ	10kΩ	2.2kΩ	None	LINK 1 IN LINK 2 IN	LED1 LED2	Ultrabright LEDs are required here. A 47kΩ resistor is wired in series with the power supply's +V. The circuit draws about 100µA. Remove resistor R1 to minimise current drain.
Square Wave Alternate LED Flasher	4.7MΩ	None	1kΩ	None	LINK 1 IN LINK 3 IN	LED1 LED2	
Modified Square Wave LED/Bulb Flasher	2.2MΩ	None	1kΩ	470kΩ and diode	LINK 1 IN LINK 3 IN	LED1	The 470kΩ and diode are wired in parallel with RX. Depending on the orientation of the diode, the LED will be illuminated longer or shorter than half of a complete cycle. By making IC1d pin 11 power a MOSFET, this configuration may be used to flash an incandescent bulb.
Modified Alternate LED Flasher	4.7MΩ	47kΩ	1kΩ	1MΩ and diode	LINK 1 IN LINK 2 IN	LED1 LED2	The 1MΩ and diode are wired in parallel with R_X, yet the diode's polarity is immaterial here. The effect is a pulsing of the two LEDs "in twos".
Quartz Clock Motor Driver	10MΩ variable	150kΩ	470Ω	None	LINK 1 IN LINK 2 IN	Stepper motor	R_Y and R_B may need to be altered, depending on the characteristics of the quartz clock's stepper motor. This is merely an experimental circuit, since an RC timer will not provide good time keeping.
Externally Pulsed Quartz Clock Motor Driver	None	150kΩ	470Ω	None	LINK 1 IN LINK 2 IN	Stepper motor	The external pulses need to match the supply voltage of the module. These may need to be further lengthened. This may be done by wiring a diode between the source of the pulses and IC1a pin 2, with the cathode to pin 2 and a resistor in parallel with C1 (try 2.2MΩ).
Continuity Tester	2.2kΩ	None	None	None	LINK 1– wired to 0V via a 1MΩ resistor (see note)	Piezo sounder	The piezo sounder is wired to the sounder outputs for LED1. The continuity tester's leads are taken from the LINK1 terminals. R1 can be increased to 1MΩ for the continuity tester – alternatively 1kΩ to avoid obtaining a signal for high impedance continuity. SC

PRODUCT SHOWCASE

High output from small LEDs



Cree, Inc, represented in Australia by Cutter Electronics, claim a new standard for lighting-class LEDs with the introduction of the XLamp XP-E and XP-C LEDs. At just just 3.45mm square by 2mm high, these breakthrough LEDs have the smallest footprint in the industry for lighting-class LEDs—providing the same high-quality lighting performance and proven reliability as Cree XR-E and XR-C LEDs in an 80% smaller package.

Thanks to their small size and low profile as well as a wide viewing angle and symmetrical package, the new XLamp LEDs, suit applications as diverse as backlighting, signage, outdoor, indoor and portable lighting, etc.

The XP-E LEDs offer 100 lumens minimum at 350mA in cool white (5000-10000°K) and 80.6 lumens at 350mA in warm white (2600-3700°K).

Contact:
Cutter Electronics
5 Highgate Way, Rowville, Vic 3178
Tel: (03) 9753 9911 **Fax:** (03) 9753 9455
Website: www.cutter.com.au

Aluminium 19-inch rack-mount cases



The new RM family of 19" rack cases from Hammond Electronics are available in 1, 2 and 3U heights and depths of 203mm, 330mm and 457mm. They are suitable for housing a wide range of equipment, either mounted in a 19" rack or, if required, used as a desktop enclosure.

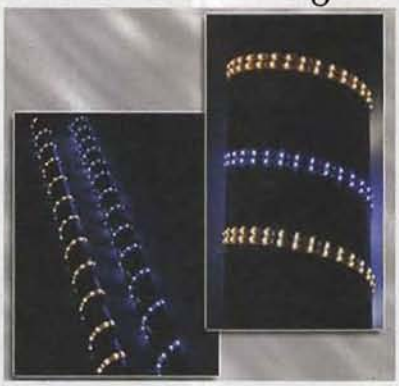
The all-aluminium construction consists of a heavy-duty extruded frame, removable vented or plain top and bottom covers and optional 19" rack mounting angles and self-adhesive rubber feet. The front and rear panels are removable and interchangeable and they are of flat construction to make machining and screening a simple process.

Front panel handles that mount to the rack mounting angles are optionally available to assist with insertion and removal from a rack; to provide greater support heavy loads, rear-mounting brackets can also be specified.

They are finished in durable black powder coat paint as standard.

Contact:
Hammond Electronics Pty Ltd
11-13 Port Rd, Queenstown, SA 5014
Tel: (08) 8240 2244 **Fax:** (08) 8240 2255
Website: www.hammondmfg.com

Even more LEDs: Tenrod's Sealed Flexible Lights



These flexible LED strip lights from Tenrod Australia can create a delightful ambience enhancement effect. They blend into furniture or ceiling features, window frames or curtain pelmets and with a choice of colours from warm white to blue, the lights are easily installed.

The flexible LED light strip operates from 12V DC and will wrap around curved surfaces, is sealed against water and dirt in a transparent envelope and offers easy mounting with its peel and stick adhesive taping.

There are 300 high-brightness LEDs in the 5-metre reel, splitable at any 3-LED unit. Colours include white, warm white, blue, green, yellow and red.

Contact:
Tenrod Australia
Units 1&2, 24 Vore St Silverwater NSW 2128
Tel: (02) 9748 0655 **Fax:** (02) 9748 0258
Website: www.tenrod.com.au

Altronics moves into Queensland

Altronic Distributors has recently expanded its wholesale sales operations opening an office in Eight Mile Plains (in Brisbane's south) to cater for the Queensland market.

They are pleased to announce the appointment of Daniel Neuss as the Queensland state manager. Daniel brings considerable electronics and customer service skills to this position, with over 10 years experience in the industry.

Altronic Distributors see this is as a way to provide Queensland customers with a greater level of service.

Contact:
Altronic Distributors (Qld)
Tel: 1300 780 999 **Fax:** 1300 790 999
Website: www.altronics.com.au
email: daniel.neuss@altronics.com.au

ANTRIM TRANSFORMERS
manufactured in Australia by
Harbuch Electronics Pty Ltd
harbuch@optusnet.com.au
Toroidal – Conventional Transformers
Power – Audio – Valve – 'Specials'
Medical – Isolated – Stepup/down
Encased Power Supplies



Encased Power Supply
www.harbuch.com.au
Harbuch Electronics Pty Ltd
9/40 Leighton Pl, HORNSBY 2077
Ph (02) 9476 5854 Fax (02) 9476 3231

Portable Sound Level Meter



The Testo 815 sound level meter from Testo provides a simple solution to PA volume problems.

With an accuracy of class 2, it is also ideal for checking air conditioning or heating noise, disco noise, machine noise or noise in combustion systems.

Features Include:

- Accuracy class 2 to IEC 60651
- Frequency weighting to Characteristic A and C
- Maximum and minimum value memory
- Built-in tripod knuckle screw (1/4 inch)
- Switchable Fast/Slow time weighting
- Easy to adjust (adjustment screwdriver included)

Contact:
RS Components
25 Pavesi St, Smithfield NSW 2164
Tel: (02) 9681 8558 **Fax:** (02) 9681 8614
Website: www.rsaustralia.com

Microzed has Hope



Microzed Computers have been appointed the Australian distributors of Hope Microelectronics Co.

This major Chinese organisation manufactures a range of digital sensors, RF integrated circuits and modules, RF semiconductor components, SAW devices, and RF/Sensor application solutions.

Products to be stocked by Microzed include pressure sensors, barometer sensors, humidity sensors, 16-bit ADC's, FSK wireless modules and solutions for 315/433/868/915MHZ, wideband RF transistors, SAW filters and SAW resonators.

Contact:
Microzed Computers Pty Ltd
PO Box 5103, Chittaway Bay NSW 2261
Tel: 1300 735 420 **Fax:** 1300 735 421
Website: www.microzed.com.au

Hemipro LED worklights

HEMIPRO high power LED worklights from GO Distribution are designed to meet the rigorous standards of the automotive repair market – which also makes them highly suited to applications such as industrial, heavy vehicle, electrical, farm and machinery maintenance workshops.

They are also versatile around homes, cars, boats, caravans, motor homes and holiday houses where people need a tough, long-lasting light source that can be simply plugged into the mains for recharging. (12V chargers are also available.)



Designed to provide high performance for 10 years or more of normal use, HEMIPRO incorporate a tough polycarbonate patent-pending "Lumiguard" lens shield which protects the lens and can be easily and quickly replaced if it gets scratched, cracked or tarnished. Rather than throwing away the entire work light, users can simply replace the Lumiguard in less than two minutes.

Using either two or three high-power LEDS, the HEMIPRO 2-LED and 3-LED work lights provide exceptionally powerful beams which equal or exceed the light area intensity of a 60W or 75W beam, respectively.

Contact:
GO Distribution
PO Box 7229, East Albury NSW 2650
Tel: (02) 6026 4886 **Fax:** (02) 6026 4889
Website: www.cliplight.com

Ozitronics
Tel: (03) 8677 1411 Fax: (03) 9011 6220
Email: sales2008@ozitronics.com
RF Data Link – A series of 4 kits to transmit data over a 433MHz RF link.



K173. Tx with serial data input
K174. Rx with serial data output
K175. Tx with parallel data input
K176. Rx with parallel data output



Documentation shows how to use with other kits for remote operation.
K173/5 - $52.80, K174/6 - $60.50
More kits & documentation available on website:
www.ozitronics.com

Hameg 200kHz LCR Bridge from Rohde & Schwarz



For around $2600 the HM8118 20kHz LCR Bridge has a list of features that most of the competition cannot touch.

Key features of the HM8118 include:

- Basic Accuracy of 0.05%.
- Measurement functions L, C, R, |Z|, X, |Y|, G, B, D, Q, È, Ä, M, N with test frequencies from 20Hz -200kHz.
- Up to 12 measurements per second in both parallel and series mode.
- Optional binning and limits for parts sorting.
- Internal programmable voltage and current bias as well as transformer parameter measurement.
- External capacitor bias up to 40V is also included.
- The HM8118 also includes a number of key measurement accessories including a Kelvin cable and 4-wire SMD Test adapter, as well as a galvanically isolated USB/RS-232 Interface.

Several additional accessories to provide for component testing.

These include the four-wire transformer cable HZ186, a four-wire test adapter including shorting plate HZ181, an eight-bin handler interface HO818 (installation only ex-factory) and a galvanically isolated IEEE-488 (GPIB) interface HO880.

For more information, data sheets, flyer and press information please visit Hameg's website www.hameg.com or contact the Australian distributors, Rohde & Schwarz. SC

Contact:
Rohde & Schwarz (Aust) Pty Ltd
Unit 2, 75 Epping Rd, North Ryde NSW 2113
Tel: (02) 8874 5111 **Fax:** (02) 8874 5199
Website: www.rohde-schwarz.com.au

SERVICEMAN'S LOG

One man's trash is another man's treasure

There's an old saying that "one man's trash is another man's treasure". Personally, I think it's all treasure so you can imagine my overwhelming joy when a friend recently found an old valve car radio for me to fix!

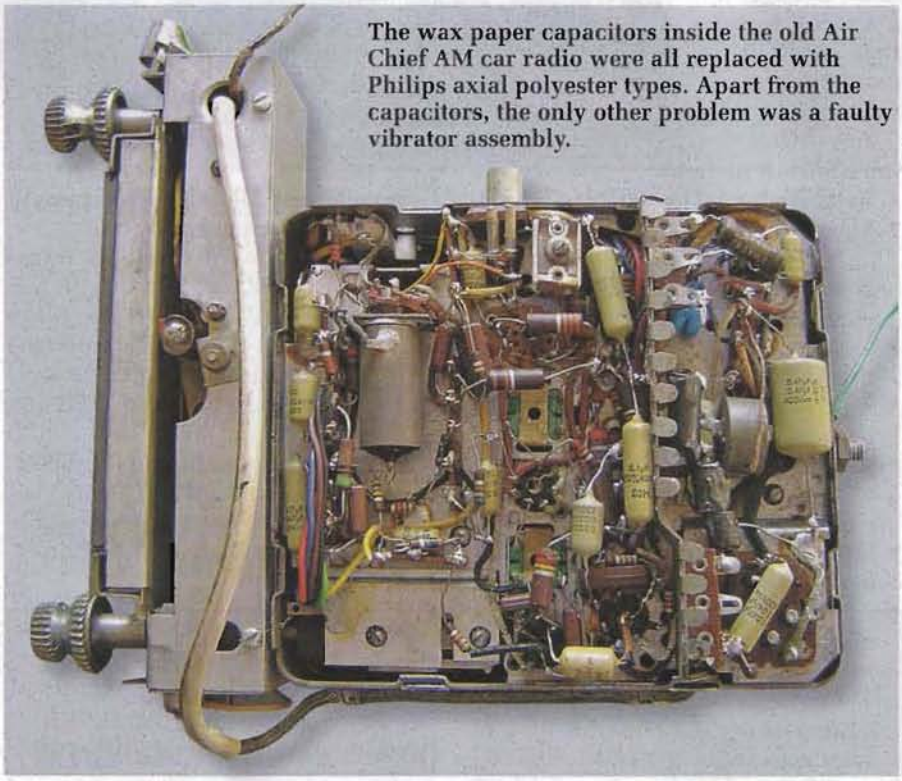
A friend of mine was rummaging around inside his deceased grandfather's old shed when he came across a couple of old car radios. They weren't easy to physically locate as they were on the bottom of what used to be a set of shelves which had now collapsed on top of them. Besides that, there was a lot of "junk" in front of them as well.

Note that I use the term "junk" loosely here, as this stuff was really treasure. There's no such thing as junk in my book.

When he got the first one out into the open, he recognised it as the radio his grandfather had had in his old 1955 Chevrolet. Unfortunately, the old Chevy had also gone to God many years ago.

The car radio was a 1954 Astor (National Automatic Service Co) RM Air Chief. This was a 12V 6-valve plus vibrator AM manual car radio made in Melbourne. Anxious to find out whether it still worked, my friend connected it to a battery and switched it on. The on/off switch needed a little coaxing but eventually the dial-lamp came on.

But that was all. The set was otherwise completely dead and that was when he brought it to me. I gave the vibrator a bit of a knock and although it tried hard, the 44-year old Ferrocart PM238 non-synchronous vibrator just couldn't quite make it.



The wax paper capacitors inside the old Air Chief AM car radio were all replaced with Philips axial polyester types. Apart from the capacitors, the only other problem was a faulty vibrator assembly.

Items Covered This Month

- Astor RM Air Chief Car Radio
- Celestial ChangHong LT3200HD LCD
- Grundig Elegance 82 MW82-2101 TV set (NIC/Dolby CUC2058 chassis)

In the end, there was nothing for it but to (literally) cut open the metal can to get to the vibrator points and clean them up with a bit of fine wet and dry paper. Thankfully, the points were not too pitted and the reed relay wasn't open circuit. The spacing was set for "8 thou" (.008 inches or about 0.2mm) and the vibrator then put back in the radio.

When power was applied, you could now hear the vibrator working but there was still no sound from the radio. I reached for my multimeter, intending to connect it to the cathode output (pin 7) of the 6X4 rectifier (to check the HT), but by now smoke had begun pouring from the PT182 transformer.

At first I thought there was a short circuit on the +245V HT rail, probably due to one of the electrolytics. However, the ohmmeter said otherwise. The problem was elsewhere.

There are 15 wax paper Ducon capacitors in this set, which I knew would not be in the best of condition after 44 years. I was hoping that one of these would be responsible for the smoke and so I began replacing them.

First, I changed a .05µF paper capacitor which is adjacent to the vibrator. This made no difference, even though the capacitor measured leaky and was way off value.

The next cab off the rank was the buffer capacitor, a .008µF (8.2nF) 2kV unit across the anodes (pins 1 & 6) of the rectifier valve. This measured short



The operating manual for the old Air Chief car radio was also found.

circuit so I was on the right track.

The value of this component is fairly critical as it sets the resonating frequency of the transformer, which in this case should be 150Hz (the frequency of the vibrator). I didn't have an 8.2nF capacitor in stock so I had to parallel up 3.9nF and 4.7nF ceramic capacitors rated at 6kV to give 8.6nF, a 7% increase in value.

That fixed the fault and the radio now worked, drawing 2.5A at 12V.

Next, I replaced the remaining 13 paper capacitors with the now rare Philips axial polyester types and the radio worked even better than before. The extra RF and IF stages (6BA6/EF93) fitted to this set improve the gain (and the reception) quite markedly compared to a modern AM radio.

These radios were also fitted into the early GM Holden range, probably the FJ series. Unfortunately, the noisy vibrators let the show down somewhat. Personally, I would now build a solid-state multivibrator to replace the noisy mechanical vibrator.

I love you, hate you

My love affair with computers continues – not! Following my bad experience recently with my PC, I decided to upgrade my 80Gb hard drive to a 250Gb 7200 RPM drive (IDE type).

I had already upgraded the machine to Service Pack 3 (SP3) but had not installed all the upgrades for my third party software.

Anyway, I bought a Seagate Barracuda ST3250820A and to make the changeover easy, I downloaded the Seagate Acronis Disc Wizard CD from their website. The beauty of this is that you simply boot from this CD and it automatically partitions and formats the new drive and then copies all the data across from the old drive – in my case over a period of about two hours. It is even easier to use than Ghost and you can even remove old partitions (if present) by using the advanced mode.

When it was all done, I booted up with the new hard drive and started to use it immediately. All was fine and I used it every day for over a month.

And then, one morning, Mrs Serviceman switched the computer on and left it to boot while she went to make some coffee. When she returned, she fully expected the computer to be ready for use. Instead, all she got was a flashing cursor in the top lefthand corner of the screen that wouldn't change no matter how long she waited. She called me and I rebooted the computer to find it wouldn't go any further. In fact, the fault appeared immediately after the POST routine (power on self test).

My first approach was to boot from a WinXP CD and press R for repair at the screen prompt. From there, I then tried

Dontronics

www.dontronics.com has 300 selected hardware and software products available from over 40 world wide manufacturers, and authors.

Olimex Development Boards & Tools: ARM, AVR, MAXQ, MSP430 and PIC.

Atmel Programmers And Compilers: STK500, Codevision C, Bascom AVR, FED AVIDICY Pro, MikroElektronika Basic and Pascal, Flash File support, and boot loaders.

PICmicro Programmers And Compilers: microEngineering Labs USB programmers, adapters, and Basic Compilers, DIY (Kitsrus) USB programmers, MikroElektronika Basic, Pascal, DSpic Pascal Compilers, CCS C, FED C, Hi-Tech C, MikroElektronika C, disassembler and hex tools.

CAN: Lawicell CANUSB, CAN232

FTDI: USB Family of IC 's. FT232RL, FT2452RL, also BL and others.

4DSystems LCD/Graphics: Add VGA monitor, or OLED LCD to your micro. Simple Serial I/F.

Heaps And Heaps Of USB Products: TTL, RS-232, RS-485, modules, cables, analyzers, CRO's.

Popular Easysync USB To RS-232 Cable: Works when the others fail. Only one recommended by CBUS. Money back guarantee.

www.dontronics-shop.com

TRUE AUDIOPHILE SPEAKERS

Danish Engineered Speaker Drivers for Astonishing Sound Reproduction with Clarity & Outstanding Performance

Tymphany & DST bring together Peerless & Scan-Speak the worlds most respected and trusted high-end loud speaker brands for the past 80 years. Visit: www.d-s-t.com.au

Find Specs / details online: www.d-s-t.com.au

Peerless vline

vifa innovation lives on

SCANSPEAK

Available from:
Wagner Electronics
138 Liverpool Road,
Ashfield, NSW, 2131
Phone: 02-9798-9233
Fax: 02-9798-0017
Email: sales@wagner.net.au
Web: www.wagner.net.au



CHKDSK/R, FIXMBR and FIXBOOT but that didn't fix it. FIXMBR, by the way, writes a new master boot record, while FIXBOOT writes a new partition boot sector to the drive.

Next, I tried reinstalling XP Professional SP2 onto the drive (over the top of the previous installation) but even that did not fix the symptoms. I then asked for advice from several acquaintances but no-one had any ideas.

It was time to eat humble-pie and ask a real guru (the one who is always lecturing me about the amount of stuff I have installed on my computers). After a brief discussion, he suggested that I try cloning the installation onto another 250Gb hard drive.

If that failed, his advice was that I might simply have to bite the bullet and reformat the drive and re-install XP. My protests that that wasn't an option, because it would take too long to reinstall all my stuff, were met with an unsympathetic shrug. I just hate computer gurus!

When I slaved the troublesome new drive in another machine, I could see that all my data was OK. So it looked as though the boot sector had been damaged or corrupted in some way on the new drive. As a result, I decided to follow my friend's advice about cloning, so I bought yet another hard drive, this time a Seagate 320Gb unit.

It took another two hours to clone the faulty hard drive to the new 320Gb unit. However, the gamble paid off because when I booted from the new clone, it fired up and everything initially appeared to work normally.

Well, if that works, I reasoned, why don't I try cloning back to the faulty disk to see what happens? Well, I did just that and somewhat annoyingly, the 250Gb drive now also worked.

However, because I had tried to reload XPSP2 back onto that disk, both disks now needed the installation to be completed, as the computer had stopped after the first reboot. This was done and I then re-ran the SP3 update to get everything up to date and working again.

All was going well – almost too well. It even handled the reboot and continued installing software as it booted up. The main screen came up again without a problem but on the very next reboot I got the message that *C:\windows\system32\config\system* was faulty, missing or corrupt.

Eventually, I solved the problem by cloning my original 80Gb drive onto the new 320Gb drive, which is really what I should have done in the first place. As for the 250GB drive, I've reformatted it and installed it as a slave, so I've now got lots of space left for lots of marvellous new stuff.

Celestial LCD TV



Our first Celestial ChangHong LCD TV came in under warranty. This new LT3200HD model is an 81cm high-definition LCD (1366 x 768) TV with an integrated HD tuner and normally gives a very good picture.

Unfortunately, this particular set had a weird intermittent fault. When it was hot, all the blacks went green. I had never encountered such a fault before and it really scrambled my tiny brain as to where to start looking.

What is excellent about this set is that the back can be removed without having to first remove the stand (ie, the set can remain in a vertical position). Almost all other LCD TVs (and monitors) have to be placed face down and their stands removed first.

This meant that, in the case of the Celestial TV, I could remove the back while the set was warm and running. Unfortunately though, due to the cold weather we had been having, as soon as I removed the well-ventilated back, the fault would disappear. So the fault was obviously heat-sensitive.

Eventually, with the aid of a towel, hairdryer and freezer, I managed to isolate the problem to IC U20 (AZ1084), a 3-terminal 3.3V IC regulator which runs very hot. This supply feeds the processor. When the fault occurred, the DC voltage remained correct but the ripple increased.

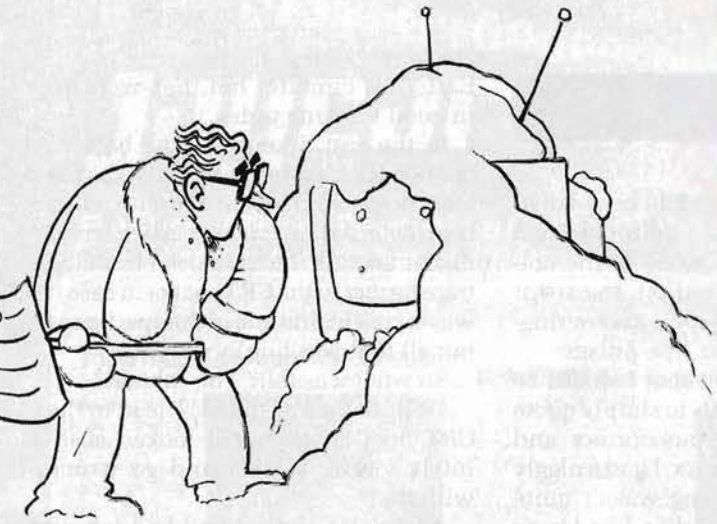
Freezing the IC would fix the symptoms immediately but unfortunately this surface-mounted component is not available as a spare part. As a result, the entire motherboard had to be replaced. The new IC felt as hot as the old one but the symptoms did not re-occur.

Stormy weather

When you are asked to do a service call for a TV that has snowy pictures – especially after a thunderstorm – you can never really be sure what you are going to find.

Recently, I was called out to look at a number of sets, all displaying the same symptoms. However, the causes were all completely different.

The first was a Philips TV. During the storm, the lights had gone out due to a power cut. The set's owner had then stumbled over an object in the



A SERVICE CALL FOR A TV THAT HAS SNOWY PICTURES~

lounge room and as she fell, her shoulder grazed the TV set and moved it slightly.

Unfortunately for her, the aerial lead to the VCR, which was sitting on top of the TV, was very short and tight. Moving the "telly" had pulled the RF lead out of the VCR, causing the snowy picture. If only they were all that easy.

The next set was a Sony rear-projection TV that had gone snowy after a lightning strike. This turned out to be a damaged VCR power supply which prevented signal getting to the TV.

Ironically, with snowy pictures, you normally get a hissing sound. In this instance, the hissing also came from a crack in the insulation of the HV unit inside the rear projection TV. This was replaced and the hiss went away for good.

The last case I had was an old Teac MV-1440TV TV/VCR. The cause this time was that the tuner was intermittently drifting. These sets are made (I think) by Funai for Fujitsu General and Teac. However, the tuner IF is manufactured by Sharp and is the same as that fitted in the Fujitsu General VGX-715A.

Unfortunately, it is no longer available and one can only attempt to repair it. Apart from dry joints, there is the 36.9MHz blue SAW filter to check, along with the AN5135NK 28-pin IC and an electrolytic capacitor on the AGC line.

After that, the next parts to check are the 33V zener diode, IC1105 (L531), IC1102 (LA7913) and D1101 (1N4002), plus the surrounding electros. Finally, if all that fails, you sell the client a new digital set-top box which will fix most faulty aerial problems too and alleviate technology obsolescence!

Grundig TV set

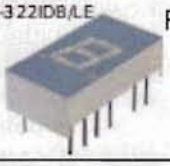
Some time ago, I wrote about a Grundig CRT TV. It was a 2000 Elegance 82 MW82-2101 NIC/Dolby using a CUC2058 chassis and at the time, its power supply had radically spat the dummy. Following repairs, it had been working well for about three months when the owner phoned to complain about hissing noises coming from the rear of the set.

I wasn't especially concerned about this as we had just been going through a particularly long rainy period and dampness often creates problems in EHT sections – especially European TVs that whose designers somehow don't fully appreciate the need for tropical insulation. Anyway, he agreed to bring the set in so that it could be fixed before it got worse and failed completely.

When it arrived, I removed the back and could immediately see that it was arcing from the small flyback transformer (TR53010). I cleaned the whole area around this transformer with CRC2-26 and used a paintbrush and clean cloth to make it all almost sparkling new again. However, despite my efforts, I could still detect hissing

FORCE ELECTRONICS AZTRONICS Your Local Electronics Stockist

Adelaide Electronic Component Specialists



Red Seven-Segment 7.62mm Digit LED Display Common Anode

$5.50 for 10



$8.70 Each

Bright LED 7x5 Dot Matrix Display Bicolour Red/Green 53.2mm x 38.5mm

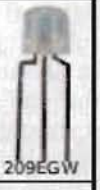


7-Segment RED 4 x 15mm Digit LED Display 50 x 19mm

$3.30 Each

$3.00 for 10

3mm Bi-Colour LED Diffused Orange/Green Common Cathode



Flexible LED 12V Strip



Available in these colours

Blue Red Green RGB Tricolour

Cool or Warm White

$4.95 each 50mm / 3 LEDs max run of 5m

$9.90 each 100mm 3 LEDs

Also Available In Waterproof

Force Electronics Holden Hill
Shop 4, 650 Main North Road,
Holden Hill, SA 5088
8261 7088
forcehh@adam.com.au

Aztronics Pty Ltd
170 Sturt Street,
Adelaide, SA 5000
8212 6212
www.aztronics.com.au

from where the EHT leads connected to the transformer.

I showed the owner the problem and told him that normally I would build up a thin layer of silicone rubber over the areas where the arcing was taking place. However, my stock of silicone had dried up which meant that he would have to wait until I got some in.

My customer, who happened to be a mechanic, then told me that he had some red (high-temperature) silicone which he used for sealing gaskets in engines. What's more, he had some in his car which he immediately retrieved.

I wasn't too sure what its electrical properties were but on his assurance (and by implication his responsibility), I agreed to use it to seal the insulation of the flyback transformer. The rubber cures fast and it had gone off in about two hours. The result was that the set was now really quiet, as it should be.

When he returned to collect the set, I explained that due to the nature of the fault, I could offer no guarantees. I also told him that a replacement transformer was expensive, so the silicone treatment was worth trying. I didn't charge him for the work I had done and he left with the understanding that he was pretty much on his own.

Two weeks later he telephoned again to say that the set was dead again. I overlooked the emphasis he gave to "dead again" and agreed to look at it again if he brought it in.

When it arrived, I plugged it in and could see that the set wasn't actually "dead" but was in fact stuck in "standby mode". It was actually trying to start but just couldn't make it.

I measured the +A 155V rail all the way to the collector of the line output transformer. In addition, the E+ 8V line was going to the line driver until the set switched back to standby.

As I had worked on the EHT insulation only a fortnight earlier, I suspected that the transformer had probably now failed completely. This was confirmed when I connected a CRO probe to the collector of the line output transistor (T53001) and could see a severe ringing instead of perfect line pulses.

At this point, I felt that I would be quite within my rights to simply quote for a new flyback transformer and leave it at that. However, I had a niggly feeling that everything wasn't quite kosher. Two weeks earlier, I had been confident that the insulation problem had been completely fixed and even now there were absolutely no signs of stress in the flyback transformer, apart from the ringing indication on the scope.

As a result (and also to satisfy my curiosity), I removed the flyback transformer and checked it using both a shorted turns tester and an HR Line Output Transformer Tester. Both pieces of equipment reported a clean bill of health and it was tested up to 18.2kV.

Feeling somewhat alarmed by now, I then checked the three secondary voltages derived from the flyback transformer. The 16V output was OK but the 45V and 200V outputs were both very low, so I spent a lot of time investigating these circuits until I could be sure nothing was wrong with them.

Next, I spent some time looking at the deflection yoke and even completely disconnected it while making sure that the A+ voltage was still reaching the line output stages. This all checked out and I then spent a lot of time checking the vertical output stages and the East West circuitry but they were all in good working order.

In the end, I kept coming back to the flyback transformer as this was the last known area where a problem had been detected two weeks earlier. I tried disconnecting the focus lead from the transformer to the CRT socket in case it was arcing inside one of the spark gaps but all that was hunky dory too.

So what was left? The cabinet?

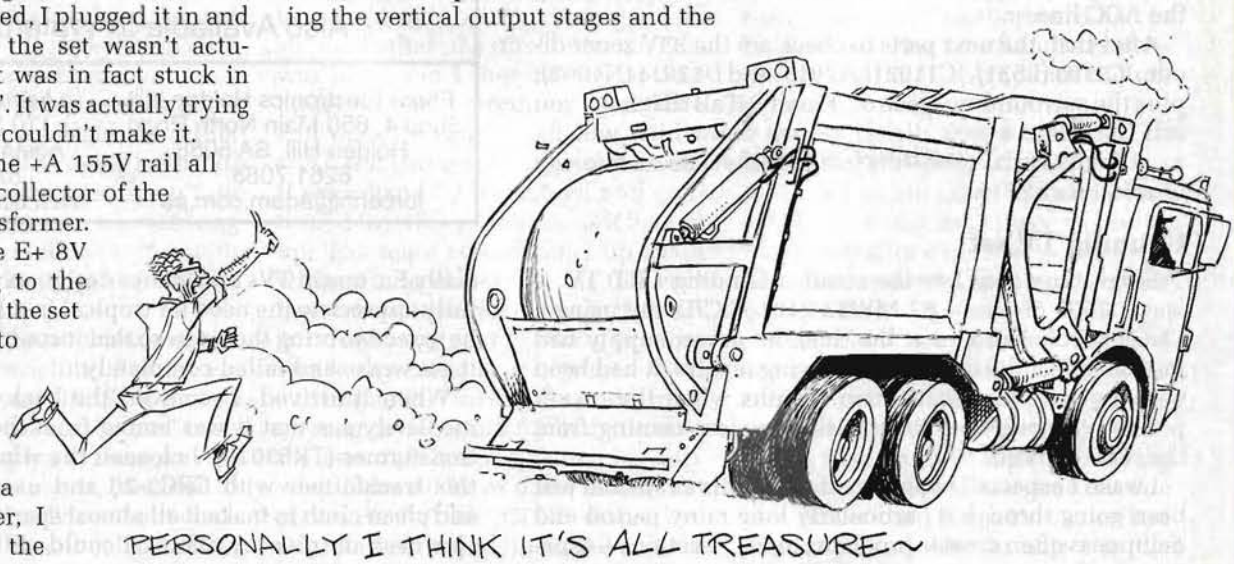
Well, there was the EHT lead to the CRT final anode but it looked absolutely virgin. What could go wrong with that?

And so, to make sure I had left no stone unturned, I disconnected the EHT lead from the flyback transformer and switched on again, not expecting much. To my surprise, the set fired up with sound and the ringing vanished from the collector of the line output transistor (T53001). To all intents and purposes, the set was now running normally, except of course there was no picture because of no EHT.

What had happened was that the picture tube was "down to air" and it was arcing internally. Disconnecting the final anode or removing the CRT socket allowed the set's electronics to resume normal service.

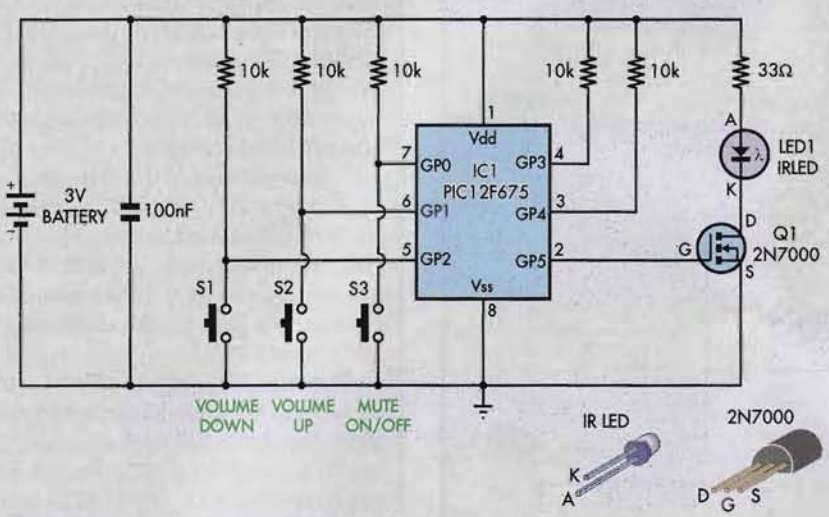
I told my disbelieving client that the picture tube was faulty – probably due to the set having been dropped – and that it was beyond economic repair. Begrudgingly, he had to accept the facts, however I never got paid nor even thanked for all the diagnostic work I had done.

You would have thought that being a mechanic, he more than most would have appreciated what I did! SC



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.



Kill those adverts quickly with the Supermute

The Supermute is a TV remote that turns the TV on or off, mutes the sound and varies the volume up or down, using only three buttons. The mute/on/off button is an industrial emergency stop button which makes it easy to kill pesky adverts.

The circuit comprises a Microchip PIC12F675 8-pin microcontroller, FET Q1, infrared LED1, the emergency stop button and two small pushbutton switches for the volume control. Holding the emergency stop button down for a second or more alternatively turns the television on or off.

A quick slap of the emergency stop button with an open hand (or closed fist!) or a prod with the foot mutes or un-mutes the TV. The pushbutton switches raise or lower the volume.

It is set for a Sony TV which has a simple IR protocol – a 5-bit address to identify the device being controlled (TV, DVD player, VCR, etc) and 7-bit commands. The carrier frequency is 40kHz. The PIC program uses the SLEEP function to limit the off-state current to less than 1mA and is woken from SLEEP with any change on input ports 1, 2 or 3.

You can determine the bit pattern by a web search or by measurement with the device's original remote, an IR detector on a breadboard and an oscilloscope.

The emergency stop button is an industrial Allen Bradley unit. Jaycar have a cheap latching button emergency stop (Jaycar SP-0786) that can be converted easily to non-latching but it is not as robust. Jaycar also have a number of large momentary contact pushbutton switches.

The software can be downloaded from the SILICON CHIP website.

Andrew Buchanan, Tawa, NZ. ($50)

4017 counter tester

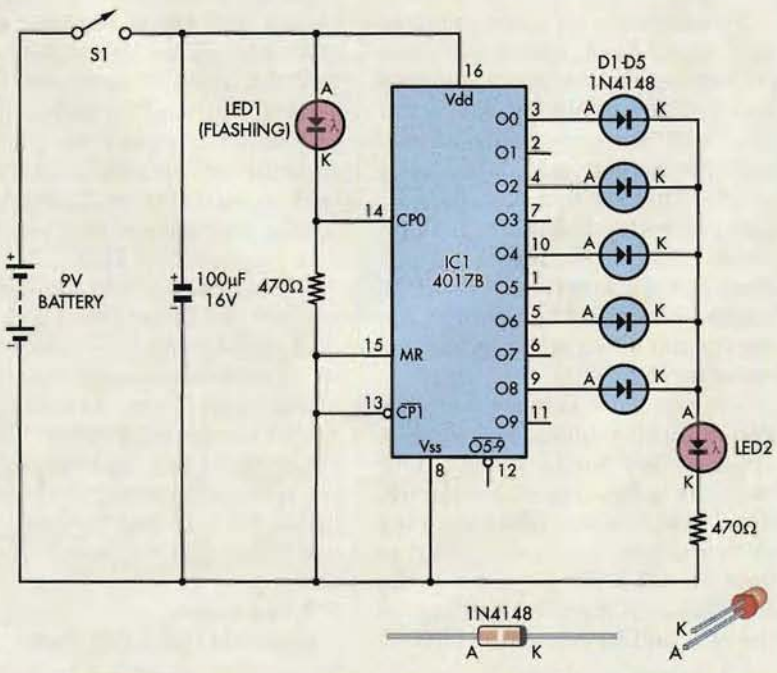
This circuit can be used to test 4017 decade counters. Flashing LED1 drives the clock input of the 4017 under test (IC1) and this sends each output high in turn.

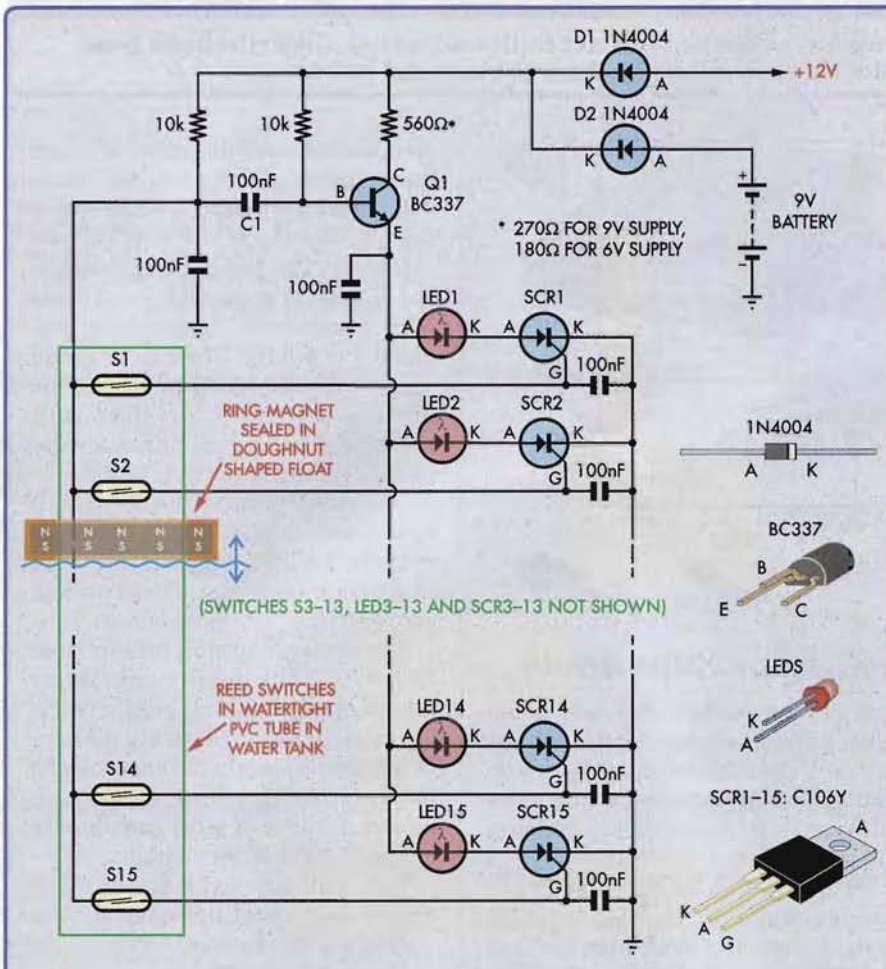
Outputs 0, 2, 4, 6 & 8 are ORed together by diodes D1-D5 (functioning as an OR gate) to drive LED2 which flashes on and off with a 50% duty cycle. When any one of the five connected outputs goes high, LED2 is on.

The flash rate is half that produced by flashing LED1 because only alternate outputs are used. Why not connect all 10 outputs via diodes? This would not be useful, as LED2 would be continuously lit.

In use, a known good 4017 would normally be installed in the test socket. You would then switch on, observe both LEDs flashing normally, then switch off and install the 4017 to be tested. It should behave in exactly the same way. Switch S1 is optional.

A. J. Lowe, Bardon, Qld. ($35)





Water tank level indicator

By contrast with some previous tank water level indicators which relied on a resistor string progressively shorted out by the water level, this tank uses a series of reed switches which are closed by a magnet attached to a float. In practice, the reed switches are mounted inside a sealed tube inside the tank and a donut shaped float with a ring magnet is tethered by the tube, rising up and down with the varying water level.

You can have as many switches and indicator lights as you like although the wiring to only four switches is depicted on the circuit. It works as follows. When any reed switch closes, it allows current to flow from the 10kΩ resistor to the associated SCR's gate, turning on the SCR and its associated LED.

Since the SCR gate voltage is initially low (and shunted by a 100nF capacitor), the closing of a reed switch will cause one end of C1 (100nF) to go low and momentarily pull the base of transistor Q1 low. This will turn off Q1 and allow the SCR which was previously latched on to turn off. As soon as C1 charges back up again, Q1 will turn on, allowing the triggered SCR to turn on and illuminate its LED.

When power is first applied and no reed switch is turned on by the float, no LED will be illuminated. It will therefore be necessary to manually raise (or lower) the float to turn on the nearest reed switch.

One side of all the reed switches is connected to a common stiff wire inside the tube and the other sides can be brought out the top via Cat5 cable.

Ron Groves,
Cooloola Cove, Qld. ($50)

PICAXE-based Star 5W LED control unit

This circuit uses a PICAXE 08M to control an MC34063 DC-DC converter driving a 1W LED. The MC34063 is simply configured with the current through the LED monitored by a 0.27Ω resistor in series with it. The voltage across the resistor is amplified using an op amp and applied to the feedback pin of the MC34063.

This is similar to the approach used in the SILICON CHIP LED control unit of May 2004 except that the LED is driven directly by the MC34063. It is recommended that readers refer to this article and to the datasheets for the MC34063.

The PICAXE 08M's PWM output is fed via trimpot VR2 and diode D1 into the MC34063's feedback input and is used to override the LED's current feedback from IC3, causing the MC34063 to reduce the current in the LED.

Inputs to the PICAXE comprise a pushbutton (normally open) and a voltage divider network (R1-R3) to allow monitoring of the supply voltage. Pot VR1 is used to vary the strobe rate. Outputs are the PWM signal and red LED1 acts as a locator beacon and for acknowledgement of button presses.

There are three programs for different operating modes:

(1) An off delay lamp (designed for camping) to provide an efficient light that powers down automatically to conserve batteries.

(2) A normal on/off lamp with three power levels.

(3) A strobe with varying flash rates.

For the off delay lamp, resistors R1-R3 and VR1 are omitted. With the On/off lamp, VR1 is omitted but the three resistors are installed. For the strobe, VR1 and resistor R3 are installed.

In all cases, the MC34063 is set up without the PICAXE connected. VR3 is adjusted to set the maximum current through the LED or a 10Ω resistor (in its place). The PICAXE is then programmed and connected to the rest of the circuit via link LK1.

VR2 is adjusted to ensure that the LED is off when it should be, ie, when the PWM output on pin 5 of the PICAXE is full on. No LED current should flow when the PICAXE's PWM output is full on.

When powered up the LED will briefly flash then remain off until the pushbutton is pressed for 3s.

In the case of the off delay lamp, after six minutes the PWM output (pin 5) of the PICAXE will ramp up to override the feedback to the MC34063 until the LED is extinguished. This happens gradually to alert users that the light is about to go off. The LED flickers briefly before going off as a final alert to users. At this point, a press of the button will bring it back to full brilliance for another six minutes.

At any stage when the LED is on, a second press will reset the time to six minutes. Another press of the button will further extend the time to 20 minutes. Note that the settings for the time durations can be changed if longer times are desired.

Holding the button pressed for about 2s will turn off the LED. When off, indicator LED1 will flash, serving as a locator beacon at night. LED1 also flashes when the button is pressed.

In the case of the on/off lamp, the initial setting up is similar. Successive presses of the pushbutton can select three light levels. When the button has not been pressed for 1s, the next press will turn the unit off. The different light levels are achieved by varying the mark/space ratio of the PWM output of the PICAXE.

The voltage divider network referred to above senses the supply voltage and this is fed into the IC1's ADC1 input. When the battery voltage falls below a set point, the LED will dim to save power. If the voltage falls further, the LED turns off to protect the battery.

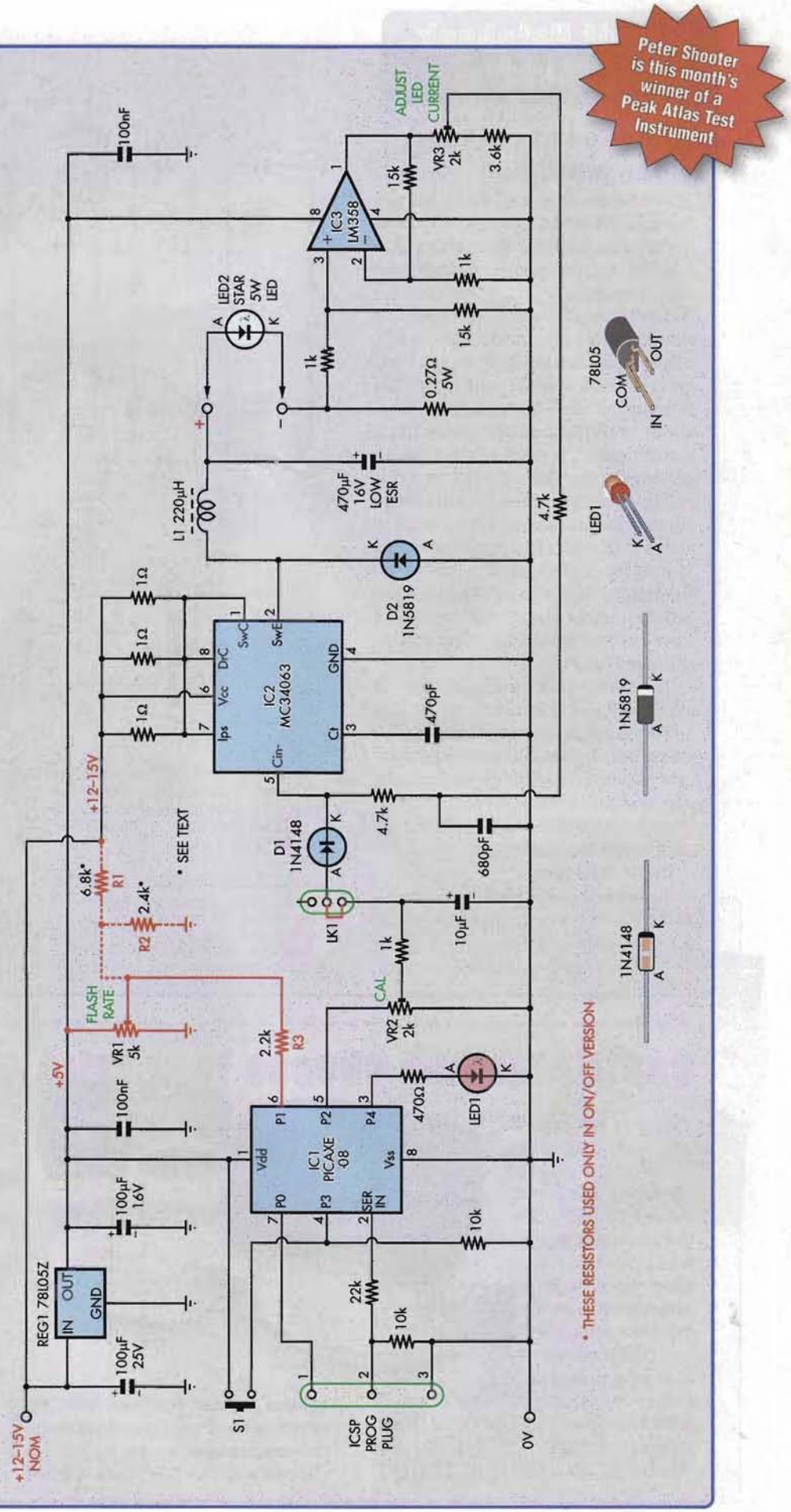
At turn on, the different light levels can be cycled through for a set number of times before the unit will default to the lowest light level. In this mode, it will not shut down due to low battery voltage. This provides an emergency mode where you will still have light.

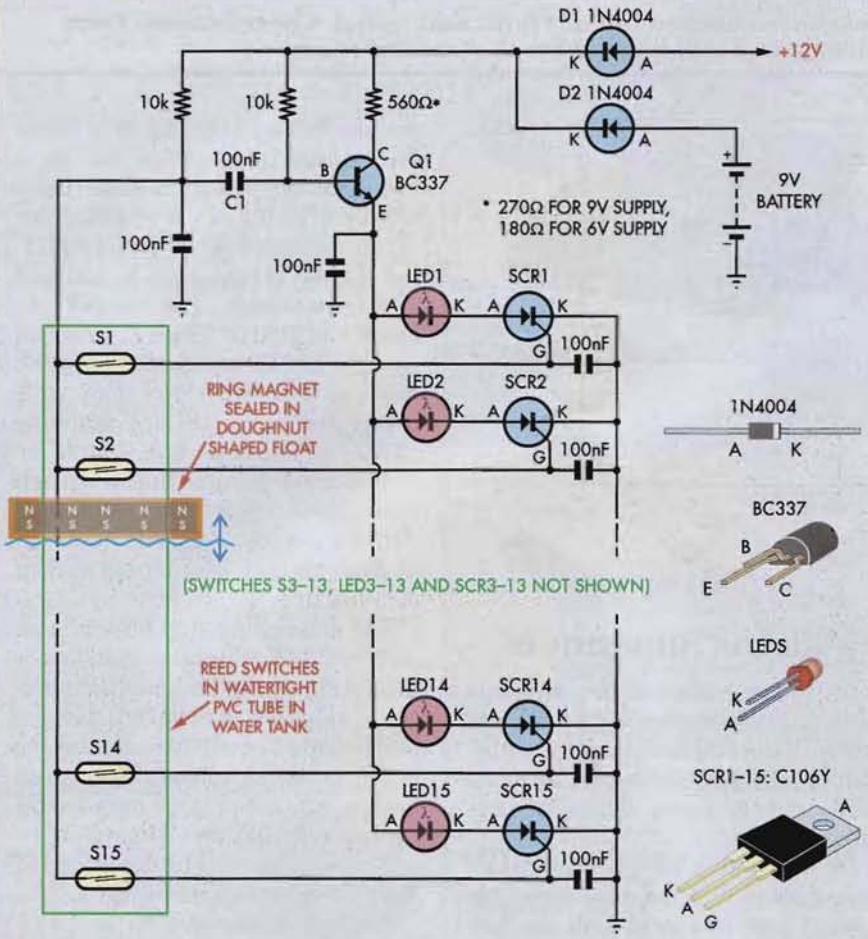
The strobe function is a simple program but can be adapted by using the analog input from the pot to also vary the mark-space ratio of the strobe.

Be cautious in testing as certain strobe rates can induce epileptic fits or seizures in some people. For others, sensations of nausea can occur.

The three .bas program listings will be available on our website.

Peter Shooter,
Fremantle, WA.





Water tank level indicator

By contrast with some previous tank water level indicators which relied on a resistor string progressively shorted out by the water level, this tank uses a series of reed switches which are closed by a magnet attached to a float. In practice, the reed switches are mounted inside a sealed tube inside the tank and a donut shaped float with a ring magnet is tethered by the tube, rising up and down with the varying water level.

You can have as many switches and indicator lights as you like although the wiring to only four switches is depicted on the circuit. It works as follows. When any reed switch closes, it allows current to flow from the 10kΩ resistor to the associated SCR's gate, turning on the SCR and its associated LED.

Since the SCR gate voltage is initially low (and shunted by a 100nF capacitor), the closing of a reed switch will cause one end of C1 (100nF) to go low and momentarily pull the base of transistor Q1 low. This will turn off Q1 and allow the SCR which was previously latched on to turn off. As soon as C1 charges back up again, Q1 will turn on, allowing the triggered SCR to turn on and illuminate its LED.

When power is first applied and no reed switch is turned on by the float, no LED will be illuminated. It will therefore be necessary to manually raise (or lower) the float to turn on the nearest reed switch.

One side of all the reed switches is connected to a common stiff wire inside the tube and the other sides can be brought out the top via Cat5 cable.

Ron Groves,
Cooloola Cove, Qld. ($50)

PICAXE-based Star 5W LED control unit

This circuit uses a PICAXE 08M to control an MC34063 DC-DC converter driving a 1W LED. The MC34063 is simply configured with the current through the LED monitored by a 0.27Ω resistor in series with it. The voltage across the resistor is amplified using an op amp and applied to the feedback pin of the MC34063.

This is similar to the approach used in the SILICON CHIP LED control unit of May 2004 except that the LED is driven directly by the MC34063. It is recommended that readers refer to this article and to the datasheets for the MC34063.

The PICAXE 08M's PWM output is fed via trimpot VR2 and diode D1 into the MC34063's feedback input and is used to override the LED's current feedback from IC3, causing the MC34063 to reduce the current in the LED.

Inputs to the PICAXE comprise a pushbutton (normally open) and a voltage divider network (R1-R3) to allow monitoring of the supply voltage. Pot VR1 is used to vary the strobe rate. Outputs are the PWM signal and red LED1 acts as a locator beacon and for acknowledgement of button presses.

There are three programs for different operating modes:

(1) An off delay lamp (designed for camping) to provide an efficient light that powers down automatically to conserve batteries.

(2) A normal on/off lamp with three power levels.

(3) A strobe with varying flash rates.

For the off delay lamp, resistors R1-R3 and VR1 are omitted. With the On/off lamp, VR1 is omitted but the three resistors are installed. For the strobe, VR1 and resistor R3 are installed.

In all cases, the MC34063 is set up without the PICAXE connected. VR3 is adjusted to set the maximum current through the LED or a 10Ω resistor (in its place). The PICAXE is then programmed and connected to the rest of the circuit via link LK1.

VR2 is adjusted to ensure that the LED is off when it should be, ie, when the PWM output on pin 5 of the PICAXE is full on. No LED current should flow when the PICAXE's PWM output is full on.

When powered up the LED will briefly flash then remain off until the pushbutton is pressed for 3s.

In the case of the off delay lamp, after six minutes the PWM output (pin 5) of the PICAXE will ramp up to override the feedback to the MC34063 until the LED is extinguished. This happens gradually to alert users that the light is about to go off. The LED flickers briefly before going off as a final alert to users. At this point, a press of the button will bring it back to full brilliance for another six minutes.

At any stage when the LED is on, a second press will reset the time to six minutes. Another press of the button will further extend the time to 20 minutes. Note that the settings for the time durations can be changed if longer times are desired.

Holding the button pressed for about 2s will turn off the LED. When off, indicator LED1 will flash, serving as a locator beacon at night. LED1 also flashes when the button is pressed.

In the case of the on/off lamp, the initial setting up is similar. Successive presses of the pushbutton can select three light levels. When the button has not been pressed for 1s, the next press will turn the unit off. The different light levels are achieved by varying the mark/space ratio of the PWM output of the PICAXE.

The voltage divider network referred to above senses the supply voltage and this is fed into the IC1's ADC1 input. When the battery voltage falls below a set point, the LED will dim to save power. If the voltage falls further, the LED turns off to protect the battery.

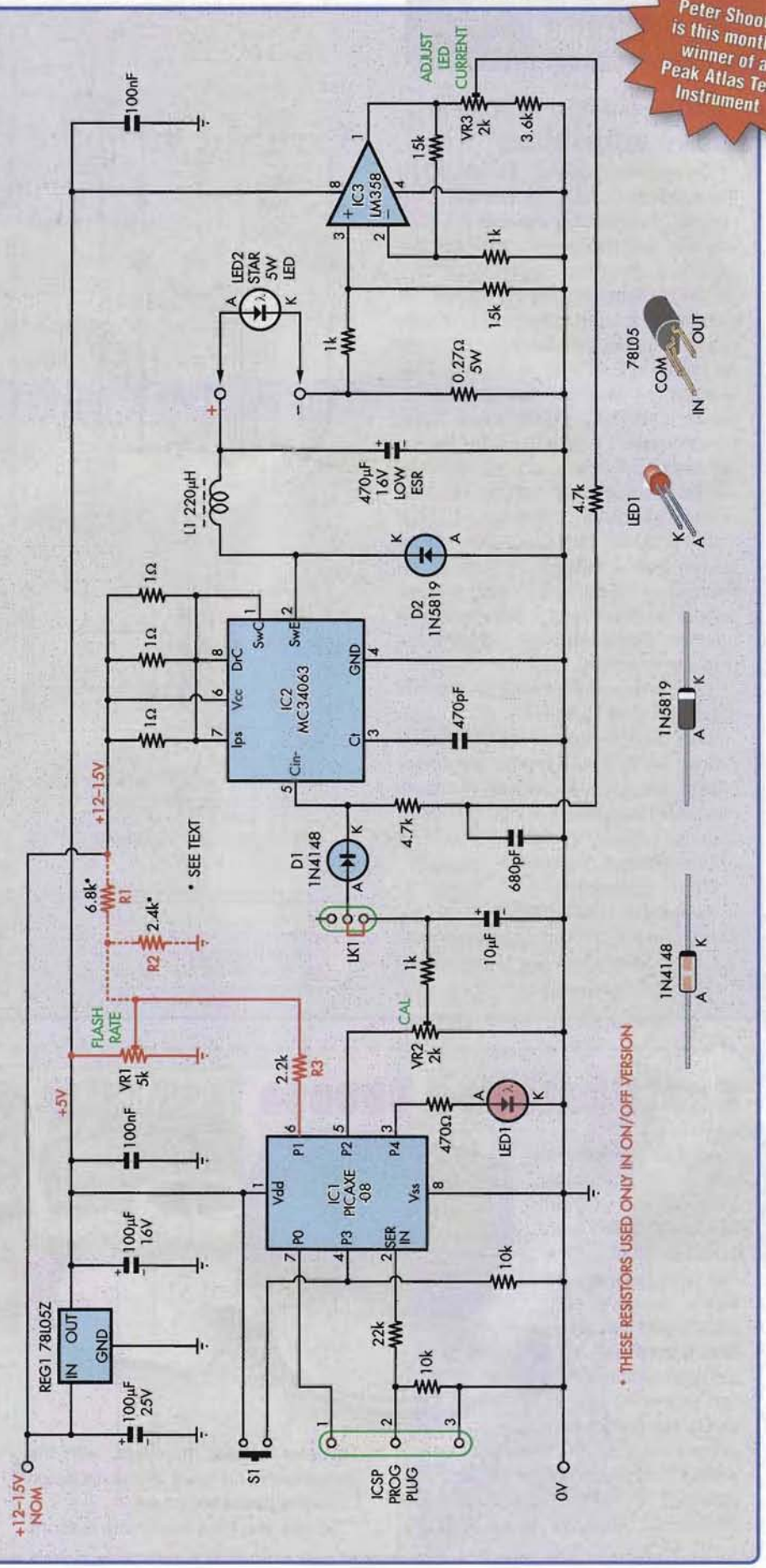
At turn on, the different light levels can be cycled through for a set number of times before the unit will default to the lowest light level. In this mode, it will not shut down due to low battery voltage. This provides an emergency mode where you will still have light.

The strobe function is a simple program but can be adapted by using the analog input from the pot to also vary the mark-space ratio of the strobe.

Be cautious in testing as certain strobe rates can induce epileptic fits or seizures in some people. For others, sensations of nausea can occur.

The three .bas program listings will be available on our website.

Peter Shooter,
Fremantle, WA.



Peter Shooter is this month's winner of a Peak Atlas Test Instrument

A low-power class-A valve amplifier

This class-A stereo valve amplifier uses two 12AX7 or related twin triodes and low-voltage mains transformers for the power supply and output stages.

The power supply is based on two 12V transformers, T1 & T2, connected back-to-back to provide an isolated 240VAC winding. This is rectified and filtered to provide about 300V DC. At the same time, transformer T1 provides the heater supply for the two valves.

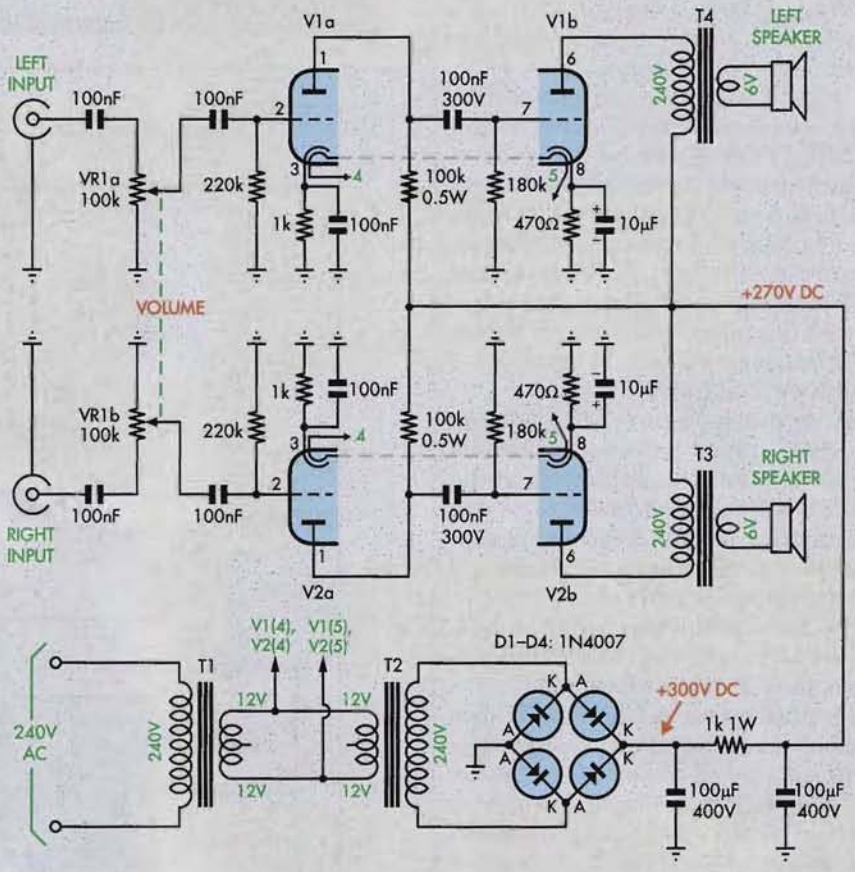
The second triode of each 12AX7 is used as the output stage, driving a 240V to 6V transformer to drive 8-ohm loudspeakers. Typically, the frequency response of small mains-power transformers is not anywhere near flat but would be adequate for this application.

The estimated power output is about 1W per channel.

This is really a project for recycled parts but if you have to buy new components, the valves and sockets can be obtained from Jaycar Electronics while the 400V capacitors can be obtained from Altronics.

Dayle Edwards,
Taylorville, NZ. ($60)

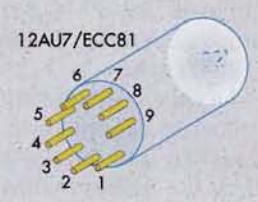
Note: do not leave out transformer T2. It is absolutely necessary to ensure safe isolation from the mains.



V1, V2: 12AU7/12AT7/12AX7/ECC81/ECC82
T1: 240V TO 12V AT 300mA
T2: 240V TO 12V AT 150mA
T3,T4: 240V TO 6V AT 150mA

WARNING: DANGEROUS VOLTAGES ARE PRESENT ON THIS CIRCUIT. DO NOT BUILD IT UNLESS YOU KNOW EXACTLY WHAT YOU ARE DOING





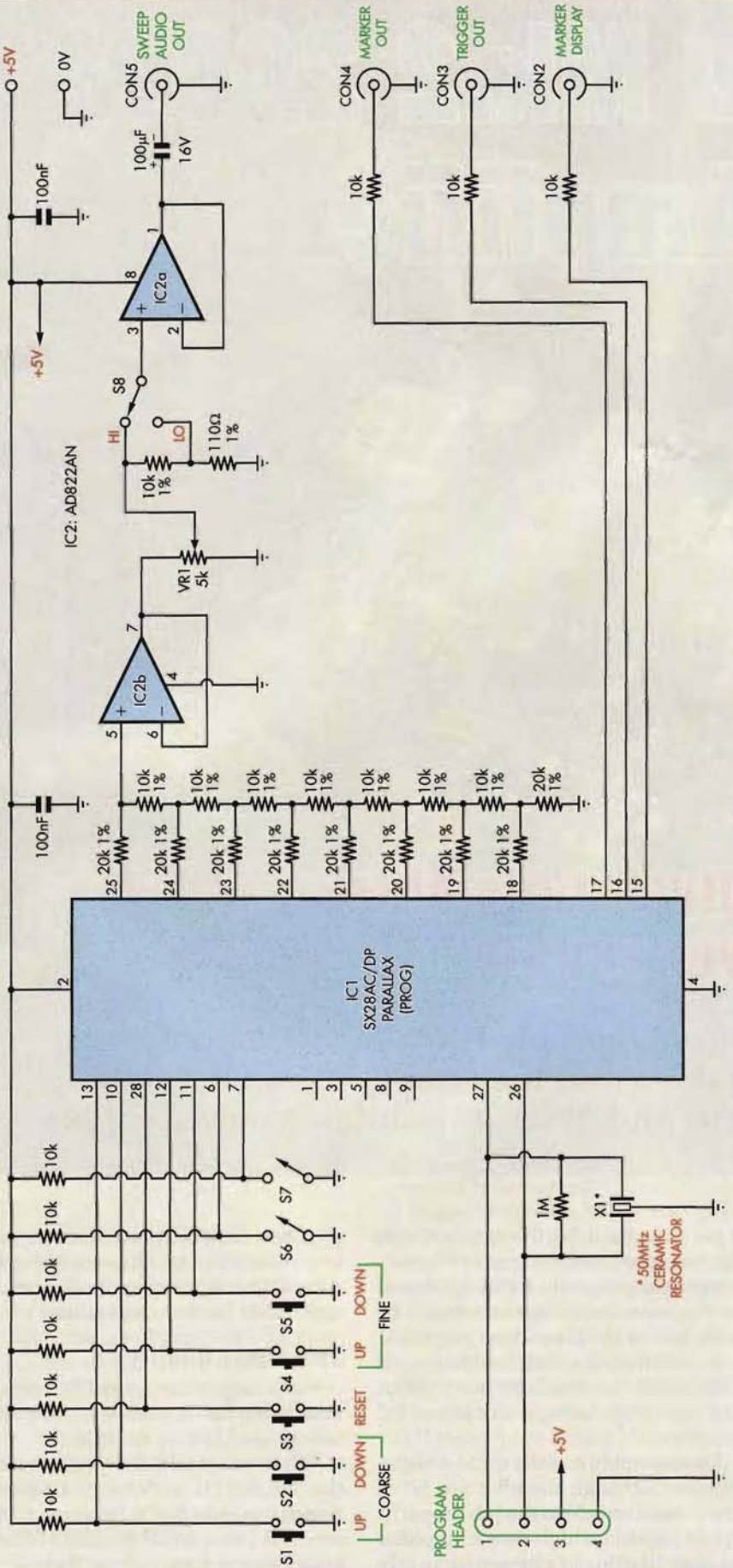
Contribute And Choose Your Prize



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.



Sweep frequency generator for audio testing

This circuit was developed to test the frequency response of amplifiers, filters and other audio equipment. It is controlled by a Parallax SX28AC/DP microcontroller (IC1).

It has two frequency ranges. The first is 0.1Hz or 100Hz to 100kHz and is used to test IR communication devices, ultrasonic and audio circuits. The second is 50Hz to 15kHz for more precise testing of audio equipment.

Trigger and marker (frequency) outputs are provided for use with an oscilloscope. The resistor ladder network provides a sinewave output which can be adjusted in level by potentiometer VR1 and range switch S8. These controls should be adjusted and the frequency range selected with switches S6 & S7.

The circuit must be powered from a regulated 5V rail.

The programmed SX28AC/DP micro can be obtained from Parallax at **www.parallax.com**. Alternatively, the software will be available from the SILICON CHIP website.

William Oliver,
Clarks Summit, PA. ($50)

Looking for real performance?



- Learn about engine management systems
- Projects to control nitrous, fuel injection and turbo boost systems
- Switch devices according to signal frequency, temperature & voltage
- Build test instruments to check fuel injector duty cycle, fuel mixtures and brake & temperature

It's all in....
Performance Electronics For Cars

Mail order prices: Aust. $A22.50 (incl. GST & P&P); Overseas $A26.00 via airmail. See www.siliconchip.com.au for ordering details.

Ultra-LD Mk.2 200W Power Amplifier



All the assembly details plus building a power supply

Last month, we introduced our new Ultra-LD Mk.2 200W Amplifier module and described the circuit. This month, we give the assembly details and describe a suitable power supply.

THIS NEW 200W audio amplifier module gives superlative performance – better than any of our previous class-AB amplifiers. That's been made possible by the use of On Semiconductor's new ThermalTrak power transistors, a circuit based largely on our high-performance class-A amplifier (published in 2007) and a new double-sided PC board with plated-through holes.

As mentioned last month, the double-sided PC board is critical to the performance of this amplifier module. It not only simplifies the supply wiring but has also been designed to largely cancel the magnetic fields produced by the asymmetric currents drawn by each half of the class-B output stage.

In addition, the double-sided board eliminates the need for wire links, the exception being a couple of 0Ω resistors.

The assembly is really quite straightforward although there's a fair bit of work involved to do the job properly. When building a high-power amplifier module like this, it's important to take your time, do a neat job and check your work carefully at each assembly stage. After all, blowing up expensive output transistors can be a real pain.

Transistor quality

We'll begin the assembly details shortly but first a word about the transistors used in this module.

To ensure published performance, the NJL3281D & NJL1302D power transistors must be On Semiconductor branded parts, while the 2SA970 low-noise devices must be from Toshiba. Be

Pt.2: By JOHN CLARKE & GREG SWAIN



wary of counterfeit parts (although it's probably too early for counterfeit versions of the power output devices).

We recommend that all other transistors used in this project be from reputable manufacturers, such as Philips (NXP Semiconductors), On Semiconductor and ST Microelectronics. This applies particularly to the MJE15030 & MJE15031 output driver transistors.

PC board changes

Fig.9 shows the parts layout on the double-sided PC board. This board is coded 01108081 and measures 135 x 115mm. The orange tracks and pads show the copper on the top of the board, while the blue-grey tracks are on the underside of the board.

The first thing to note is that the PC pattern differs slightly from that used for the prototype module. That's because we subsequently decided to increase the number of vias used to link the top and bottom supply rail tracks. Up to 4.5A peak can flow through each output transistor when the module is operated into a 4Ω load, so it's important to ensure sufficient current-carrying capability.

However, the main reason for increasing the number of vias was to make sure that a fault in the output stage would not cause the vias to fuse, instead of the 5A fuses blowing. If that happened, the board would be difficult to repair, as the solder mask goes right up to the edges of the vias.

As a result, we've increased the number of parallel vias in the high-current paths, generally grouping them together in patterns of five or more (so that they look like the face of a dice). Note that, unlike the outer vias, the middle via of each group of five has a solder pad on both sides of the board. This allows a tinned copper wire "feed-through" to be fitted to each of these middle vias and soldered in place.

These tinned copper wire feed-throughs ensure that the vias can not possibly fuse in the event of an output stage fault. They also ensure very low resistance between the top and bottom track sections.

We've also added extra vias to connect the low-current signal tracks on both sides of the PC board, in the interests of redundancy. This is a "belts 'n braces" measure but is still good practice.

Another change from the prototype board involved re-routing the tracks to transistor Q8. That's because a BC639 is now specified for Q8 and this transistor has a different pinout to the transistor originally intended for use in this location. In addition, a 22kΩ resistor has been added in series between Q8's collector and ground.

We also added a 390Ω 1W resistor to the board to provide the headphone output. As part of this change, CON3 was changed from a 2-way terminal block to a 3-way terminal block to give the "Phones Out" terminal (note: these changes are not shown on the photos).

Apart from that, there are only a few minor changes to improve component fit, especially to the bottom right of the PC board.

Board assembly

Fig.9 shows the assembly details. Begin by installing the tinned copper wire feed-throughs to the middle pad of each group of five vias. It's simply a matter of pushing the wire through each via and soldering it on one side. When you do this, the solder should run up inside the via and onto the solder pad on the other side of the board.

If not, solder it on the other side of the board as well, then cut the wire off short on both sides of the board.

Note that it isn't really necessary to fit feed-throughs to the vias immediately below the fuseholders, since the fuseholder pins themselves act as feed-throughs. However, they can be installed if you wish. Don't forget the via that sits under the two 0.1Ω resistors at top left.

Once the feed-throughs are in, install the two 1N4148 diodes (D1 & D2), followed by the resistors (but not the 5W types) and the capacitors. The resistor colour codes are shown in Table 1 but we strongly advise that you also check each value using a multimeter before it is installed. Mount them so that they all face in the same direction,

WARNING!

High AC & DC voltages are present on the power supply and power amplifier modules when power is applied. **In particular, make sure you don't get across the two 40V AC input terminals on the power supply. The 40V AC transformer windings that connect to these terminals are wired in series, so there's 80V AC between them.**

Similarly, note that **there is 110V DC between the +55V and -55V supply rails**, both on the power supply module and the amplifier module. Do not touch any of this AC or DC supply wiring (including the fuseholders) when the amplifier is operating, otherwise you could get a very nasty shock which could even prove fatal.

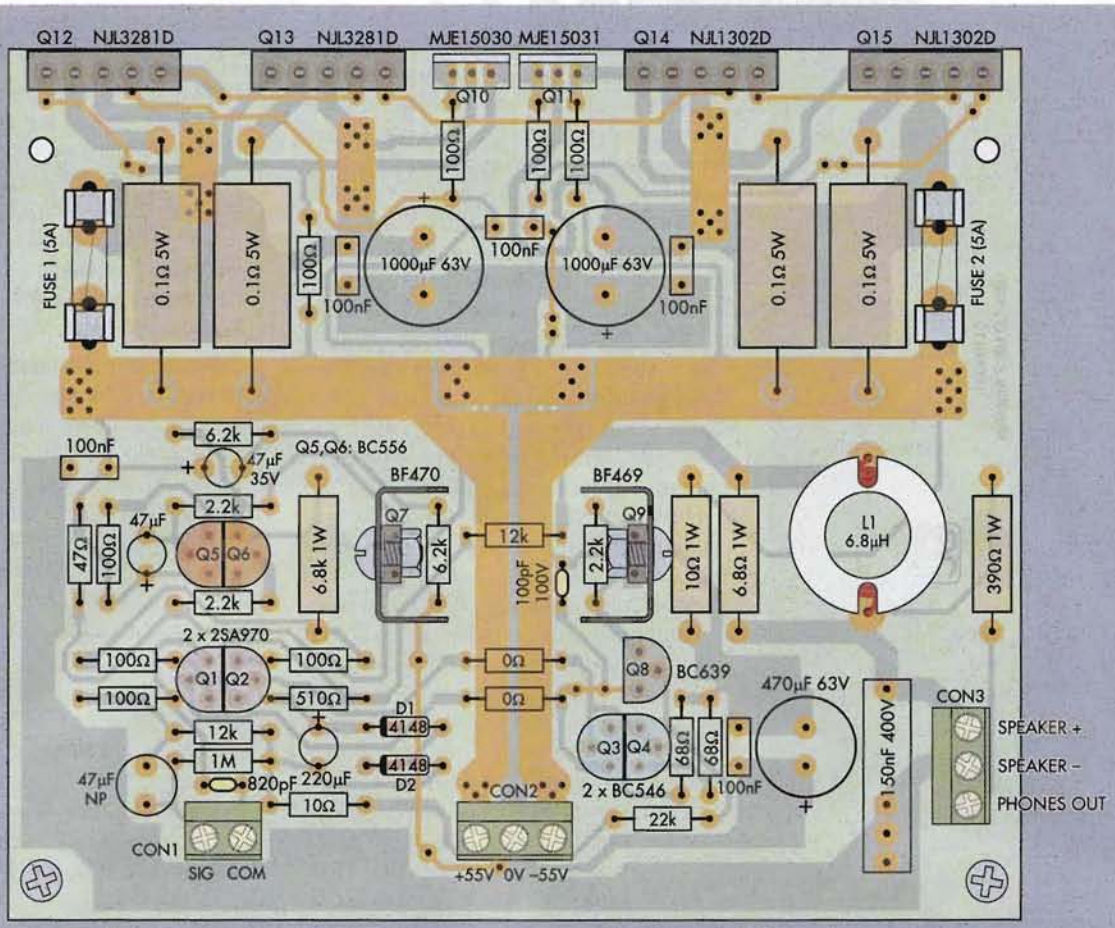


Fig.9: follow this parts layout diagram and the instructions in the text to build the Ultra-LD Mk.2 Amplifier module. Note that you should install a tinned copper wire feed-through wherever there's a via with a solder pad, typically in the middle of each group of five vias.

to facilitate checking later on.

Make sure that the diodes and electrolytic capacitors are all installed with the correct polarity. If you make a mistake, it's not as easy to remove a component from a double-sided board with plated-through holes as it is from a single-sided board. It can be done, although you usually have to sacrifice the part – see the panel headed "Bullet-Proofing The Ultra-LD Mk.2" for details on removing components.

We suggest that you leave the two 1000µF electrolytic capacitors off the board for the time being, as this makes it easier to secure transistors Q10 & Q11 to the heatsink later on. Even with the capacitors in place, you still have good screwdriver access to these transistors. However, there's a risk that one of these capacitors could be damaged if the screwdriver slips while doing up the mounting screws.

Note that the 100pF capacitor on the collector of transistor Q9 should be rated at 100V. Alternatively, you can use a 3kV type, such as the Altronics R-2882.

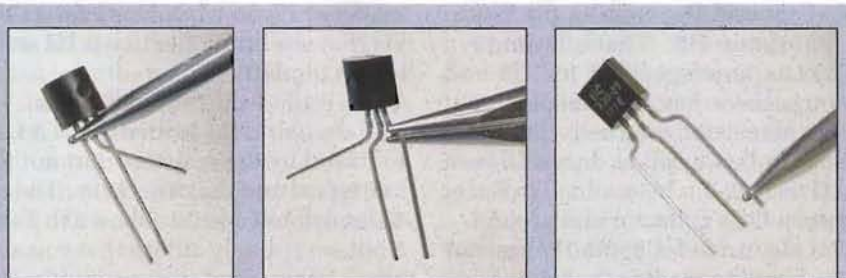
Now install the four 0.1W 5W resistors. These have their leads bent down through 90° some 5mm from their bodies and should be mounted about 1.5mm above the surface of the PC board, to allow the air to circulate beneath them for cooling.

The easiest way to do this is to use a strip of cardboard about 20mm wide and 1.5mm thick as a spacer. You simply push the resistor all the way down onto the cardboard, solder the leads, then pull the cardboard back out.

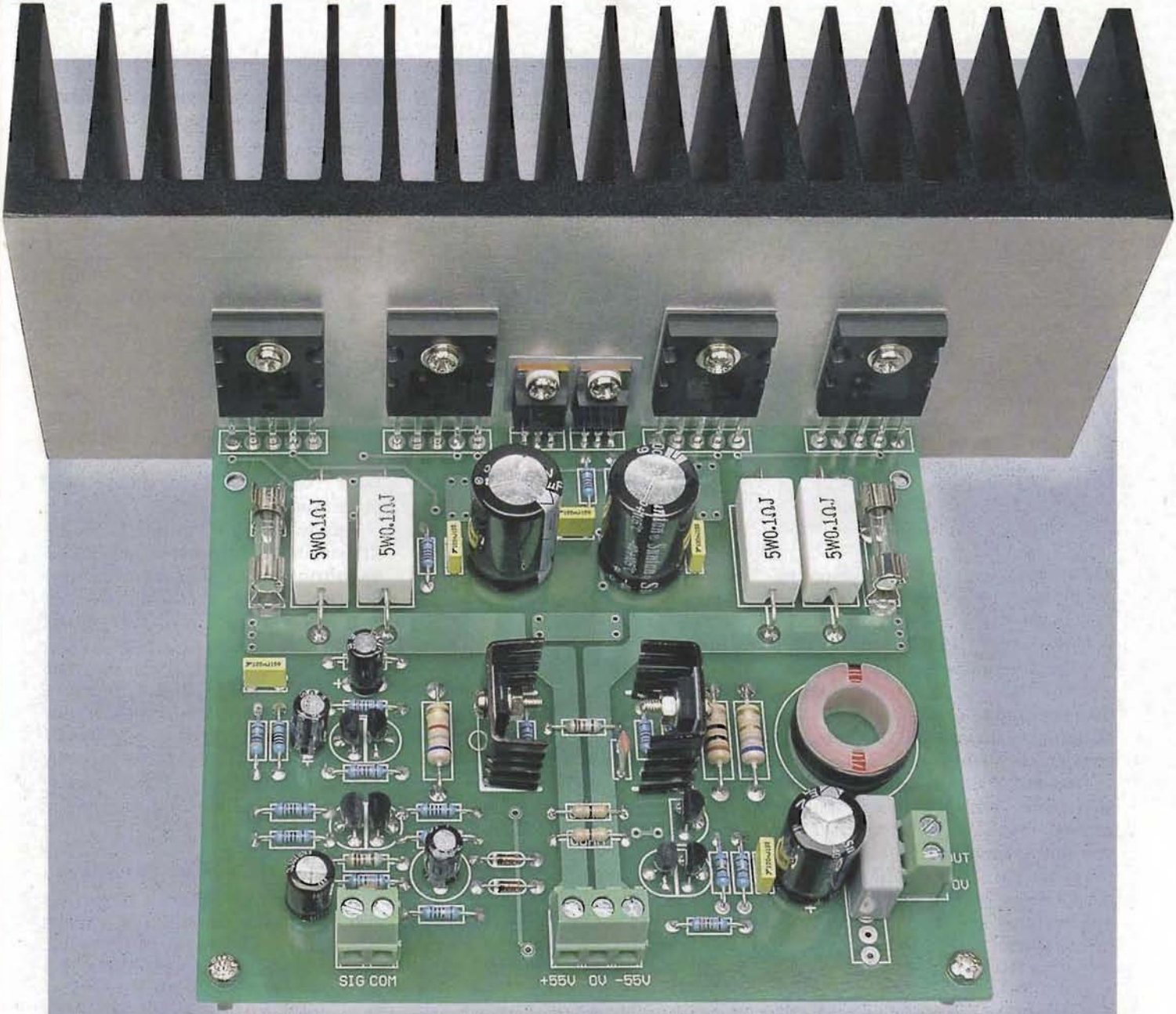
Mount the 5W resistors with their values all facing up and reading in the same direction. Again, this makes it easier to check them later on.

The fuse clips are next on the list. Note the each fuse clip has a little lug on one end which stops the fuse from moving lengthways. If you install the clips the wrong way around, those lugs will stop you from fitting the fuses.

It's a good idea to use sticky tape to



The leads of the TO-92 transistors should be cranked to fit their mounting holes in PC board using a pair of needle-nose pliers. Here's how it's done.



This prototype module differs slightly from the version shown in Fig.9. Take care to ensure that all transistors go in their correct locations and are correctly orientated. It's a good idea to slightly splay the bottom fins of the heatsinks fitted to Q7 & Q9, to increase the clearance to the solder pads of the adjacent 6.2kΩ & 2.2kΩ resistors.

hold the fuse clips in place while you solder their leads. This same trick is also useful when it comes to mounting some of the other parts, such as the screw terminal blocks.

Small signal transistors

The small-signal (TO-92-package) transistors (2SA970s, BC546s, BC556s & BC639) can now go in. As supplied, these transistors usually have their leads in a straight line, although the centre lead may sometimes be cranked out. These leads should be splayed outwards and cranked to fit nicely into their allocated holes.

The way to do this is as follows: first, grip the three leads adjacent to the transistor body using a pair of needle-nose pliers and bend the centre lead back and up by about 70° (if it hasn't already been cranked). That done, grip each of the two outer leads in turn and bend it outwards and up by about 70°. Finally, grip each lead in turn at the end of the pliers and bend it downwards again – see photos.

Install each transistor on the PC board after dressing its leads. If the leads are dressed correctly, the transistors will each sit about 4mm proud of the PC board. Note that transistor pairs Q1 & Q2, Q3 & Q4 and Q5 & Q6 are installed with their flat sides facing each other.

Make sure that you don't install these transistors in the wrong positions. Inadvertently swapping 2SA970s for BC556s will cause problems (even though they are both PNP types) because their pin-outs are different. Similarly, swapping BC546 NPN transistors for BC556 or 2SA970 PNP types could cause serious damage when the amplifier is powered up. You have been warned!

The TO-126-package transistors, Q7 & Q9, are fitted to U-shaped flag

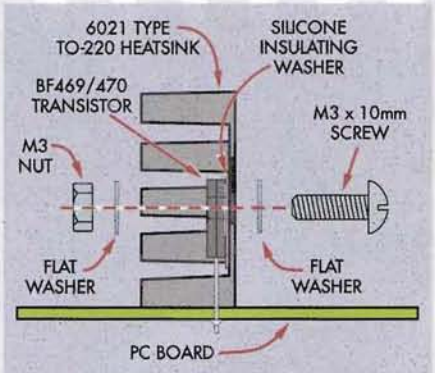


Fig.10: follow this diagram to attach the BF469 and BF470 transistors to their respective heatsinks. The silicone insulating washer is optional but it's not a bad idea to isolate the heatsinks from the transistor collectors to prevent accidents when testing.

heatsinks before they are soldered to the PC board. The best approach is to first loosely attach one transistor to the inside face of its heatsink using an M3 x 10mm screw, nut and two flat washers – see Fig.10. The assembly is then be fitted in position and pushed all the way down until the heatsink contacts the PC board.

That done, the transistor's leads are soldered and the heatsink mounting screw tightened. As with the fuse clips, you can use some sticky tape to hold the assembly in place while the leads are soldered. It's best to lightly solder one lead first and then make any adjustments that may be necessary before soldering the other two leads.

Repeat this procedure for the other transistor. Be sure to use a BF470 (PNP) transistor for Q7 and a BF469 (NPN) for Q9. Don't get them mixed up, otherwise the smoke will get out when you apply power!

It's important to centre these heatsink so that their fins cannot contact the solder pads of the adjacent 6.2kΩ and 2.2kΩ resistors (splay the bottom fins of each heatsink slightly if necessary). If you're fussy, you can fit TO-126 silicone insulating washers to isolate the collectors of the transistors from the heatsinks (we did this to avoid accidents with test probes while testing the prototype). However, provided you centre the heatsinks correctly, it's not really necessary.

Winding the choke

The next step is to wind the 6.8µH inductor. This is done by close-winding about 1.5m of 1mm-diameter enamelled copper wire onto a plastic bobbin (Altronics L-5305 or Jaycar LF-1062). This bobbin can have an inside diameter of either 10mm or 11.8mm (OD = 20mm or 21mm).

It order to do a neat job, it's necessary to make a small winding jig to hold the bobbin. This jig not only prevents the bobbin from being damaged but also makes the job much easier. The accompanying panel ("Making A Winding Jig For The 6.8µH Inductor") shows how the winding jig is made.

Once you have the jig, begin the winding by feeding about 40mm of the wire through one of the bobbin slots and the exit hole in the jig (loosen the handle if necessary to do this). Bend this end back through 180° to secure it, then tighten the handle and wind on 25.5 turns as evenly and tightly as possible. Finish by bending the remaining wire length through 90° so that it exits down through the opposite slot.

The windings are now secured using a couple of layers of insulation tape and the bobbin removed from the jig. That done, cut off the excess leads at each end, leaving about 10mm protruding.

Finally, complete the inductor by fitting some 20mm-diameter (9mm wide) heatshrink tubing over the windings. Be careful when shrinking it down with a hot-air gun though – too much heat will damage the bobbin.

You can now test fit the finished inductor on the PC board, bending its leads as necessary to get the bobbin to sit down flush on the board. It's then just a matter of stripping the enamel from the wire ends and tinning them before soldering the inductor in place.

Heatsink transistor mounting

As shown in the photos, the driver and output transistors (Q10-Q15) are all mounted on a large finned heatsink measuring 200 x 75 x 48mm (L X H x D); eg, Jaycar HH-8546.

You've got two choices when it

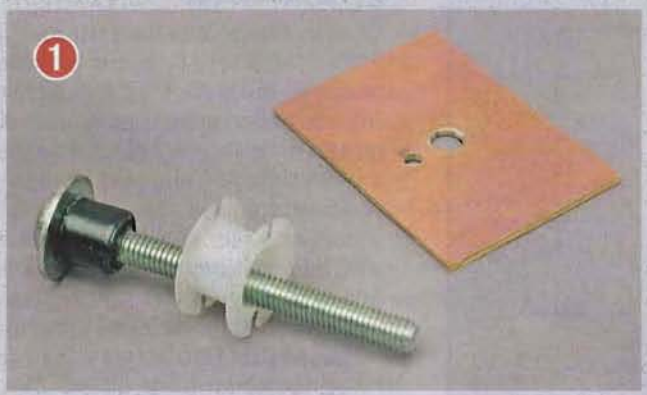
Table 2: Capacitor Codes

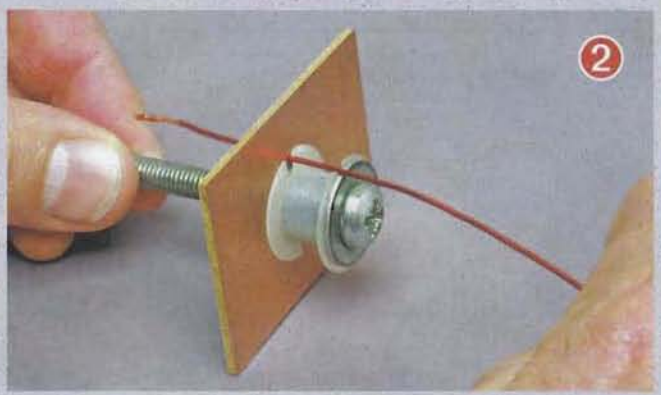
Value	µF Code	IEC Code	EIA Code
150nF	0.15µF	150n	154
100nF	0.1µF	100n	104
820pF	.001µF	820p	821
100pF	NA	100p	101

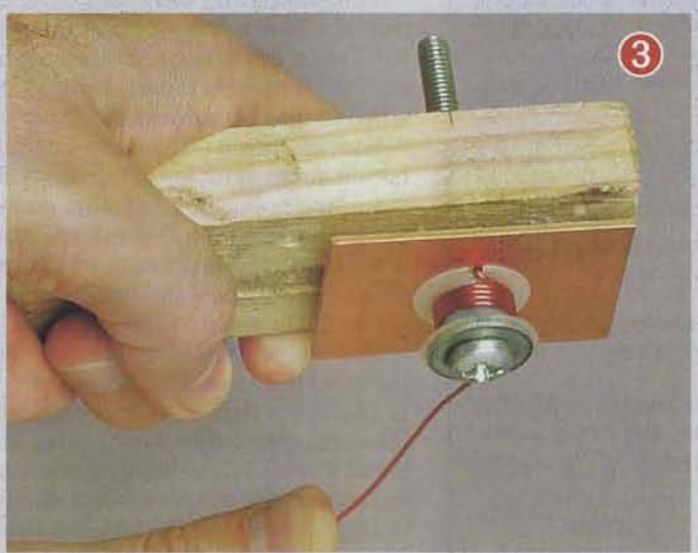
Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	1	22kΩ	red red orange brown	red red black red brown
❑	2	12kΩ	brown red orange brown	brown red black red brown
❑	1	6.8kΩ 1W 5%	blue grey red gold	not applicable
❑	2	6.2kΩ	blue red red brown	blue red black brown brown
❑	3	2.2kΩ	red red red brown	red red black brown brown
❑	1	510Ω	green brown brown brown	green brown black black brown
❑	1	390Ω	orange white brown brown	orange white black black brown
❑	8	100Ω	brown black brown brown	brown black black black brown
❑	2	68Ω	blue grey black brown	blue grey black gold brown
❑	1	47Ω	yellow violet black brown	yellow violet black gold brown
❑	1	6.8Ω 1W 5%	blue grey gold gold	not applicable
❑	1	10Ω	brown black black brown	brown black black gold brown
❑	1	10Ω 1W 5%	brown black black gold	not applicable
❑	4	0.1Ω	not applicable	not applicable
❑	2	0Ω	black	black

Making A Winding Jig For The 6.8µH Inductor









These photos show how the winding jig is used to make the 6.8µH inductor. First, the bobbin is slipped over the collar on the bolt (1), then an end cheek is attached and the wire threaded through the exit slot (2). The handle is then attached and the coil tightly wound onto the bobbin using 25.5 turns of 1mm-diameter enamelled copper wire (3). The finished coil (4) is secured using a couple of layers of insulation tape and a band of heatshrink tubing.

The winding jig consists of an M5 x 70mm bolt, two M5 nuts, an M5 flat washer, a piece of scrap PC board material (40 x 50mm approx.) and a scrap piece of timber (140 x 45 x 20mm approx.) for the handle.

In use, the flat washer goes against the head of the bolt, after which a collar is fitted over the bolt to take the bobbin. This collar should have width that's slightly less than the width (height) of the bobbin and can be wound on using insulation tape.

Wind on sufficient tape so that the bobbin fits snugly over this collar without being too tight.

Next, drill a 5mm hole through the centre of the scrap PC board material, followed by a 1.5mm exit hole about 8mm away that will align with one of the slots in the bobbin. The bobbin can be slipped over the collar, after which the scrap PC board "end cheek" is slipped over the bolt (ie, the bobbin is sandwiched into position between the washer and the scrap PC board).

Align the bobbin so that one of its slots lines up with the exit hole in the end cheek, then install the first nut and secure it tightly. The handle can then be fitted by drilling a 5mm hole through one end, then slipping it over the bolt and installing the second nut.

comes to mounting these transistors: (1) drill 3mm holes right through the back of the heatsink and attach the transistors using M3 screws, nuts and washers; or (2) drill and tap mounting holes and attach the transistors using M3 screws and washers.

Drilling the holes right through the heatsink is the easiest option but note that you will have to offset the module horizontally by 10mm towards one end so that the holes go between the heatsink fins. Alternatively, if you elect to tap the heatsink, the module can be centred horizontally. This method also makes it easier to install the mounting screws.

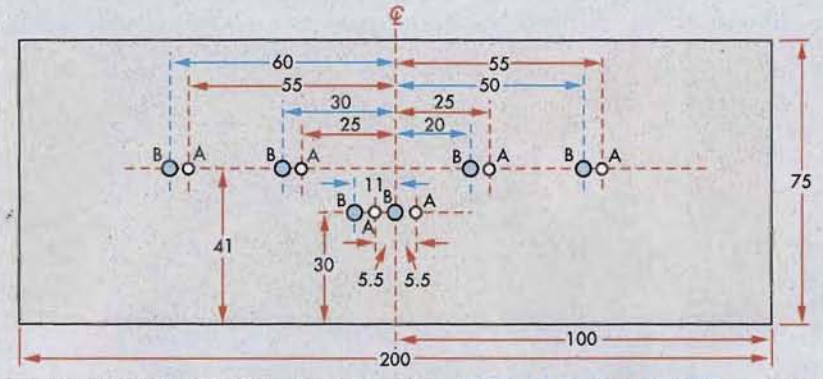
The heatsink drilling details are shown in Fig.11. You should also refer to the accompanying panel for information on drilling and tapping aluminium, since there are some special techniques to be followed if the job is to be a success.

We'll assume here that you've tapped the heatsink, ie, by drilling and tapping the white holes marked "A" on Fig.11.

Begin the heatsink assembly by attaching the two driver transistors, Q10 & Q11. Fig.12 (A) shows the mounting details for these devices.

Note that they must each be electrically insulated from the heatsink using a TO-220 silicone insulating washer and insulating bush. However, because

Drilling & Tapping The Aluminium Heatsink



HOLES A: DRILL 2.5mm DIAMETER, TAP FOR M3 SCREW HOLES B: DRILL 3.5mm DIAMETER (SCALE 1/2)

Fig.11: this half-size diagram shows the drilling details for the heatsink. For tapped holes, mark out and drill the white holes marked "A" to a depth of 7mm (2.5mm drill, M3 tap). Alternatively, if you intend drilling right through the heatsink, drill the blue holes marked "B" (3.5mm drill).

FIG.11 ABOVE SHOWS the heatsink drilling details. The white holes are drilled if you intend tapping the holes, while the blue holes are drilled if you want to drill right through the heatsink (ie, between the fins).

If you intend drilling right through the heatsink, simply mark out the blue hole locations using a sharp pencil, then accurately drill the holes **using a drill press.** Use a pilot drill to begin with – the holes have to go between the fins so it's vital to accurately position them.

Be sure to use a suitable lubricant when drilling the holes. Kerosene is the recommended lubricant for aluminium but we found that light machine oil (eg, Singer) also works well for jobs like this.

Don't try drilling the holes in one go. **When drilling aluminium, it's important to regularly remove the bit from the hole and clear away the metal swarf.** If you don't do this, the aluminium has a habit of migrating onto the drill bit and ruining it.

Don't even think of using a hand-drill for this job by the way. There's no way you'll get the holes perfectly perpendicular to the mounting face.

Once the holes have been drilled, deburr them using an oversize drill to remove any metal swarf from the mounting surface. This is vital to prevent punch-through of the insulating washers.

Finally, the heatsink should be thoroughly scrubbed cleaned using water and detergent and allowed to dry.

Drilling & tapping

Alternatively, if you want to centre the module horizontally on the heatsink, you will have to drill and tap holes to accept M3 screws in the locations shown (ie, the white holes). This method is more time-consuming than drilling right through but it does make it easier to mount the transistors when it's done.

To do the job, you will need a 2.5mm drill, an M3 intermediate (or starting) tap and an M3 finishing tap. If you are unable to obtain a finishing tap, you can make one by grinding most of the tapered end off an intermediate tap.

The first step is to mark out and drill the mounting holes to a depth of exactly 7mm using a 2.5mm drill. **As before, be sure to regularly clear the hole and the drill bit of any metal swarf and keep the drill bit well-lubricated.**

Once the holes have been drilled, tap each one in turn, starting with the M3 intermediate tap and then finishing with the M3 finishing tap. The trick here is to take it nice and slowly. **Keep the lubricant up and regularly wind the tap out to clear the metal swarf from the hole.**

You will know when you're coming to the end of the hole by the increased resistance to turning the tap handle. Do not at any stage apply undue force to the tap. It's easy to break a tap in half and if the break occurs at or below the heatsink's face, you can scratch both the tap and the heatsink (and about $25).

As before deburr the holes using an oversize drill and scrub the heatsink clean using water and detergent. Make sure that the mounting surface is perfectly smooth before moving installing the heatsink transistors.

Q10 & Q11 are quite close together, it's necessary to trim about 1mm off the adjacent sides of each insulating washer so that they don't overlap.

Use an MJE15030 for Q10 and an MJE15031 for Q11 – don't get them mixed up. Both devices are secured using an M3 x 6mm screw and flat washer. Do the screws all the way up but don't tighten them yet.

Next, fit a 10mm spacer to each of the four corner mounting positions on the PC board. When they're on, sit the board assembly on a flat surface and then lower the heatsink assembly into position so that Q10 & Q11's leads go through their mounting holes.

The four output devices (Q12-Q15) can now be fitted. As shown in Fig.12 (B), these devices must also be insulated from the heatsink by using silicone insulating washers.

Start by fitting Q12. The procedure here is to push its leads into their PC mounting holes, then lean the device back, feed through the mounting screw, hang the insulating washer off the end of the screw and finally loosely screw the assembly to the heatsink.

The remaining three devices are installed the same way, taking care to fit the correct transistor type at each location. Once they're in, push the board down so that all four spacers are in contact with the benchtop – this automatically adjusts the transistor lead lengths and ensures that the bottom of the board sits exactly 10mm above the bottom edge of the heatsink.

Now adjust the PC board assembly horizontally so that each side is 32.5mm in from its adjacent heatsink end, then do up the transistor mounting screws while keeping the insulating washers correctly aligned.

The next step is to lightly solder the outside leads of Q12 & Q15 to their pads on the top of the board. The assembly is then turned upside down and the remaining heatsink transistor leads soldered.

Before soldering the leads though, it's important to prop the front edge of the board up so that the board sits at right-angles to the heatsink. If you don't do this, it will sag under its own weight and will remain in this condition after the leads have been soldered.

Complete the soldering, then turn the board right way up again and tighten down the transistor mounting screws. They should be tight to ensure

good thermal coupling between the devices and the heatsink.

Checking device isolation

Now check that each device is indeed electrically isolated from the heatsink. That's done by switching your multimeter to a high ohms range and checking for shorts between the heatsink mounting surface and the collectors of the heatsink transistors (note: the collector of each device is connected to its metal face or tab).

In practice, it's simply a matter of checking between the fuse-clips closest to the heatsink and the heatsink itself. That's because the device collectors in each half of the output stage are connected together and run to their respective fuseholder.

In each case, you should get an open-circuit reading. If you do find a short, undo each transistor mounting screw in turn until the short disappears. It is then simply a matter of locating the case of the problem and remounting the offending transistor.

Be sure to replace the insulating washer if it has been damaged in any way (eg, punched through).

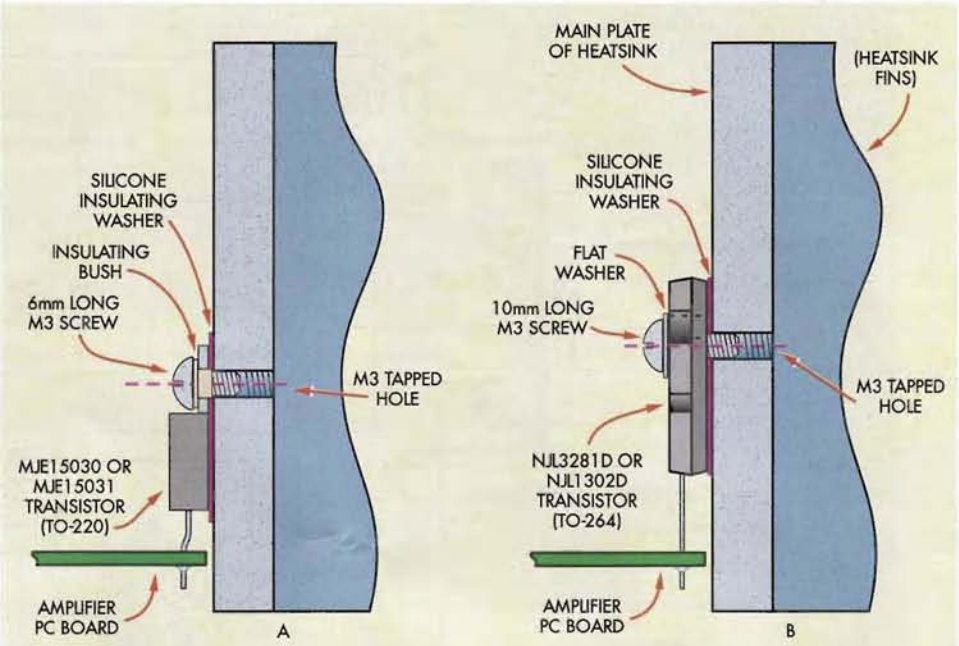


Fig.12: this diagram shows the mounting details for the TO-220 driver transistors (A) and the four output transistors (B). After mounting these transistors, use your multimeter to confirm that they are properly isolated from the heatsink – see text.

Completing the assembly

The assembly can now be completed by installing the two 1000µF 63V capacitors and the three screw terminal blocks (CON1-CON3). Take care when installing the latter – the access holes must face outwards.

You should also remove the two support spacers from the edge of the board adjacent to the heatsink. **In fact, it's quite important that the rear edge of the board be supported only by the heatsink transistor leads.** Basically, this avoids the risk of eventually cracking the PC tracks and pads around the heatsink transistors due to thermal expansion and contraction of their leads as they heat up and cool down.

In short, the rear spacers are installed only while you install the heatsink transistors and must then be removed. They play no part in securing the module. Instead, this edge of the module is secured by bolting the heatsink itself to the chassis.

This can be done by tapping M3 or M4 holes into the main plate on the underside of the heatsink or by using right-angle brackets. The front of the board can be secured using the two M3 x 10mm spacers fitted earlier.

That completes the assembly of the power amplifier module. However, before testing it, you need to build the power supply module.

Power supply

As noted last month, this new design dispenses with the regulated power supply used for the original Ultra-LD amplifier module. Instead, the Mk.2 module is powered using unregulated ±55V rails only.

Fig.13 shows the circuit details of the power supply. It's based on a centre-tapped (toroidal) mains transformer (T1) with two 40V windings and two 15V windings.

As shown, the two 40V windings are connected together to give 80VAC centre-tapped and this arrangement drives bridge rectifier BR1. This in turn feeds six 4700µF 63V electrolytic capacitors (ie, 14,100µF on each side) to provide balanced ±55V DC supply rails to power the amplifier.

In addition, two LEDs are connected in series with 3.3kΩ 5W current-limiting resistors across the ±55V supply rails. These serve two purposes: (1) they provide a handy indication that power is present on the supply rails; and (2) they (slowly) discharge the filter capacitors when the power is switched off (see warning panel).

The two 15V windings are also connected together (to provide 30VAC centre-tapped) and these drive bridge rectifier D1-D4 and two 2200µF filter capacitors to derive unregulated rails of about ±20V. These rails are then fed to 3-terminal regulators REG1 & REG2 to derive regulated ±15V supply rails to power a preamplifier module.

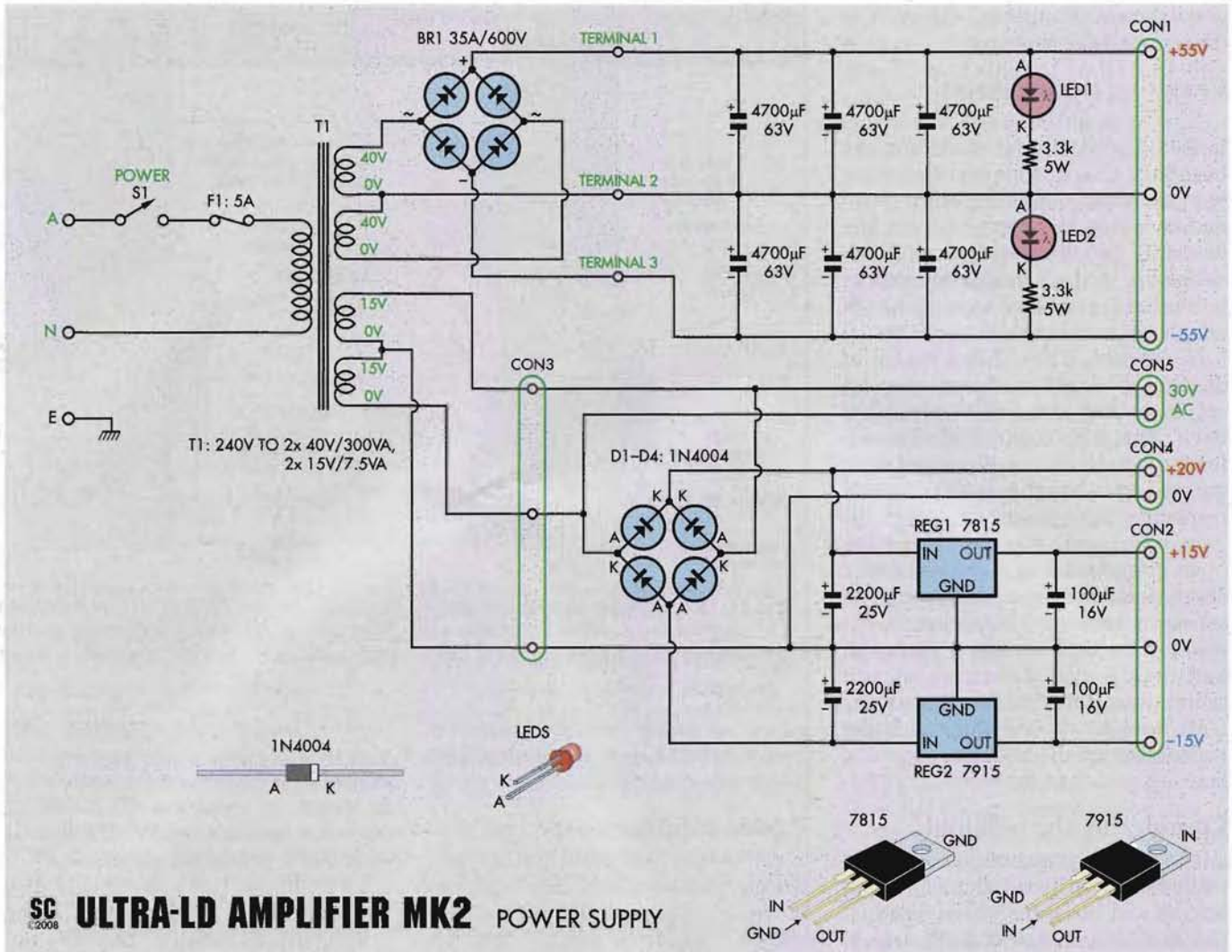
In addition, the +20V rail is also made available as an output, along with a 30VAC output. The +20V rail can be used to power the "Universal Speaker Protector & Muting Module" (SILICON CHIP, July 2007), while the 30VAC output is connected to the "AC Sense" input of this module (it's used to quickly disconnect the speaker when the power goes off, to avoid switch-off thumps).

By the way, if you're looking for a preamplifier to use with the Ultra-LD Mk.2 amplifier, the preamplifier module described in August 2007 SILICON CHIP (and used in the Class-A Stereo Amplifier) is ideal.

Note, however, that regulators REG1 & REG2 on that preamplifier board must be replaced by wire links if powering it from the power supply described here. These links are connected between what were the IN and OUT pads for each regulator on the preamplifier board.

Power supply assembly

Fig.15 shows the parts layout for the power supply board. This board is coded 01109081 and carries all the



SC ULTRA-LD AMPLIFIER MK2 POWER SUPPLY

Fig.13: the power supply is based on a toroidal transformer (T1) with two 40V windings and two 15V windings. The two 40V windings are connected in series and drive bridge rectifier BR1 and six 4700µF filter capacitors to produce the ±55V rails. Similarly, the 15V windings drive a bridge rectifier based on diodes D1-D4. This feeds 3-terminal regulators REG1 & REG2 to produce ±15V rails for a preamplifier. The +20V rail, derived from the output of D1-D4, is used to power the loudspeaker protector.

parts following the transformer except for 35A bridge rectifier BR1 which must be mounted on a metal chassis to ensure adequate heatsinking.

Begin by installing diodes D1-D4, the two LEDs and 3-terminal regulators REG1 & REG2. Make sure these parts are all oriented correctly and don't get REG1 & REG2 mixed up.

Both regulators are mounted with their metal tabs flat against the PC board. To install them, first bend their centre leads down through 90° about 5mm from their bodies, then bend their outer leads down through 90° about 7mm from the bodies. The regulators can then be fitted to the PC board and secured using M3 x 6mm screws, flat washers and nuts.

Tighten the screws firmly before soldering the device leads.

Note that there's enough room on the PC board to fit mini-heatsinks to the regulators. This will depend on the current drawn by the preamplifier you elect to use but should not be necessary in most cases.

The three Quick-Connect male spade terminals (TERMINAL1-TERMINAL3) are next on the list. These are used to terminate the connections from bridge rectifier BR1 and the centre-tap of the 40V transformer windings. They are each secured in place using an M4 x 10mm screw, nut, flat washer and star washer – see Fig.14.

The trick here is to use a Phillips-head screwdriver to hold the M4 screw stationary while you do up the nut with a ratchet-driven socket.

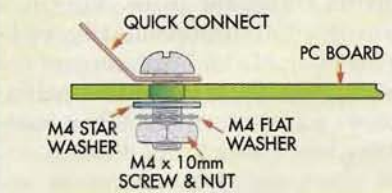
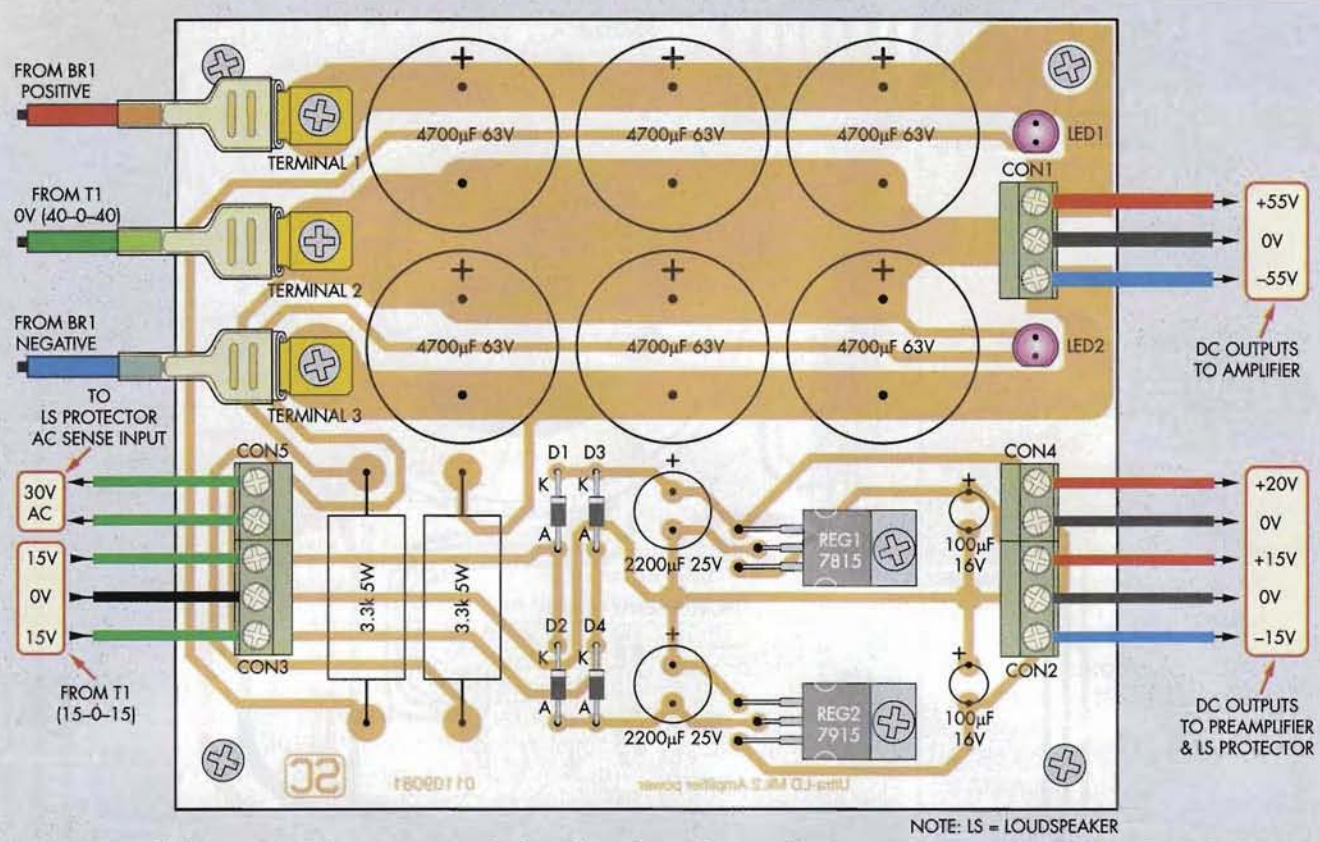


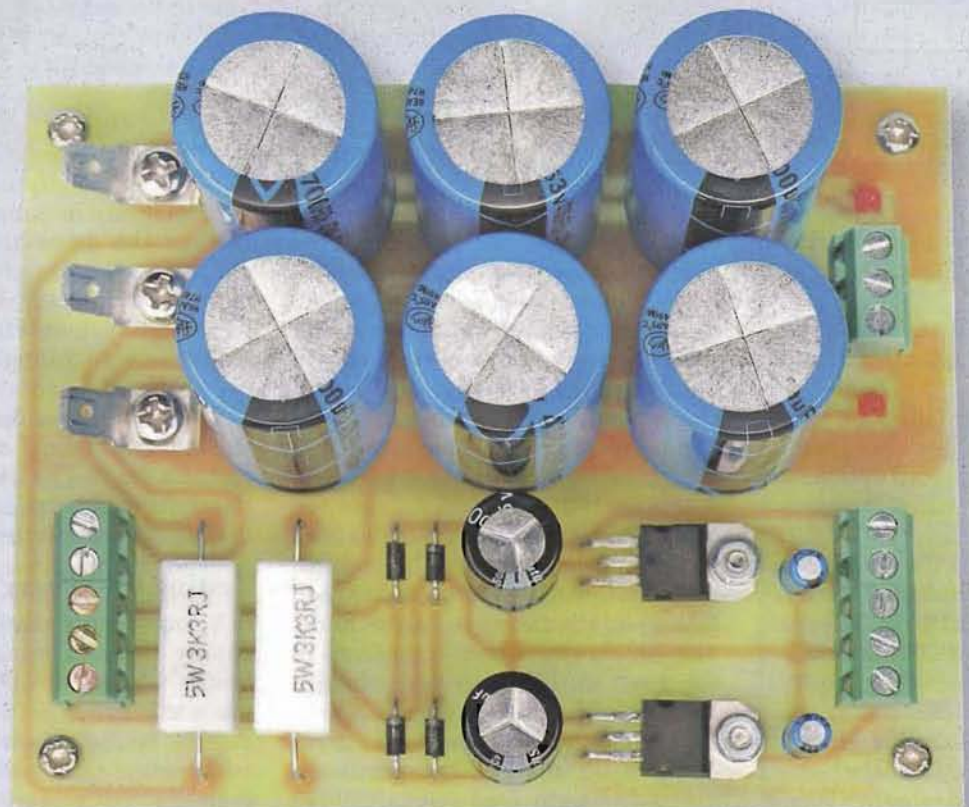
Fig.14: here's how the single-ended male Quick Connects are secured to the Power Supply module PC board.

Once all the Quick-Connect terminals have been tightly secured to the PC board, you can then install the remaining parts. These include the two 3.3kΩ 5W resistors, the electrolytic capacitors and the screw terminal blocks. Note that the two 5W resistors should be stood off the board by



NOTE: LS = LOUDSPEAKER

Fig.15: install the parts on the power supply board as shown here, taking care to ensure that all the electrolytic capacitors are mounted with the correct polarity. Be sure also to use the correct regulator at each location. The two LEDs indicate when power is applied and remain lit until the 4700µF capacitors discharge after switch-off.



We modified the power supply PC board after this prototype was produced, so that heatsinks could be fitted to the two 3-terminal regulators if necessary. This will depend on the current drawn by the preamplifier.

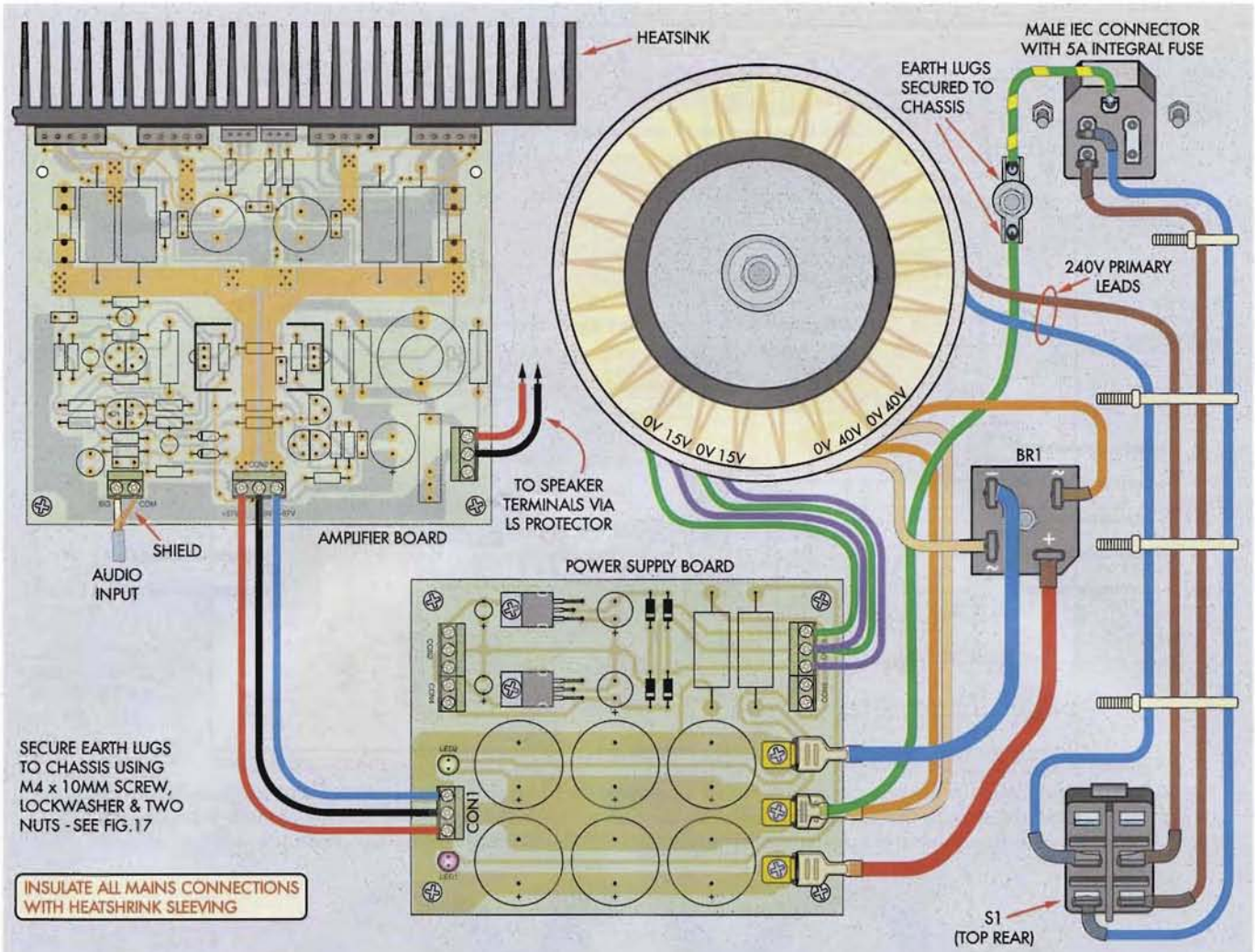


Fig.16: here's how to wire the completed power amplifier and power supply boards into a metal case. The mains wiring at right would be typical of most installations but ensure that all exposed terminals are fully insulated.

1-2mm, to allow the air to circulate beneath them for cooling (use a cardboard spacer).

Be sure to install the electrolytic capacitors with the correct orientation. These things have a nasty habit of exploding if they're installed the wrong way around so double-check them.

Be sure also to dovetail connectors CON3 & CON5 together (to form a 5-way connector) before installing them on the PC board. If you solder one connector to the board first, you may not be able to dovetail them. The same goes for connectors CON4 & CON2.

Putting it in a case

The completed amplifier module and its power supply should be housed in an earthed metal case but we'll leave the details of this up to you. **However, don't get involved in mains wiring unless you are experienced and know exactly what you are doing.**

Fig.16 shows the suggested wiring layout (but without a speaker protector or preamplifier). **Make sure that the chassis is securely earthed via the mains and be sure to insulate all exposed mains terminals.**

Note that you will have to use a piggyback female spade connector (eg, Altronics H-2016A) to terminate the commoned 40V & 0V connections from the toroidal transformer. This connector plugs into the 0V terminal (TERMINAL 2) on the power supply module. The female spade connector fitted to the green earth lead is then plugged into the back of this connector.

The other end of this earth lead is crimped to an earth lug. Similarly, the mains earth lead (green/yellow) is crimped to a second earth lug and the two earth lugs are securely bolted to the chassis.

Once the assembly is complete, check your wiring very carefully. In particular, make sure that BR1's positive and negative terminals connect to the correct terminals on the power supply board.

You should also use a multimeter to confirm that the chassis is correctly earthed. Do that by checking for continuity between the earth terminal of the IEC socket and the chassis.

Testing the power supply

It's now time to check that the power supply is functioning correctly but first a warning: **avoid contact with the ±55V rails, both on the power supply module and on the amplifier module. There's 110V between them and getting across the two rails simultaneously could have serious consequences.**

The same goes for the transformer



The 68Ω 5W test resistors are soldered to the fuse-clip pads on the underside of the PC board.

secondary windings – make sure that you don't get across either of the two 40VAC windings or the 80VAC that's applied to bridge rectifier BR1.

You must also allow the 4700µF filter capacitors on the power supply module to discharge down to a couple of volts before attempting to work on this module. Don't just rely on the LED indicators – use your multimeter to confirm that the supply rails have indeed dropped to a low value before touching it.

Similarly, make sure these capacitors have discharged before connecting the power supply to the amplifier module, or before disconnecting it (otherwise you could damage the amplifier).

To check the power supply, first make sure that the supply wiring is disconnected from the amplifier. That done, apply power to the power supply board on and check the various DC outputs. You should be able to measure close to ±55V on CON1, +20V on CON4, ±15V on CON2 and 30VAC on CON5.

If you don't get the correct voltages, switch off immediately and check for wiring and component errors.

Testing the power amplifier

Assuming you do get the correct voltages, switch the power supply off and follow this step-by-step procedure to check the power amplifier module:

STEP 1: remove the fuses from the amplifier module and install two 68Ω 5W resistors in their place (not 470Ω 5W as suggested in the parts list last month). The best way to do this is to tack solder the resistors across the fuseholder pads on the underside of the PC board. They should be mounted about 5mm away from the edge of the board, to prevent heat damage during testing – see photo.

The 68Ω resistors are there to limit the current through the output stage to about 800mA if there is a fault in the amplifier that turns the output transistors hard on. This protects the output transistors from damage but note that the 68Ω resistors will quickly burn out under such circumstances (since they will be dissipating over 40W).

STEP 2: use your multimeter to again check that the heatsink transistors are all isolated from the heatsink. If one of these is shorted, its corresponding 68Ω 5W resistor will again quickly burn out if power is applied.

STEP 3: check that the power supply is off and that the filter capacitors are discharged, then connect the +55V, 0V and -55V supply leads to the amplifier at CON2. Make sure these are connected correctly, otherwise the amplifier will be damaged when power is applied.

STEP 4: apply power and check the supply voltages at the fuseholders (ie, at the ends furthest away from the heatsink). You should get +55V at FUSE1 (with respect to the 0V rail) and -55V at CON2.

STEP 5: check the voltage across each 68Ω 5W resistor. This should be in the range from 9-14V (depending on the supply rails and the exact value of the 68Ω test resistors).

Switch off immediately and go to the troubleshooting procedure if you get a

Power Supply Parts List

PC Board Module

1 PC board, code 01109081, 126 x 96mm
3 3-way PC-mount terminal blocks, 5mm pitch (Altronics P2035A or equivalent) (CON1-CON3)
2 2-way PC-mount terminal blocks, 5mm pitch (Altronics P2034A or equivalent) (CON4-CON5)
3 chassis-mount single-ended Quick Connect (spade) terminals (TERM1-TERM3) (Jaycar PT-4910 or equivalent)
3 M4 x 10 screws
3 M4 a 10mm nuts
3 M4 flat washers
3 M4 shakeproof washers
4 M3 x 9mm tapped Nylon spacers
6 M3 x 6mm screws
6 M3 nuts
2 M3 shakeproof washers

Semiconductors

4 1N4004 diodes (D1-D4)
1 7815 15V regulator (REG1)
1 7915 -15V regulator (REG2)
2 3mm red LEDs (LED1,LED2)

Capacitors

6 4700µF 63V electrolytic
2 2200µF 25V electrolytic
2 100µF 16V electrolytic

Resistors

2 3.3kΩ 5W

Additional Parts

1 300VA transformer with 2 x 40VAC 300VA windings and 2 x 15VAC 7.5VA windings
1 35A 400V bridge rectifier (BR1)
1 chassis-mount IEC male socket with fuseholder (eg, Jaycar PP-4004, Altronics P-8324)
1 DPST mains switch (S1)
1 M205 5A fuse

Miscellaneous

Earth crimp lugs, female Quick Connectors, 240VAC cable, machine screws & nuts, etc.

Silicon Chip Binders



These binders will protect your copies of SILICON CHIP. They feature heavy-board covers & are made from a distinctive 2-tone green vinyl. They hold 12 issues & will look great on your bookshelf.

★ 80mm internal width

★ SILICON CHIP logo printed in gold-coloured lettering on spine & cover

★ Buy five and get them postage free!

Price: $A13.95 plus $A7 p&p per order. Available only in Aust.

Silicon Chip Publications
PO Box 139
Collaroy Beach 2097

Or call (02) 9939 3295; or fax (02) 9939 2648 & quote your credit card number.

Use this handy form

Enclosed is my cheque/money order for

$_____ or please debit my

❑ Visa ❑ Mastercard

Card No:

_____

Card Expiry Date ____/____

Signature _____

Name _____

Address _____

_____ P/code_____

Modifications & Corrections

A couple of minor modifications have been made to the circuit of the Ultra-LD Mk.2 Amplifier following the publication of Pt.1 last month. In addition, there a couple of corrections:

(1) The 470µF 63V capacitor on the -55V rail is shown with reversed polarity on the circuit diagram (Fig.1) – ie, its negative lead should go to the -55V rail. As well, the voltages marked across the 0.1Ω resistors are out by a factor of 10. They should be 7-10mV, not 70-100mV.

(2) The 68Ω resistor in series between the +55V rail and Q7's collector has been reduced to 47Ω – see Fig.17.

(3) A 22kΩ resistor has been added in series between Q8's collector and ground – see Fig.18 (note: this change has been incorporated onto the PC board patterns sent to the parts retailers).

(4) The following changes should be made to the parts list: add 1 x 22kΩ 0.25W resistor, add 1 x 47Ω 0.25W resistor, add 1 x 10Ω 0.25W resistor, delete 1 x 68Ω 0.25W resistor and change the two 470Ω 5W test resistors to 68Ω 5W. There should also be 5 x 100nF 63V MKT polyester capacitors (not four).

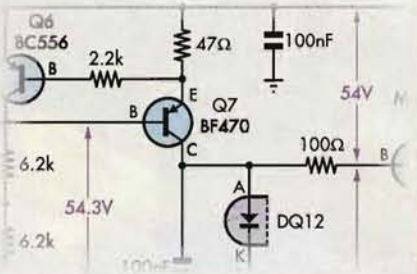


Fig.17: Q7's 68Ω emitter resistor has been reduced to 47Ω to increase the bias current through the integral diodes (DQ12-DQ15) in the output transistor packages.

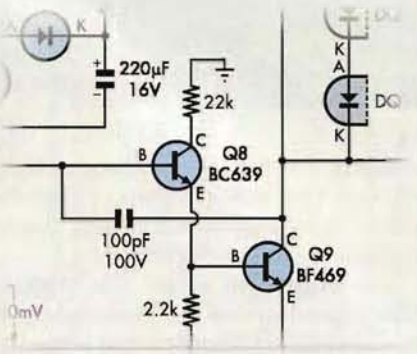


Fig.18: a 22kΩ 0.25W resistor has been added into Q8's collector circuit to protect this transistor (and Q9) against over-drive conditions.

value that's much higher than 14V.

STEP 6: check the voltage at the loudspeaker terminals. You should get a reading of ±30mV or less.

STEP 7: check the voltage across each of the 0.1Ω 5W emitter resistors in the output stage. **This voltage should be somewhere between 7-10mV** (not the 70-100mV marked on Fig.1 last month). This equates to a current of 70-100mA through each output transistor which means that the total output stage quiescent current is in the range of 140-200mA.

Be careful not to short a resistor lead to the adjacent +55V and -55V tracks on the top of the board when making these voltage checks.

If the voltage across the 0.1Ω 5W emitter resistors exceeds 10mV, increase the 47Ω resistor between the supply rail and Q7's emitter to 56Ω, or even to 68Ω if necessary to bring the voltage back into the 7-10mV range. This resistor is located on the far lefthand side of the PC board, immediately below a 100nF capacitor.

STEP 8: check the voltages marked on the circuit diagram (Fig.1) last month. These should all be close to the indicated values except that the voltages across the 0.1Ω resistors should be 7-10mV, not 70-100mV .

STEP 9: if everything is correct, switch off and allow the power supply filter capacitors to discharge to a low level (around 2V or less). When they reach this level, disconnect the power supply, remove the 68Ω 5W resistors from the amplifier module and install the 5A fuses.

STEP 10: connect an audio signal source and a loudspeaker (preferably via a loudspeaker protector module), then re-apply power and test the amplifier module with music.

Troubleshooting

If the voltage across the 68Ω test resistors is much greater than 14V (eg, close to the supply rail), switch off immediately (note: the resistors may burn out before you do this).

The first thing to check is that the

Bullet-Proofing The Ultra-LD Mk.2

WE HAVE HAD VERY few problems in developing this new amplifier module but inevitably in making comparisons between different prototype modules, adversity eventually "reared its head" and we blew up a module. Quite spectacular it was too, with two 1W resistors briefly catching fire. So what had we done?

The good news was that the fuses had not blown so it was probable that the output transistors were not damaged. We then disconnected the module and carefully examined it. Even though the two 1W resistors were severely charred, there was no other obvious damage.

The two resistors in question were the 10Ω 1W resistor in the -55V supply rail and the 6.8Ω 1W resistor in the output RLC network. OK – the 10Ω resistor now measured about 50Ω while the 6.8Ω resistor could not be measured without taking it out of circuit because it is in parallel with the 6.8µH inductor. So really, if the charred resistors were the only damage, then the amplifier should still work, shouldn't it?

Fixing it

Accordingly, we removed the fuses, connected the 68Ω test resistors in their place and re-applied power. This time, there were no fireworks or smoke but the output of the amplifier was now measuring over -50V instead of under 30mV.

So there was more damage. And since the output was fully pegged to the negative supply rail, the most likely victim would have to be Q9, the BF469 voltage amplifier transistor. It is also in close proximity to the aforesaid 10Ω resistor which would have died if the transistor failed.

A quick test of the transistor's base-emitter and collector-base junctions with a multimeter confirmed that it had indeed died. And so had its driver transistor (Q8, BC639). All the other transistors on the board appeared to be OK.

To cut to the chase, we then replaced these two transistors and the two burnt-out resistors and the amplifier was fixed.

Why did it fail?

So how had we blown it up? In fact, we had been doing a test at 100W on the module and we had disconnected the input signal lead while the power was still applied. Why would that blow it? Well, we had fitted an in-line RCA socket so we could easily connect and disconnect the input signal. But in removing the RCA plug (which was tight and fairly difficult to pull out), the amplifier was briefly left without an input earth while the active was still connected. The result was a severe over-drive condition for the amplifier. That was why the 6.8Ω resistor cooked.

Second, Q8 was shorted and pulled Q9's base to 0V. That in turn caused Q9 to short and place a severe overload on the decoupled -55V rail, which caused the 10Ω 1W resistor to cook.

Subsequently, we tested the module in overdrive conditions and repeatedly blew the BC639 transistor (Q8) after 10 seconds or so. Now while we strongly recommend that you do not over-drive the amplifier because of the serious risk of damage to your speakers, we had to come up with a modification to remove the risk to the BC639.

Fortunately, this was relatively simple and involved adding a 22kΩ collector current-limiting resistor to Q9 (ie, this resistor is connected between Q9's collector and ground). This limits Q9's dissipation under strong overdrive conditions but has no effect on the performance in normal operation.

This extra resistor required a small change to the PC board. Kit retailers will have the modified PC board.

Checking the quiescent current

Since publishing the first article and the performance test results last month, we have now had more experience with this amplifier circuit and with the variations in the NJL3281D/NJL1302D transistors. In particular, variations in the forward voltage drop of the integral diodes can be enough to cause the quiescent current to be less than the nominated setting of 7-10mV across the 0.1Ω emitter resistors.

Anything less than about 7mV leads to small degrees of crossover distortion. Although these very low crossover distortion levels would not be apparent to anyone who did not have a distortion analyser, we were unhappy with this result and decided to fix the problem.

Accordingly, we increased the current through the voltage amplifier stage involving transistors Q7 & Q9. This was done by reducing Q7's 68Ω emitter resistor to 47Ω, which significantly increases the current through the four integral diodes.

Using a 47Ω resistor should suit the vast majority of cases. If the resultant voltage across the 0.1Ω emitter resistors is more than 10mV across each one, the 47Ω resistor should be increased to 56Ω or if that is not sufficient, to 68Ω, as noted in the test procedure (ie, use a resistor that gives 7-10mV across the 0.1Ω emitter resistors). Do not reduce the resistor below 47Ω.

Removing parts from the board

If you need to remove components such as resistors or transistors from this double-sided board, the easiest way to do it is to first remove as much solder as you can from each pad using a solder sucker. Next, you clip away the body of the component using small side-cutters, then grab each lead with needle-nose pliers on the top of the board while you heat up its copper pad underneath. The lead can then be pulled out from the top.

You then use solder-wick (or desoldering braid) to remove the residual solder in the plated through holes but be careful not to overheat the PC pads, as they may detach themselves from the board. Often, it will be necessary to drill out the holes to clear the solder, so that you can install the new component's leads.

heatsink transistors are all correctly isolated from the heatsink. If this checks out, apply power to the amplifier without the fuses or test resistors in place – ie, so that the output stage (Q10-Q15) is left unpowered.

Now check the voltage between the bases of transistors Q10 & Q11. This should be close to 2.2V. If it's much higher than 2.2V, this indicates that the DQ12-DQ15 diode string is open circuit. This could be due to an open-circuit track on the PC board or more likely, a missed solder connection on one of the output transistor leads (ie, the "A" & "K" diode leads).

If the voltage across the diode string is correct, check the base-emitter voltage of each transistor in the amplifier. In each case, you should get a reading of 0.6-0.7V if the transistor is working correctly. Check also that the correct transistor type has been used at each location.

Finally, be sure to use this module with a loudspeaker protector, as a fault in the output stage can quickly burn out an expensive loudspeaker system (and maybe even start a fire due to a red-hot voice-coil). The recommended unit is the "Universal Speaker Protector & Muting Module" (see SILICON CHIP, July 2007). SC

DSP Musicolour: adding a remote control



With a small and low-cost add-on PC board, the DSP Musicolour can be operated via an infrared remote control – very handy if you want to use it in hard-to-reach places.

Part Four – by Mauro Grassi

Remote control adds so much more convenience! After completing the DSP Musicolour design (as published in the June, July and August issues) we looked at the possibility of adding infrared remote control.

It turned out to be really simple – so here we describe how to build a simple remote control receiver PC board to allow the DSP Musicolour to be operated via a remote control which uses RC5 codes – the vast majority – or a universal remote control. The DSP Musicolour firmware contains the decoding functions.

The schematic for the remote control receiver board is shown overleaf It contains little more than an infrared receiver module that amplifies and demodulates the remote control signal. The signal is then decoded by the firmware.

Apart from the IDC header which connects the Remote Control PC board back to the main board, there are only three other components: a 47µF capacitor to bypass the supply rail (taken from the DSP Musicolour's 5V rail) and a 100Ω resistor to limit the current and further isolate the infrared module from the supply rail.

Finally, there is a 330Ω resistor. As the RF6 pin of the microcontroller (IC1) can function as an output as well as input, this resistor is used on the output of the module to limit the current into the data output of the infrared receiver module.

MUSICOLOUR - THE MOVIE!

It's quite hard to put into words just how sensational the DSP Musicolour lightshow really is . . . so you'll be able to see it! Around the time this issue appears, we hope to have ready a short demonstration movie which can be accessed via the SILICON CHIP website.

Construction

This is a simple board that should take a matter of minutes to build. Simply refer to the component overlay and the accompanying photograph.

Begin by installing the resistors. There are only two of them so it's going

to be particularly difficult to mix them up. (Hint: the 100Ω has bands which start with brown and black while the 330Ω has two orange bands!) But if in doubt, check them with a DMM.

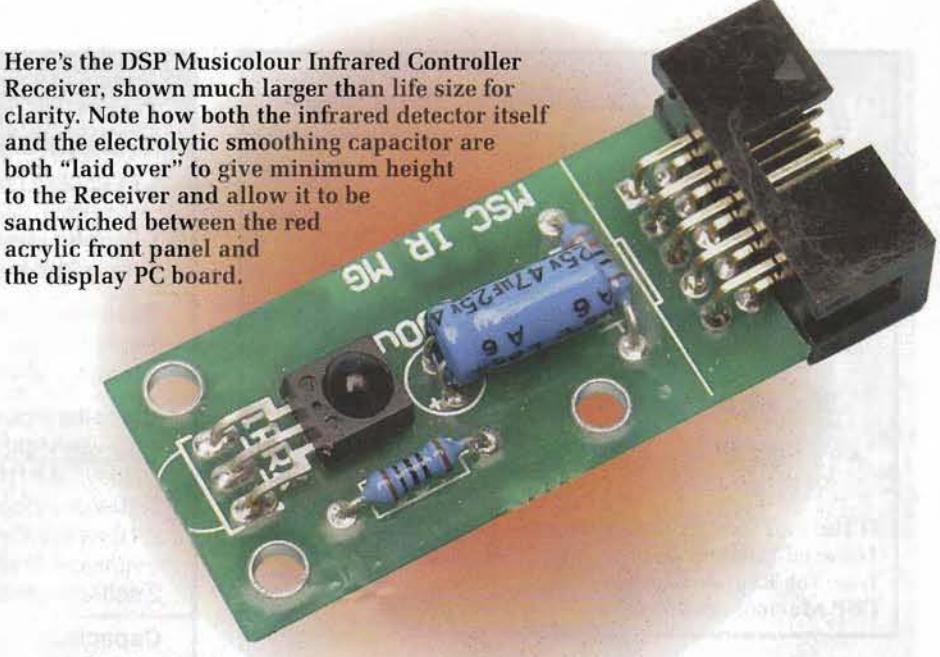
Next is the 47µF capacitor which, being polarised, must be oriented correctly as shown in the component overlay. To make the PC board as low in height as possible, it must be "laid over" 90° so that it lies along the board. Therefore you will need to bend both leads down 90° before soldering it in.

Then solder in the infrared receiver module, allowing around 7mm of lead. Similarly to the electrolytic, it mounts so that it lies flush with (ie, parallel with) the PC board surface, as shown in the enlarged photo at right. The last thing to solder in is the 10-way IDC header.

The remote control board connects to the main board via a 10-way ribbon cable, from CON1 on the remote control board to CON3 on the main board. We explained how to make a 26-way ribbon cable connecting the main board to the display board in the July 2008 issue (page 26 under Ribbon Cable Assembly).

The 10-way ribbon cable used to connect the remote control board is made in the same way.

The completed remote control PC board sits between the red acrylic front panel and the display board, as photographed below. It actually sits on top of some resistors between LED array 3 and two 74HC595 ICs.



Here's the DSP Musicolour Infrared Controller Receiver, shown much larger than life size for clarity. Note how both the infrared detector itself and the electrolytic smoothing capacitor are both "laid over" to give minimum height to the Receiver and allow it to be sandwiched between the red acrylic front panel and the display PC board.

It is secured in place with a self-adhesive foam pad or two (available at any newsagent or stationer). Being a couple of millimetres thick, these pads have the added advantage of providing insulation between the remote control board and the components on the display board underneath.

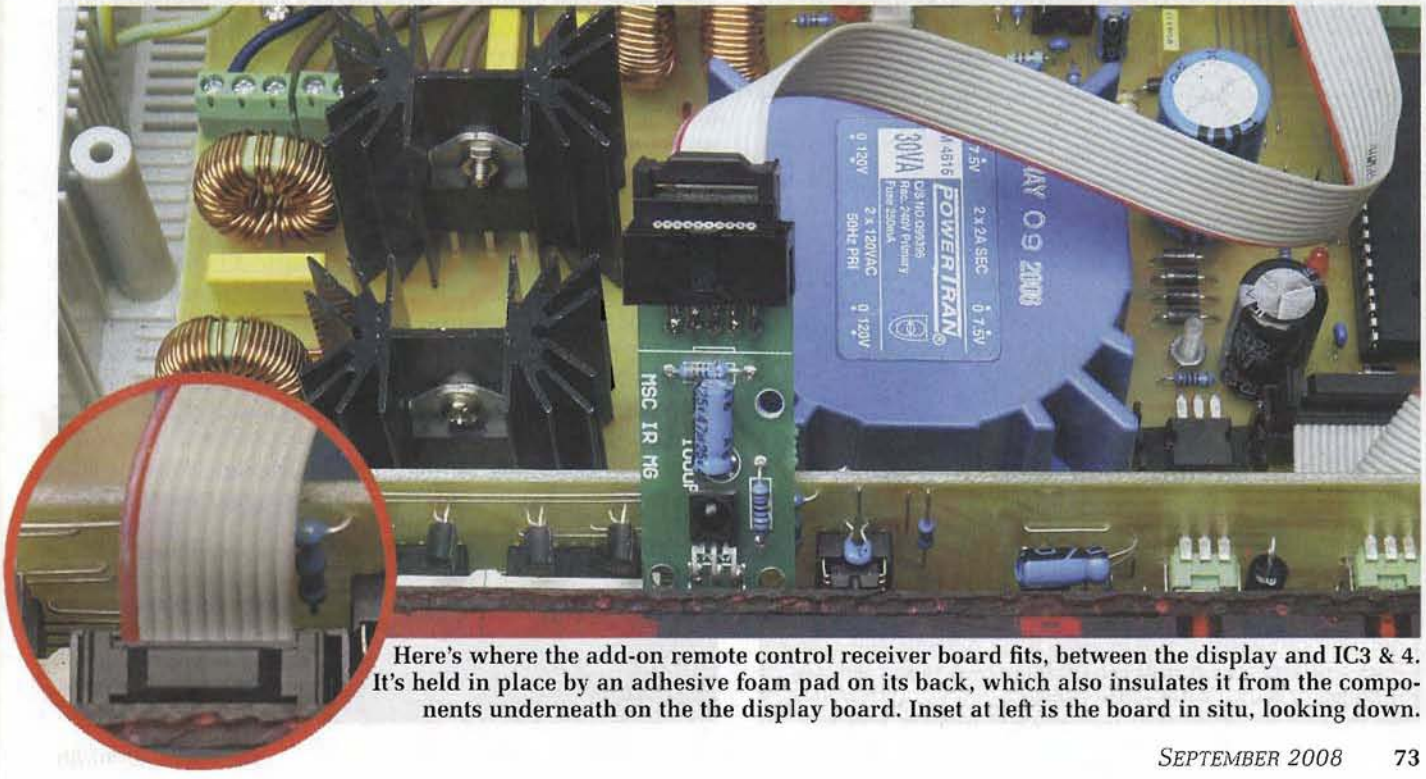
You will need to open the case to install it so you must first make absolutely certain that the IEC mains power lead is not plugged in.

The ribbon cable connecting to the remote control PC board also helps locate the board – when its IDC connector is plugged in, the top edges of both the controller PC board and the display board are in alignment, with just enough room for the IDC cable to go over the top of the display board and wedge between the display board and case top.

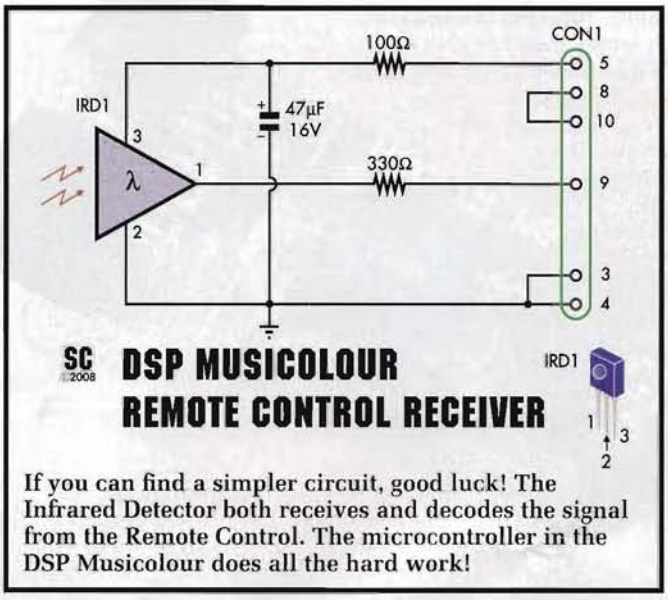
Once the board is connected, close the case and insert the screws which hold the two halves together, then (and only then) power up the DSP Musicolour. Don't be tempted to take a short cut and leave the screws out!

Defining the codes

There are only nine remote control codes used to control the DSP Musi-



Here's where the add-on remote control receiver board fits, between the display and IC3 & 4. It's held in place by an adhesive foam pad on its back, which also insulates it from the components underneath on the the display board. Inset at left is the board in situ, looking down.



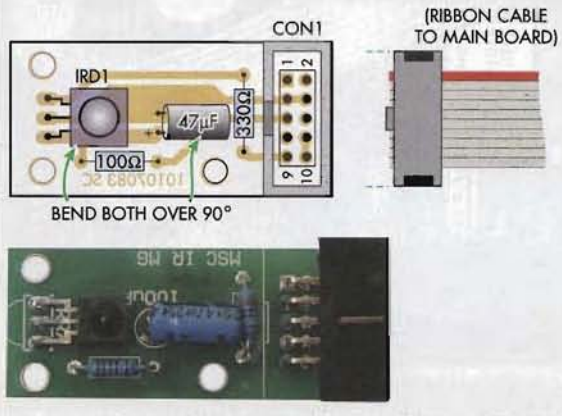
If you can find a simpler circuit, good luck! The Infrared Detector both receives and decodes the signal from the Remote Control. The microcontroller in the DSP Musicolour does all the hard work!

colour. These must be defined at least once, using the front panel buttons, before operating the DSP Musicolour with a remote control.

First, you must make sure that your remote control is an RC5-compliant remote control. RC5 is a protocol designed by Philips but not all remote controls in use today actually work with this protocol. Other protocols will not work with this decoder, so you should make sure that you have an RC5 remote control. If you are using a universal remote, there is a good chance of it working if you set it to a Philips appliance (eg, a TV set or VCR).

Go to SYSTEM>Remote Control and follow the prompts. You will be asked to define each of the nine keys in turn, keys 1 to 7 correspond to the buttons on the front panel in the following order: UP, SET, DOWN, CH1, CH2, CH3 and CH4.

The corresponding button LED will light and you should press the key on your remote control that you want to use to emulate that key on the front panel. Naturally, you would use the channel up and channel down buttons for up and down – it makes it easier to remember.



Here the Infrared Receiver PC board and component overlay *are* shown life size. And there's not much to it! Watch the polarity on the 47µF electrolytic capacitor and note which way around the pins go on the infrared detector (actually, if you get this back to front, the lens will face down into the PC board – a pretty good indication that it's not quite right!).

Parts List – Remote Control for DSP Musicolour

1 PC Board coded 10107083 measuring 24mm x 44mm
1 infrared remote control using RC5 code, at least nine buttons (see text)

Semiconductors
1 infrared receiver module (IRD1) (Jaycar ZD1952, Altronics Z1611)

Miscellaneous
1 10-way right-angled IDC header (Jaycar PP1118, Altronics P5060)
1 10-way ribbon cable, approx 20cm long
2 10-way IDC cable line sockets (Jaycar PS0984, Altronics P5310)
2 self-adhesive foam pads (adhesive both sides)

Capacitors
1 47µF 16V electrolytic, PC board mounting

Resistors (0.25W, 1%)
1 330Ω 1 100Ω

After the seven buttons on the front panel, the next two buttons are used to emulate the SELECT potentiometer and require you to enter a key for "+" and "-" to emulate the analog potentiometer.

Again, you would normally define these two buttons as Volume UP and Volume DOWN on your remote control. Even universal (programmable) remote controls normally have channel up/down and volume up/down labeled.

To test that the DSP Musicolour is correctly understanding the remote control signal you can go to the SYSTEM>RC5 Echo submenu. This will display (in hexadecimal) the 12-bit code received by the Musicolour. You should see the numbers displayed as you send commands to the Musicolour using your remote control.

We have tested the DSP Musicolour with the Digitech AR-1725 (Jaycar AR-1725) universal remote shown earlier, and we set it up as follows (most other universal remotes will work too).

We had intended to use the much cheaper Select1 remote control (Jaycar AR1703) but found it only had seven buttons, so was not suitable.

However, if your household is typical, you probably have a growing collection of once-used infrared remote controls. One of these may be suitable if it uses the Philips (RC5) protocol. If you don't know and can find the code sheet for it, program it for any Philips device and try it out. You can't do any harm, even if it is wrong. It simply won't work!

Of course, it may be that the batteries are flat . . . If it doesn't have a visible LED tell-tale, the easiest way to check



Here's the display for programming your remote control – as each LED lights, you press the appropriate button on your remote control.

Button on Front Panel to Emulate	Press this key on remote control when prompted
AUTO/UP	"Volume UP" button
SET/OK	"OK" button
USER/DOWN	"Volume DOWN" button
CH1/A	"1" button
CH2/B	"2" button
CH3/C	"3" button
CH4/D	"4" button
Potentiometer + control (*)	"Channel UP" button
Potentiometer – control (*)	"Channel DOWN" button

Table 1: this shows a suggested remote control code definition sequence using a Digitech AR-1725 universal remote control (or any RC5 remote control with 9 buttons or more) and the optional remote control decoder PC board. ***Note (*): this control is not a button on the front panel, but is used to emulate the SELECT potentiometer on the front panel using the remote control.***

that an infrared remote control is actually outputting infrared is to view it through just about any digital or video camera. Most are sensitive to infrared and you should see bright white (or sometimes green) flashes in the viewfinder when aimed at the remote control.

If you are using the Digitech remote control, set it for the VCR 115 code (this is the code for a Philips VCR, although many other Philips codes should work too).

Go to the SYSTEM>Remote Control submenu. There you will see whether the remote control has been defined. If it indicates that it has not been defined, you may press SET to define the remote control codes. You will be asked for confirmation and if you proceed, you will be able to define the remote control codes to suit your remote. You'll be prompted to define each of the nine keys in turn. You can refer to Table 1 giving a suggested definition (you can of course choose another sequence of keys to define if you wish).

Once you've defined the remote control codes, the DSP Musicolour will respond to both the buttons on the front panel and to the remote control keys you have defined. So you can operate the DSP Musicolour with either.

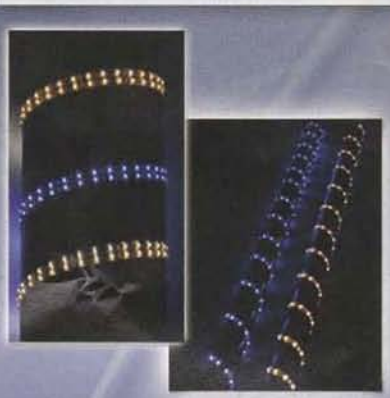
Finally, an errata: on the Display PC board component overlay published on page 26 of the July issue, the ICs labelled IC1, IC2, IC3 and IC4 should be labelled IC3, IC4, IC5 and IC6 respectively to agree with the circuit diagram published in June. The actual type numbers of those ICs are all correct as published. SC



This screen is for checking the remote control: it displays the received codes from your remote control as decoded by the firmware.

TENROD

Sealed Flexible Lights



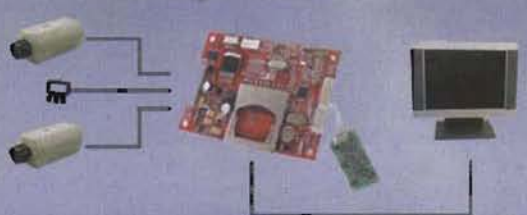
Delightful Lighting Effect with stick-on flexible LED strip



- High Brightness LED
- Split-able at any 3-LED unit
- 12 VDC
- Sealed in water resistant envelope
- Self adhesive underside taping
- Now available in stock
- White, Warm-White, Blue, Green, Yellow, Red

Digital Video Recorder Modules

DVR8100 Video & Still Image Recording on Motion Detect



- 2 Video Ch Input
- NTSC & PAL
- Alarm output
- Trigger input
- SD card
- On Board Flash
- JPG & AVI file format
- Real time clock
- Date & time stamp
- PIP, OSD
- With keyboard
- RCA connections
- DC input (9V to 12V)
- Kit available

Quality System

Quality Endorsed Company

www.tenrod.com.au
sales@tenrod.com.au
NSW: tel: (02) 9748 0655 fax: (02) 9748 0258
VIC: tel: (03) 9886 7800 fax: (03) 9886 7799
QLD: tel: (07) 3879 2133 fax: (07) 3879 2188
NZ: tel: (09) 298 4346 fax: (09) 353 1317
Unit 1, 24 Vore Street Silverwater NSW 2128



Pt.2: By JOHN CLARKE

LED Strobe & Tachometer

Last month, we published the circuit of our new LED Strobe & Tachometer and showed how to build the main unit and the strobe light. This month, we describe the assembly of the optional Photo-Interruptor and IR Reflector Amplifier boards. We also describe how the unit is used.

LET'S START WITH the assembly of the Photo-Interruptor board – see Fig.11. This board is coded 04108083 and carries just the photo-interruptor itself, a 150Ω resistor and three PC stakes.

The assembly should take only a few minutes. **Just be sure to install the photo-interruptor with the correct orientation, ie, with its diode symbol (indicated in blue on Fig.11) on the righthand side.** It should be secured to the PC board using two M3 x 6mm screws and nuts before the leads are soldered.

The completed assembly is wired to a 3.5mm jack plug using 2-core shielded cable, with the shield wire used as the 0V (GND) connection (ie, it goes to the sleeve) – see Fig.6 last month (page 67). Make sure that the tip and ring connections are made correctly. The tip connection is right at the end of the plug, while the ring is the separate section just behind the tip.

The 0V or ground terminal is the main body connection. Use your multimeter to identify the jack plug terminals if you are unsure.

To test the unit, plug it into the main unit, apply power, set the unit to Trigger mode and then return to the main RPM display. If a slotted disc (or some other opaque shape) is now rotated through the photo-interruptor, a reading should appear on the display. In addition, the strobe should flash each time the light path is interrupted. If this doesn't happen, check your connections.

In practice, this unit is intended to be used with a small slotted disk (see photo) that spins within the gap of the photo-interruptor (ie, the disk is driven by the rotating machinery). You will need to manufacture the disk to suit your application.

The completed Photo-Interruptor

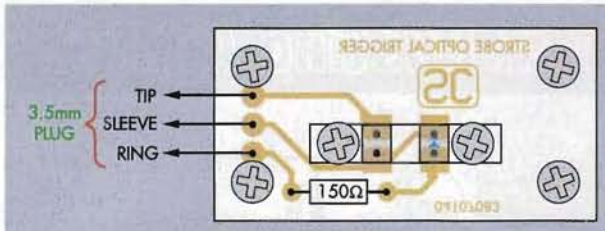


PHOTO INTERRUPTOR BOARD

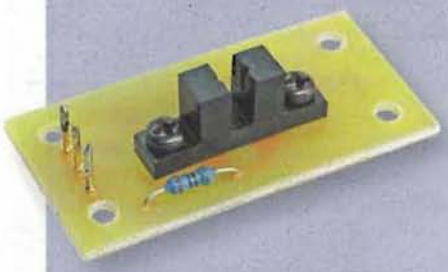
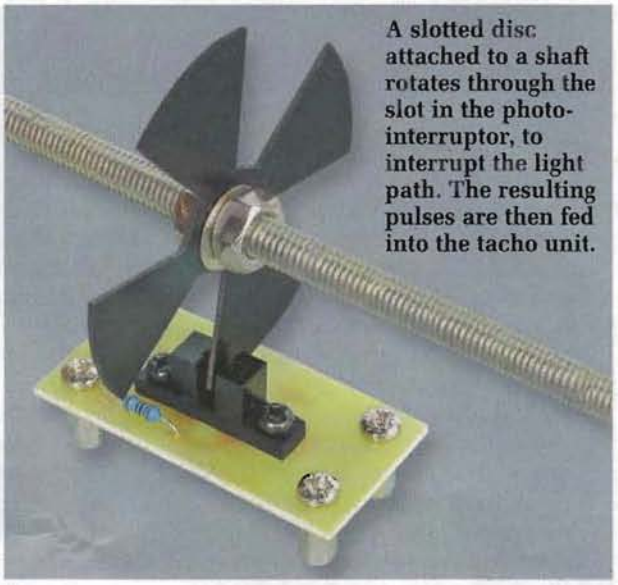


Fig.11 (above): make sure you get the photo-interruptor the right way around when building the photo-interruptor board (ie, diode symbol to the right). The PC board is mounted on Nylon standoffs, to avoid shorting the tracks.



A slotted disc attached to a shaft rotates through the slot in the photo-interruptor, to interrupt the light path. The resulting pulses are then fed into the tacho unit.

board can be attached to a fixed section the machine. Be sure to mount it using Nylon (not metal) spacers at the output end, to prevent shorts to the soldered joints.

IR reflector amplifier

This circuit is built on a PC board coded 04108084 and measuring 53 x 32mm. This is housed in a plastic utility box measuring 82 x 53 x 31mm.

Fig.12 shows the assembly details. Begin by installing the resistors. Follow these with IC2, making sure it goes in with the correct orientation, then install the three electrolytic capacitors. Be sure to mount these capacitors with the correct polarity.

Finally, complete the board assembly by installing the three PC stakes, the infrared LED (IRLED1) and the infrared photodiode (IRSENS1). Note that IRLED1 is mounted at full lead length, so that it can later be bent over horizontally to protrude through the side of the box. Take care with the orientation of both these parts.

An accompanying photo shows how the board is mounted in its plastic case. It sits on four M3 x 6mm tapped Nylon spacers and is secured using M3 x 12mm countersink Nylon screws and M3 nuts.

Two holes are drilled in one end of the box for the IR LED and photodiode, while another hole is drilled at the other end of the box to accept a cable gland.

As before, the PC board is wired to a 3.5mm jack plug using 2-core shielded cable, with the earth shield used as the 0V (GND) connection – see Fig.7 last month. Once again, make sure you get the tip and ring connections correct.

Testing the IR reflector board

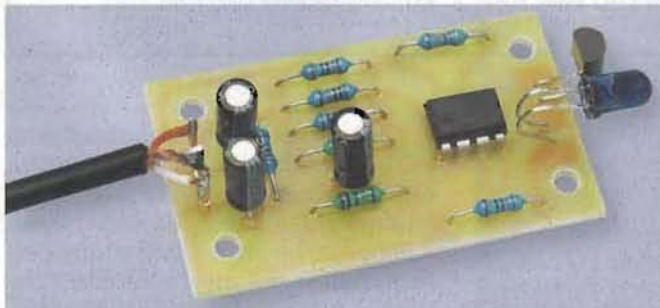
Having completed the assembly, the next step is to test the IR Reflector Amplifier board for correct operation. To do this, first plug it into the trigger input of the LED Strobe & Tachometer unit, then set the Trigger mode and return to the main RPM display.

Now wave your hand in front of the sensor end of the IR Reflector box and check that the LCD shows an RPM reading. If this doesn't happen, check your wiring connections.

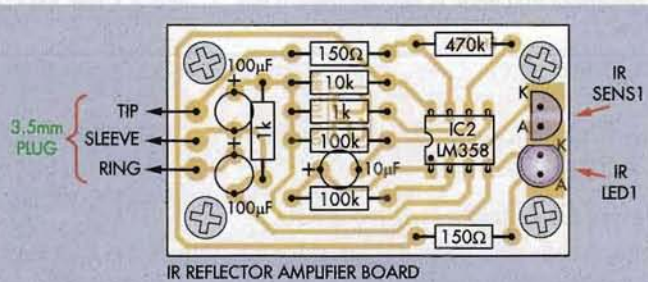
Note that as well as picking up reflected signals from IRLED1, the circuit will also detect signals from other infrared sources, such as incandescent lights running on the 50Hz mains. This means that measurements are best done in natural light or subdued light.

Measuring the RPM of a machine should be done with the sensor about 30-40mm away from the rotating shaft or fan. **This means that you have to exercise a great deal of caution, to ensure that neither the sensor or any part of your body touches any moving parts.** In complex situations, the best approach may be to mount this sensor unit in a fixed position before switching the machine on. In short, use your common sense.

Note that as well as displaying the RPM value, the LCD also indicates rotation by displaying an Up or Down arrow that flashes on and off. Note also that it may be necessary to average the readings to account for slight



The IR reflector amplifier board must also be mounted on Nylon spacers, to avoid shorting tracks.



IR REFLECTOR AMPLIFIER BOARD

Fig.12: follow this diagram to build the IR reflector amplifier. Take care to ensure that IR SENS1 & IR LED1 are installed with the correct polarity.

Using White LEDs As Strobes: Busting A Myth

BEFORE ATTEMPTING TO use a white LED as a strobe we had to be sure of its suitability. Initially, we had our doubts because we had read somewhere that white LEDs cannot be strobed at a fast rate. The reason given was that unlike coloured LEDs, white LEDs contain a phosphor and the persistence of this phosphor prevents them from switching on and off at a fast rate.

One of the reasons behind this story is that most of the phosphors we are familiar with do have long persistence. These include those used in toys that glow for hours after being exposed to light and in fluorescent lights that continue to glow for a short time after being switched off. Similarly, some white LEDs do glow for a short period after the power is switched off.

In this case, we wanted to use a Luxeon white LED as a strobe for this project so we set out to test its suitability. First, we checked the manufacturer's data sheet and this specified less than 100ns for both the turn-on and turn-off periods.

From this, it is clear that white Luxeon LEDs do indeed switch on and off very quickly and so would be quite suitable for our proposed strobe.

How they're made

Further research on the web revealed that there are several ways in which white LEDs can be made. One way is to use red, green and blue LED chips and mix their outputs together to produce white light. These have a fast response because no phosphor is involved in converting the colour. Another way to achieve white light is to use a phosphor that converts the emission from a single colour LED into a white spectrum. There are two types, one based on a blue LED and the other on a near-ultraviolet LED.

The blue-LED-based white LEDs use a phosphor that adds in colours toward the yellow end of the spectrum so that the combination of the blue light and the phosphor emission produces a white light. This construction is the most common form used for white LEDs. However, the phosphor used does not phosphoresce but emits light by a process called "scintillation", an effect that has no light persistence.

The alternative white LED construction is not so common and is based on a near UV LED and a mixture of a red and blue emitting phosphors plus a green emitting copper and aluminium doped zinc sulphide. The emission works in a similar manner to fluorescent lights. We do not have any information about the response time for these LED types but presumably these do have a long persistence.

For our strobe, we use the more common blue-LED-based white LED. This type is manufactured by Luxeon, Cree and several others.

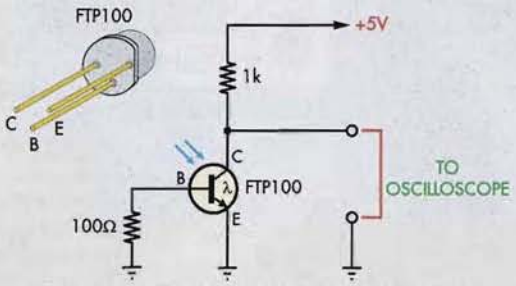


Fig.13: this simple phototransistor circuit was used to measure the response time of the white LED used in the strobe.

Measuring the response time

To further assess its suitability, we decided to measure the response time of a 1W Luxeon white LED. This was done using a phototransistor to detect the white light as shown in Fig.13.

This circuit uses a low-value (1kΩ) collector resistor to ensure that the phototransistor switches on quickly. In addition, the 100Ω resistor from base to ground ensures that the phototransistor quickly switches off in the absence of light.

By pulsing the LED and monitoring this on one channel of a 200MHz oscilloscope, we could measure the response at the collector of the phototransistor on the second channel of the oscilloscope. We measured the rise-time for both a 1W white Luxeon and a Cree XR-C white LED from 10% to 90% full brightness to be just 290ns which is really quite fast. The "fall-time" response from 90% to 10% brightness was 360ns.

Next, we wanted to make sure that were measuring the response time of the phosphor rather than the light from the blue LED itself. To do this, we placed a Polaroid red circular polarising filter over the white LED to block the blue spectrum from the phototransistor. When we did this, the response times remained the same, although the amount of light available for the measurement diminished markedly.

This all means that the white LED response is very likely to be better than 100ns, just as the manufacturers claim. The slower response times we measured are actually the phototransistor response times – **ie, the phototransistor is slower than the white LED.**

From this, it is clear that the 1W white LEDs specified are more than fast enough for strobe applications. However, one question remains: if white LEDs do have a fast response, why do some continue to glow for a short time after the power is switched off?

The main reason is because they are often driven by a supply with a filter capacitor and it takes time for the filter capacitor to discharge after switch off.

speed variations while the machine is running.

Using the strobe/tacho unit

Each time you switch it on, the unit shows the main readout on the LCD. This will either be in Generator mode or Triggered mode, depending on the last selection.

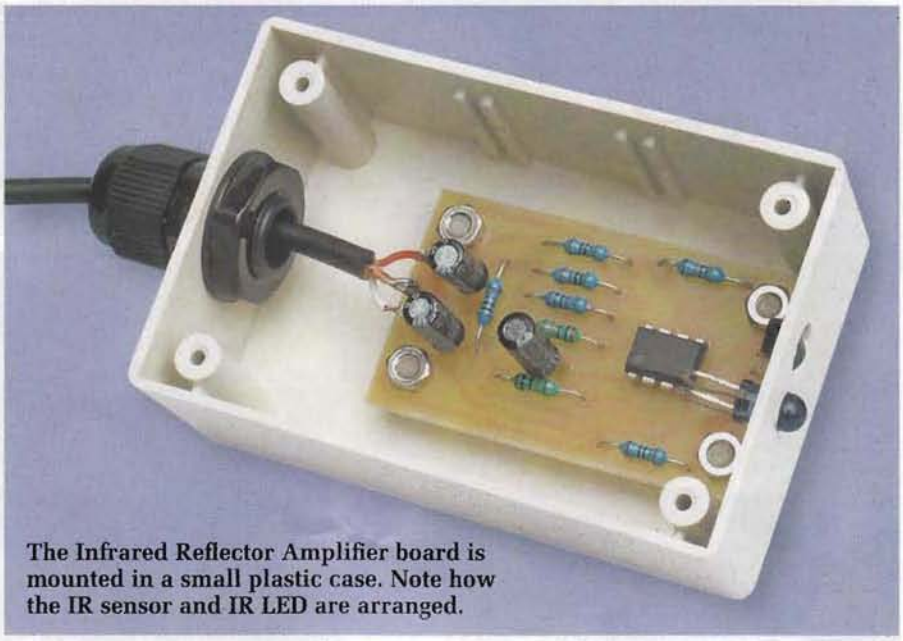
In Triggered mode, the LCD shows the RPM on the top line, then the word "Trig" and either an up or down arrow if there are incoming trigger signals from an external sensor. This arrow will flash on and off, with an up arrow displayed when rising edge triggering is selected and a down arrow when falling edge triggering is selected.

The second line shows the frequency in Hz and following that the division ratio (ie, 0.5 and 1-8). An asterisk (*) on the far righthand side is displayed whenever the strobe is flashing correctly but is not displayed when the strobe LED is continuously lit (as happens when the flash period is longer than the time between flashes).

In the Generator mode, the display shows the RPM in the top line followed by the word "Gen". The second line shows the frequency in Hz. As before, an asterisk (*) is shown on the righthand side when the strobe LED is flashing.

In this mode, RPM adjustments are made using the Up and Down switches and the fine adjust potentiometer. The Up and Down switches adjust RPM in 100 RPM steps, while the potentiometer adjusts in 1 RPM steps over a 100 RPM range.

Selection of either mode is made using the Mode switch. When pressed, the display shows 'Trig/Gen' on the top line and the selection (either 'Gen or Trig') on the second line. The selection is then made using the Up or Down switch.



The Infrared Reflector Amplifier board is mounted in a small plastic case. Note how the IR sensor and IR LED are arranged.

Options

When the Generator mode is selected, a further press of the Mode switch brings up the "Flash Mode" option. This can be set to either "Automatic" or "Fixed" using the Up and Down switches.

Pressing the Mode switch again brings up the "Flash Period" setting. If the "Fixed" mode is selected, the period can be adjusted from 32µs to 6.5ms in 25.4µs steps. The display shows the value in "µs" for readings less than 1000µs (1ms) and in ms for readings above 1ms.

Note that because the flash period is fixed, it is possible for the frequency of the RPM signal to be high enough for the LED to stay fully lit (as indicated earlier), ie, when the unit is flashed at a faster rate than the update period.

Correct operation is indicated by an asterisk (*) at the lower righthand side of the LCD. When the asterisk appears, the strobe is flashing. Conversely, if the strobe is lit continuously, the asterisk is off.

If the Automatic mode is selected, then the display will show the automatic percentage value from 1-10% (ie, this is the strobe's duty cycle). These value is altered using the Up and Down buttons.

Press the Mode switch again returns the unit to the main tachometer display mode (showing RPM and frequency).

Trigger mode

The Trigger mode allows even more selections. These are Edge, Division, Flash Mode, Flash Period and Averaging (of the reading). As before, these are selected using the Mode switch.

First, the trigger edge can be set to either rising to falling. In this case, the LCD shows "Edge" on the top line, while the second line shows either "Rising" followed by an up arrow or "Falling" followed by a down arrow (depending on the selection). The Up and Down switches allow the setting to be changed.

The Division selection allows the number of incoming trigger pulses to be divided by a set value, to give the correct reading on the LCD. When this is selected, the top line shows the word "Division", while the second line shows the divide-by value. Division values of 0.5 and from 1-8 are available and are again selected using the Up and Down switches.

For example, if you wanted to use the IR reflector sensor to measure the rotational speed of a 3-bladed fan, the division value would be set to three.

The Flash Mode and Flash Period settings are adjusted in the same way as for the Generator mode. The Averaging mode is included to smooth out irregular measurements on a machine that is not running smoothly. You can average over 1-10 measurements and this is set using the Up and Down buttons. Higher averaging may be useful when the measured machine rotation varies markedly.

Finally, when the main RPM and frequency reading is displayed, the strobe firing position can be altered using the Up or Down switches. Note that this feature is available only when the division is set to two or more.

Using a Hall Effect sensor

If you wish, you can use a Hall Effect trigger instead of the photo-interruptor. As with the latter, this can be wired directly to the tachometer unit using 2-core shielded cable and a stereo 3.5mm jack plug.

Note that the supply for the Hall effect sensor connects between the ring (+5V) and the ground 0V. The tip connection is for the Hall effect sensor's output signal. SC



Issues Getting Dog-Eared?

Keep your copies safe with these handy binders

Available Aust. only. Price: $A13.95 plus $7 p&p per order (includes GST). Just fill in and mail the handy order form in this issue; or fax (02) 9939 2648; or call (02) 9939 3295 and quote your credit card number.

Buy five and get them postage free!

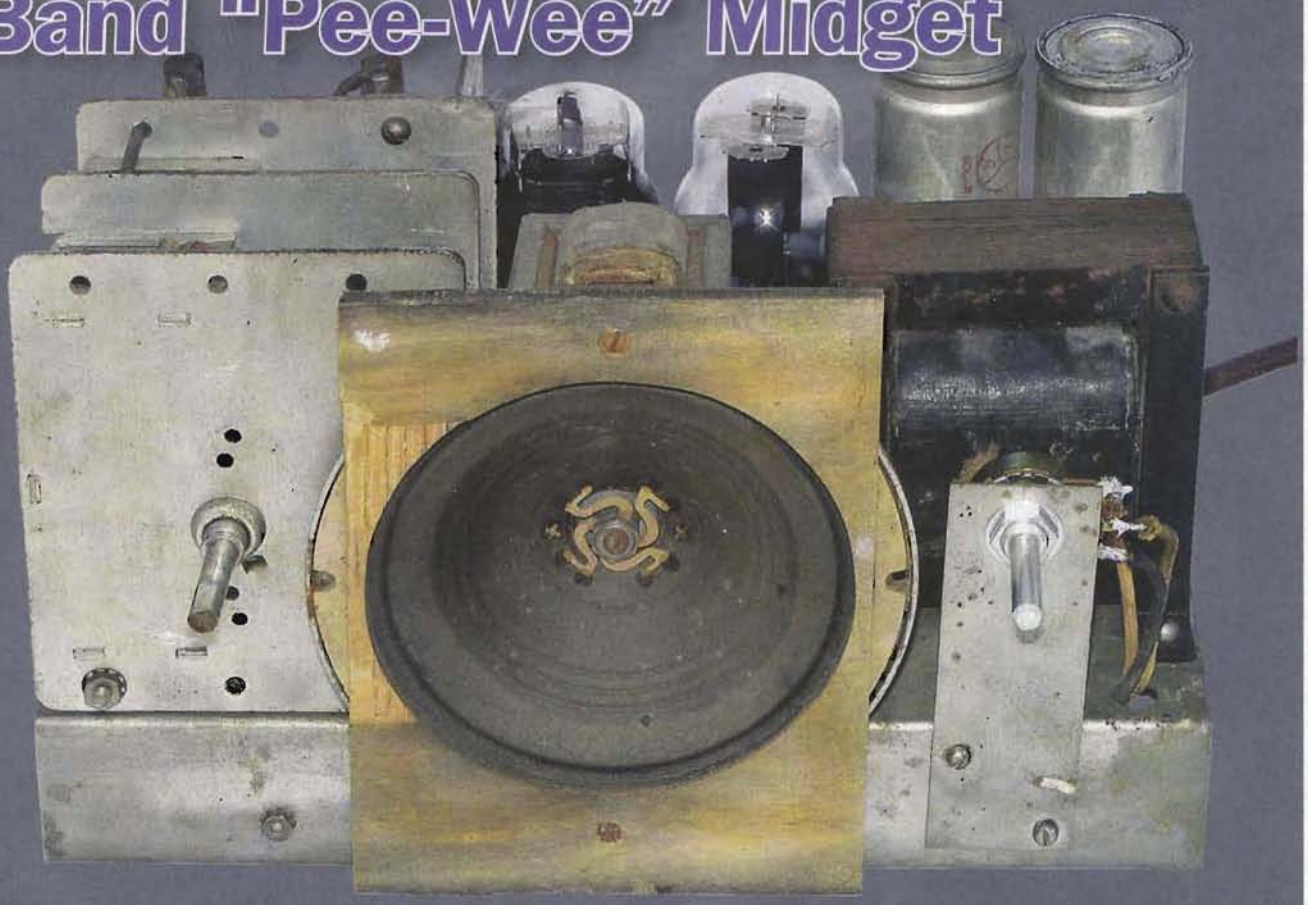


Vintage Radio



By RODNEY CHAMPNESS, VK3UG

The Raycophone Broadcast-Band "Pee-Wee" Midget



Manufactured by Raycophone around 1933, the Pee-Wee Midget is an early superhet receiver with a regenerative IF stage. It's an interesting set but is does have a few design problems that limit its performance.

IN THE 1920s and into the early 1930s, tuned radio frequency (TRF) receivers were the norm. Experimenters and manufacturers were still feeling their way with radio receiver design and felt comfortable with TRF circuits despite their increasingly obvious limitations.

By then, however, the more adventuresome were experimenting with superheterodyne receivers. In fact, a few superhets such as the RCA 26 (see SILICON CHIP, August 2008) were already being sold in Australia and overseas. Despite this, superhets were very thin on the ground, as very few people understood this "tricky" new technology.

The Raycophone company

One interesting Australian company at that time was Raycophone Pty Ltd. This company was run by Raymond Allsop who was both the director and

the chief engineer. Radio was just one aspect of his involvement with electronics, his main interest being with sound movie equipment in the pre-WW2 era.

At that time, Raycophone was still relatively unknown as far as radio was concerned. And despite some considerable research, I have been unable to discover when they commenced operation and when they closed. The only reference to the production of radio receivers is in the "Radio Trade Annual and Service Manual" for 1939, which contains circuits and rudimentary technical information on several receivers produced by Raycophone in 1933.

However, I have been unable to find any circuits in the "Australian Official Radio Service Manuals".

Raycophone Pty Ltd was located at Booth and Trafalgar Streets, Annandale, NSW. During WW2, they produced Fortress amplifiers, signalling lamps, anti-submarine equipment, movie (sound) projectors and cathode-ray oscillographs.

As an aside, Raycophone projectors are still in use at a cinema in Swanpool (a small township south of Benalla in Victoria), even though they were built in 1948.

The Raycophone "Pee-Wee"

I first saw a circuit of this 1933 receiver several years ago and wondered whether I would ever see one. Recently, however, I found out that one of our local vintage radio club members had a working unit and he readily agreed to lend it to me.

As shown in the photos, the set is installed in a fairly small cabinet which is made of quite heavy timber. The cabinet is quite attractive when viewed as a mantel receiver, although the underside of the cabinet is untreated bare timber. It would have been better if some small buffers had been fastened to the bottom of the cabinet, so that it could be made to look like the rest of the cabinet.

The front of the receiver is quite attractive, with the speaker in the centre and two controls (tuning and volume) either side of it. In this set, the tuning control is on the left and the volume control on the right, which is the opposite to that used on other sets (the right hand is normally used for tuning). Both controls have some indistinct lettering near them.



The Raycophone "Pee-Wee" is a compact unit that's housed in an attractive wooden cabinet. The lack of a dial and indistinct markings around the tuning knob makes it difficult to tune to a wanted station.



The chassis is easy to remove but care must be taken to avoid damaging the under-chassis components.The parts mounted on the top of the chassis are all easily accessible.

Strangely enough, the volume control is wired to increase in volume as it is turned anti-clockwise, which is somewhat annoying. The tuning control is fitted with a medium sized knob. This is connected directly to the shaft of the tuning gang, which makes tuning rather critical.

There are no markings on the knob and this, coupled with the indistinct markings on the surround, further complicates tuning. Basically, it's impossible to know what station or part of the band the set is tuned too.

A glance inside the cabinet shows that there is little spare space, with the components squeezed quite close together. It's easy to remove the chassis from the cabinet, however. All you have to do is remove the two knobs and four bolts on the underside of the cabinet. The chassis then slides out.

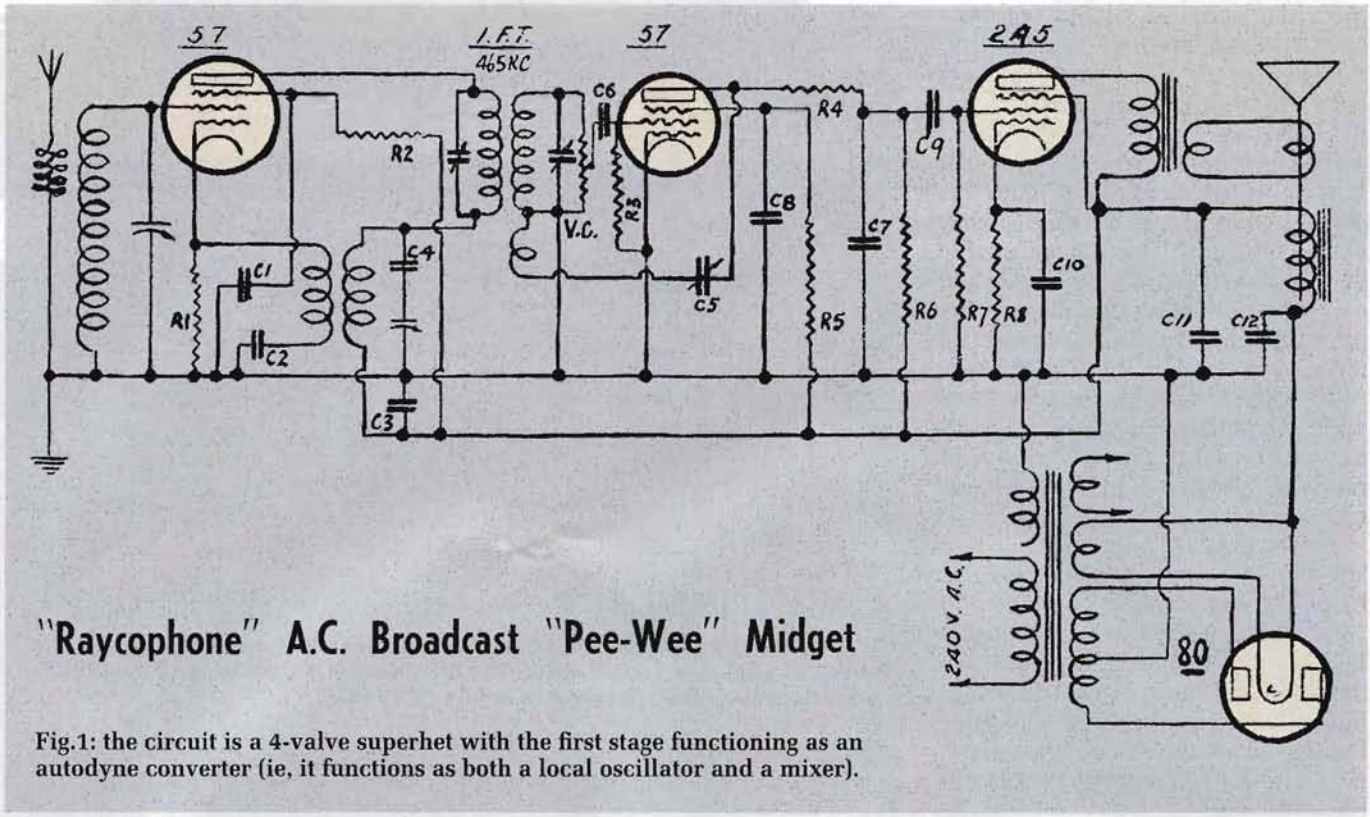


Fig.1: the circuit is a 4-valve superhet with the first stage functioning as an autodyne converter (ie, it functions as both a local oscillator and a mixer).

The components used in the early 1930s were quite large by today's standards. As a result, the large components mounted on top of the chassis nearly fill all the available space.

Most of the components on the underside of the chassis are mounted on a large component board. This is neatly done but it does make it difficult to access the valve pins underneath it without first disconnecting quite a few leads.

The aerial and oscillator coils and the regenerative intermediate frequency (IF) transformer are all located under the chassis. None of them are shielded in any way and care must be taken to ensure that none of their leads are broken when working on the set.

Circuit details

Fig.1 shows the circuit details of the receiver. Basically, the Pee-Wee was an "austerity-model" 4-valve receiver built towards the end of the depression of the 1930s. The set's basic circuit design was commonly called a "Super-Gainer" in amateur radio circles.

As shown in Fig.1, the signal from the tuned antenna circuit is presented to the grid of a 57 pentode. This functions as an autodyne converter stage – ie, it functions as both a local oscillator and a mixer.

Note that because the valve is being used as an autodyne converter, its cathode resistor (R1) is considerably higher than it would be if the valve was simply configured for RF amplification.

The IF output from this stage is at 465kHz and this is fed to an IF transformer. It is then fed via a potentiometer to a second 57 valve which functions as a fixed tuned regenerative detector. The potentiometer functions as the volume control (V.C.).

In operation, variable capacitor C5 feeds back a portion of the amplified RF signal (ie, from the plate), which is then re-amplified. This capacitor is adjusted so that the receiver does not go into oscillation due to excessive feedback when the volume control is fully anti-clockwise.

In addition, the audio signal on the plate of the second 57 is fed out via R4 and C9 to the 2A5 audio output valve. Note that R4 and C7 act as an RF attenuator to prevent IF signals getting into the audio output stage.

The 2A5 is connected as a conventional cathode-biased audio output stage. It drives a 5-inch (127mm) electrodynamic loudspeaker via a speaker transformer.

The power supply is quite conventional with two filament windings, one at 2.5V and the other at 5V. The high-voltage secondary drives either an 80 or a 280 rectifier valve. This functions as a full-wave rectifier with two 8µF electrolytic capacitors and the speaker's field coil filtering the rectifier's output.

Restoration

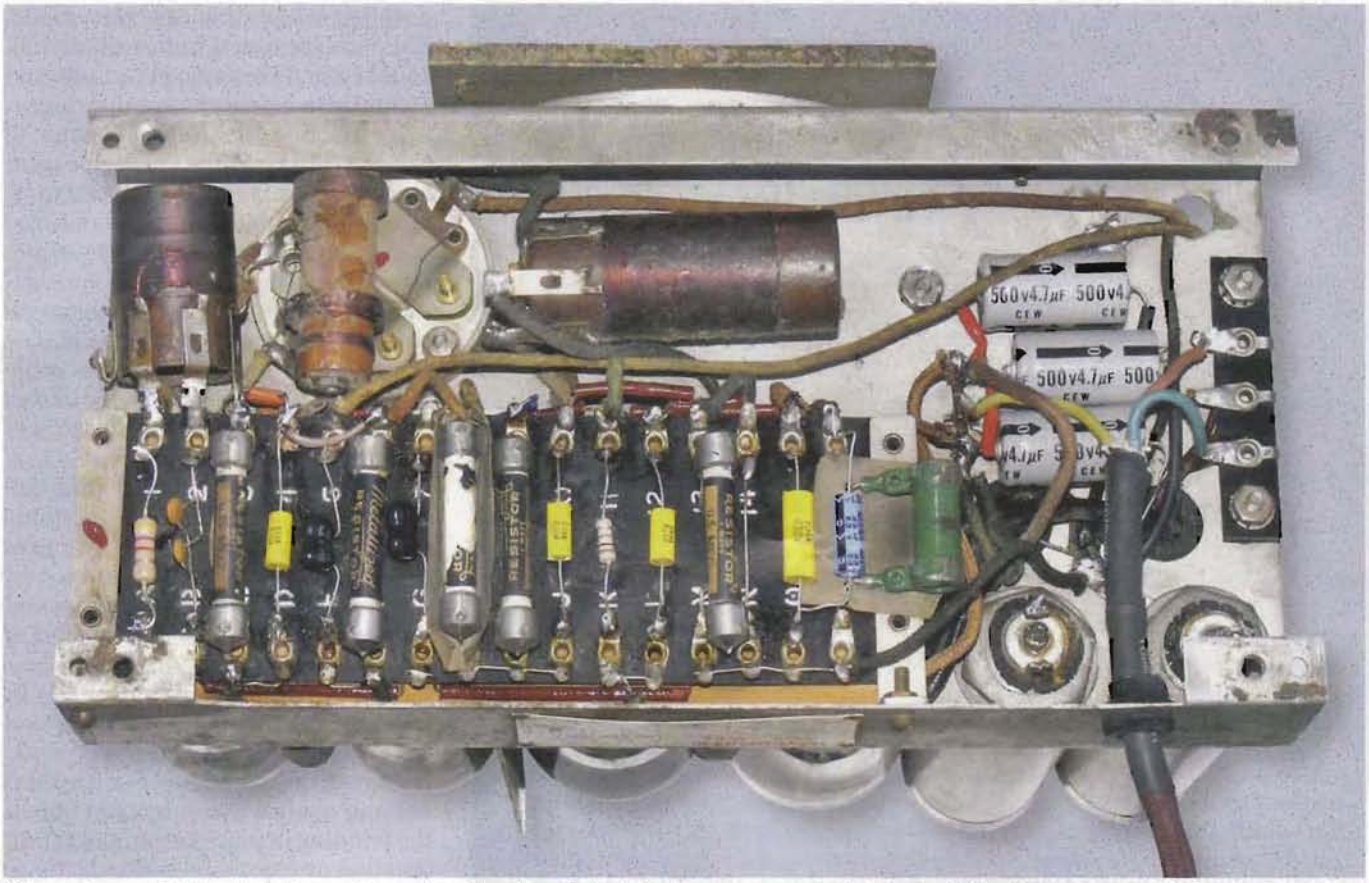
As supplied to me, the receiver had only quite recently been restored to working order. The cabinet had also had work done it and looked to be in good order.

The circuit details indicate that all but one of the low-value fixed capacitors are mica types but they are, in fact, mostly paper types. As usual, they were all quite leaky and had been replaced, some with polyester types and others with silver mica capacitors.

The electrolytic capacitors had also been replaced. However, the high-voltage chassis-mount units had been left in-situ to maintain the above-chassis appearance. Instead, they had simply been disconnected and replaced with much smaller modern pigtail types mounted under the chassis.

A couple of out-of-tolerance resistors had been replaced as well. Finally, a new 3-core power cord had been fitted and anchored into position.

At this stage, I decided to apply



The parts are laid out quite neatly under the chassis but the long component strip is difficult to remove. This means that the parts under it can only be accessed for service after a lot of work.

power and see how well the set performed. Well, it worked but not as well as expected. Even local stations were quite weak and the set oscillated in many places across the broadcast band.

Troubleshooting

It was time for some troubleshooting. First, I checked the "start-up" voltage at the output of the rectifier and got a rather unpleasant surprise. During warm-up, the voltage on the electrolytic capacitors rose to just over 500V. However, one of the electrolytics fitted was rated at 350V, while the other had a 450V rating (the person who originally drew up the circuit diagram had neglected to note any of the voltages expected within the receiver).

I certainly could not leave those capacitors in circuit or a rather dramatic failure would occur within a short period of time. Unfortunately, I didn't have any 8µF 500V capacitors but I did have some 4.7µF 500V capacitors. I placed one 4.7µF capacitor on the output of the 80 rectifier and connected another two in parallel across the HT line after the field coil.

Note that the voltage ratings of the capacitors that had been fitted were quite adequate once the set had commenced operating. Directly heated rectifiers like the 80, 5Y3GT, etc are operational within a couple of seconds of switch on.

By contrast, indirectly heated valves take up to around 15 seconds to start to draw current and during this time there is no voltage drop to speak of


into MICROS OR PICS?

There's a reference to suit every microcontroller maestro in the SILICON CHIP reference bookshop: see the bookshop pages in this issue



Microcontroller Projects in C – by Dogan Ibrahim
Graded projects introduce microelectronics, the 8051 and programming in C.
$81.50



Hands-On ZigBee – by Fred Eady
An in-depth look at the clever little 2.4GHz wireless ZigBee chip that's now being found in a wide range of equipment from consumer to industrial.
$98.50



PIC Microcontroller – know it all (Newnes)
Newnes have put together the best of subjects their authors have written on over the past few years into this one handy volume!
$79.95



Programming 16-Bit Microcontrollers in C – by Luci Di Jasio
Learning to fly the PIC24. Includes a CD ROM with source code in C, Microchip C30 complier and MPLAB SIM.
$80.50



PIC in Practice – by DW Smith
Ideal introduction to PICs. Based on popular short courses for the PIC for professionals, techs, hobbyists, students and teachers.
$60



The PIC Micro – personal intro course – by John Morton
A very practical guide which assumes no prior knowledge. So it is an ideal introduction to the widely-used PIC micro.
$52

• Audio • RF • Digital • Analog • TV • Video • Power Control • Motors • Robots • Drives • Op Amps • Satellite



There's not much room left inside the cabinet when the chassis is slid into place, although the valves can still be replaced. Note the thickness of the timber used to make the cabinet.

across the rectifier or across components such as the field coil.

This means that the peak voltage that the supply can deliver on no-load is substantially more than the loaded voltage. It is therefore necessary to allow for the very high start-up voltage which occurs at switch-on.

Curing the instability

The instability (oscillation) problems in the RF sections of the receiver proved difficult to fix. And although I have made major improvements, I have not been 100% successful.

First, resistor R1 had previously been replaced with a wirewound unit which would be inductive. As a result, I replaced it with a carbon resistor and this reduced the instability somewhat with the set no longer oscillating at all times in certain locations.

Next, I tried adding extra filter capacitors to the HT line for both 57 valves and this gave a further slight improvement in one of the locations (ie, to the first 57). I then tried swapping the two 57 valves but this made no difference.

My next step was to examine the set's earthing arrangement. This revealed that all stages are earthed via an insulated lead that runs from one end of the chassis to the other. That meant that the RF section was earthed at the furthest end of the chassis and I felt that this could be contributing to instability problems.

As a result, I separated the earth wire part way along the component strip board. The front-end was then directly earthed to chassis near the converter stage, using a much shorter lead.

This simple modification again improved the stability but it still wasn't the complete answer.



This view shows the unshielded 465kHz IF transformer windings. The leads are easily damaged when the chassis is removed.

Alignment checks

Next, I took a look at the alignment and this proved to be a bit of a mess, probably due to the age of the set.

The problem here is that none of the coils can be adjusted, as iron-dust adjustments slugs were still to become popular when this set was made. The receiver tuned from around 550-1500kHz and I extended this to around 1550kHz to cater for a local station.

In practice, the set will tune to above 1700kHz if the oscillator trimmer capacitor is reduced almost to its minimum value. However, the aerial stage cannot be peaked for best performance if this is done.

This led me to suspect that the aerial coil had too much inductance. The wire used to wind this coil is quite fine and its location makes it difficult work on without risking damage, so I decided to leave it alone.

In the past, I've noticed that coil inductance can increase in some very old sets, perhaps due to moisture ingress into the coil former. As a result, the alignment of the aerial and oscillator coils in this set are a bit of a compromise.

The secondary winding of the IF transformer also gave quite a broad response, with only a slight peak. However, the owner had fitted a 50kΩ volume control potentiometer across the winding in place of the 500kΩ unit that had originally been fitted.

Initially, I reasoned (incorrectly) that the lower resistance would damp out any tendency for the stage to oscillate, as I couldn't turn C5 to reduce the regeneration feedback. I was wrong and after fitting a 500kΩ potentiometer, the IF winding peaked nicely and the set's tendency to oscillate dropped dramatically.

However, it would still oscillate on some stations and it turned out that there were further problems, which came to light later.

Special potentiometer

The original potentiometer was apparently a special unit and was possibly an anti-log type. However, I didn't have a direct replacement. With some of the potentiometers I tried, earthing the frame (ie, when the pot was mounted) reduced the performance of the set. Apparently, the tuning of the IF transformer's secondary was being affected by the capacitance between the potentiometer's elements and its frame (which is earthed).

In addition, only a very small portion of the pot's travel was having any effect on the volume.

In the end, I decided to go back to the 50kΩ potentiometer and install a 390kΩ resistor in series with its

"earthy end. This arrangement gave 440kΩ of resistance across the winding and allowed the pot to vary the volume over almost all of its travel.

As before, I found that earthing the frame of the potentiometer had the undesired effect of reducing the volume. As a result, I insulated the pot's frame from the chassis using insulated washers and an O-ring. I then retuned the secondary winding of the IF transformer and this fixed the problem.

It's worth noting that conventional potentiometers are not rated for RF work so it was not surprising that I struck this problem.

Following these modifications, the set is now probably performing as well as it did when new. However, it is very much an "austerity receiver" and its performance is only reasonable. It has no AGC so the volume control has to be manually adjusted to reset the level when tuning between weak and strong stations.

In practice, weak stations are not worth listening to, although the set would probably work better if the aerial coil had the right inductance. What's more, it still shows signs of instability when tuned to some stations.

Photo Gallery: Philips Model 112E Receiver



Made in the Philips' South Australian factory in 1949, the Model 112E was a 4-valve mantel set housed in a pale-blue bakelite cabinet. An unusual feature was the dial glass which protruded from the top of the set. The valve line-up was as follows: 6X5GT rectifier, ECH35 converter, EBF35 IF amplifier and EL33a audio output valve. This radio was restored by Tony Lightfoot of the HRSA. Photo by Kevin Poulter.

Summary

The Raycophone "Pee Wee" is an interesting little set but like most "austerity receivers", its performance is nothing remarkable. I have always been interested in superhets that use a regenerative IF stage and they can perform quite well if properly designed and constructed.

In this set, direct access to parts under the component strip is almost impossible (unless the strip is removed). This can make servicing it difficult. In addition, the clearance between the bottom of the chassis lip and many of the parts mounted under the chassis is only a millimetre or so. The coils in particular are quite vulnerable to damage when sliding the chassis in and out of the cabinet.

Another problem is that some sections of the set that are working at RF have quite long leads, This is bad design practice and can cause instability. The tuning is also quite touchy due to the direct-drive coupling and the relatively small control knob. This is made worse by the lack of a tuning indicator.

With more thought given to its design and component layout, this little set could have been much better than it is, both in terms of stability and overall performance. It could have been made easier to service as well.

In summary, the Raycophone Pee Wee has a number of design inadequacies that compromise its performance and make it difficult to use and service. SC



into VIDEO/TV/RF?

There's something to suit every RF fan in the SILICON CHIP reference bookshop: see the bookshop pages in this issue



Television & Video Technology – by KF Ibrahim

New edition has a full and comprehensive guide to video and TV technology including HDTV and DVD, starting with fundamentals.

$60.50



Practical Guide To Satellite TV – by Garry Cratt

The book written by an Aussie for Aussie conditions. Everything you need to know – including what you cannot do!

$49



RF Circuit Design – by Chris Bowick

A new edition of this classic RF design text - tells how to design and integrate RF components into virtually any circuitry.

$67



DVD Players and Drives – by KF Ibrahim

DVD technology and applications - ideal for engineers, technicians, students, installation and sales staff.

$85



Hands-On Zigbee – by Fred Eady

An in-depth look at the clever little 2.4GHz wireless chip that's starting to be found in a wide range of equipment from consumer to industrial.

$96.50



Practical RF H'book – by Ian Hickman

A reference work for technicians, engineers, students and the more specialised enthusiast. Covers all the key topics in RF that you need to understand.

$80

• Audio • RF • Digital • Analog • TV • Video • Power Control • Motors • Robots • Drives • Op Amps • Satellite

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

Speed controller for motorised shutters

I have an extension to my house which has motorised shutters in the roof. The motor looks like those used in car windscreen wipers. A control unit applying +12V or -12V to the motor performs opening and closing the shutters. The system works fine except that the motor is too fast, resulting in the shutters crashing closed.

Possible solutions include changing the gear ratios in the motor mechanism or using an electronic controller to the motor. The second option would seem to be preferable.

Your 12V 10A Motor Speed Controller (SILICON CHIP, June 1997, Jaycar KC5225) would appear to do the job well, however the motor needs to be able to operate in the forward and reverse direction so that the shutters open and close. Obviously I cannot simply reverse the supply polarity to the Motor Speed Controller unit.

Is there a simple solution to this problem? Can the output polarity of the Motor Speed Controller be reversed? Is there another circuit better suited to this situation? (G. B., via email).

● The output from the Motor Speed Controller cannot be reversed but the connections to the motor can. Presumably the control unit switches off power once the shutters are fully open or closed and power is off after partially opening or closing the shutters.

Depending on whether the control unit for the shutters is electro-mechanical (ie, just switches and a relay) you should be able to supply the controller with power via the Motor Speed Controller. The control unit for the shutters will then provide the supply reversal for the motor. The reverse diode for the motor used in the Motor Speed Controller should be connected across the output terminals of the Motor Speed Controller and not the motor.

If the control unit for the shutters is electronic then it will need to be powered directly via the 12V supply. The Motor Speed Controller would then have to be powered by connecting it to the + and - terminals of a bridge rectifier (rated at 35A) and the AC terminals of the bridge rectifier connected to the control unit outputs that normally connect to the motor.

The Motor Speed Controller outputs would then connect to a DPDT relay rated for the motor. You could use the Jaycar SY-4008 cradle relay. Connect the NO (normally open) contact of the first pole to the NC (normally closed) contact of the second pole and this connects to one output of the shutter controller. Connect the NC contact of the first pole to the NO contact of the second pole and connect to the other shutter controller output. The common relay terminals connect to the motor.

The relay coil connects across the output of the control unit for the shutters (like the AC terminals for the diode bridge do). As before, the reverse diode for the motor should be connected across the output terminals of the Motor Speed Controller and not the motor itself.

Altering class-A operating conditions

I would like to know if lowering the quiescent current of the 20W Class-A amplifier would lower the heatsink temperature. Does lowering the operating temperature of a working amplifier have any detrimental effect? (D. G., via email).

● If you lower the quiescent current substantially you will certainly reduce the power dissipation and the operating temperature of the amplifier. However, it will then no longer be operating in Class-A over most of its power range and the performance will not be as good.

How Are Windmills Synchronised To The Grid?

There is quite a lot of interest over our way in wind farms. I would like to know how all those wind turbines, all rotating at different speeds, manage to generate electricity at 50Hz and do it so that they are in phase with each other and also the national grid into which they feed? Come to think of it, how do all the other generators supplying power to the national grid keep in phase?

We even have a direct current link between the North and South Islands and that really has me foxed. Could you please explain how it is done and thus solve for me one of life's great mysteries? (C. S., Lower Hutt, NZ).

● We wrote briefly about this subject in our feature story on Australia's first grid-connected wind farm, in the January 1999 issue. In fact, the windmills do not rotate at widely different speeds. Their blades are constantly adjusted for pitch so that the power output is more or less constant. The alternator speed is, in fact, constant although the blade speed can vary by about ±10%.

Synchronising alternators to the grid is quite easy. All that needs to be done is to run the turbine/alternator at the correct speed and frequency, ensure that the alternator phase is matched to the grid and then the "switch" can be thrown to connect the alternator to the grid. After that, the alternator is always locked to the grid unless a serious fault develops.

The article on the BassLink (Tasmania to Victoria) HVDC link in this issue should answer your last question. This uses the same principles as the NZ HVDC link.

Yes, the heatsink gets quite warm but all parts operate well inside their ratings.

How to reform electrolytic capacitors

I have been searching unsuccessfully through your online archived magazine indexes for a specific article I know to have been printed. It was an article relating to the "Forming of Capacitors".

I thought it was around August 2006 but can find no mention of it on this site. Can you help? (B. G., via email).

● The article was in October 2006.

Protection from microwave wanted

I am looking to purchase a kit that will protect my family from microwaves and/or EMF. Can you help me? (D. F., Louisville, KY, USA).

● Unless you and your family live permanently in a Faraday cage (ie, a room made of metallic mesh to screen out electromagnetic radiation) or in a deep underground cave, there is no way to avoid microwaves or electromagnetic radiation. However, unless you are exposed to high-power fields from, say, nearby airport or ships' radar, cell-phone or TV broadcast towers, there is little to worry about.

Claims for Browns Gas refuted

I have been researching HHO or Browns Gas. I am not sure but it looks like there are two camps regarding the manufacture of HHO or Browns Gas. One camp makes small amounts of gas through very simple electrolysis (using 8-25A) and their argument is that only a small amount of gas is needed as it makes the petrol burn more efficiently.

The other camp (Stan Meyers and others) makes all sorts of claims but produces huge amounts of gas through some sort of pulse technology and is able to produce these amounts at very low amps.

My personal feeling is that Stan Meyers and others are on the right track with this pulse technology and a number of problems have been fixed. If you look at YouTube, regarding the pulse frequency changing with the decreasing fluid level in the electrolyser bottle, this has been fixed by the addition of a fluid level sensor and a reservoir with a pump so that the fluid level can remain constant.

I am hoping that you can look at Stan's circuit which drives his electrolyser and make any modifications needed to get this kit ready for manufacture through Jaycar or any one else that wishes to take it on. (S. W., Murray Bridge, SA).

● Leo Simpson comments: virtually all the claims made with regard to "Browns Gas" are fallacies. I first became aware of Yull Brown some 30 years ago (he wasn't claiming to be a Doctor then) when "Electronics Australia" featured an article on "the oxy-hydrogen economy" in the March 1978 issue. I was sceptical even then. I was working for EA at the time.

Subsequently, I was invited to Mr Brown's home workshop at Auburn in Sydney to do a follow-up story on another application for oxy-hydrogen, as it was then called. However, the meeting did not last long. When I raised questions about the efficiency of the electrolysis process, Yull Brown became angry and ordered me off the premises.

Let's list the facts about electrolysis of water and the use of the resultant gas as a fuel:

(1) Yes, water can be electrolysed and the resultant oxygen-hydrogen mixture burns very cleanly and with high calorific value to give pure water as the combustion product – no argument there.

Repairing A Kenwood Mixer

I discovered your website when I was attempting to find a place in Australia where I could buy a new circuit board for our Kenwood mixer. Not being technical, I just try to look for the obvious when working on broken things.

We brought this mixer with us from the UK and hardly ever use it. Recently, my children were using it (I wasn't watching at the time) and they called out because there was smoke billowing from the machine. As far as I can determine though, it was still working.

As there isn't too much to the machine I started looking at the motor and discovered that one of the components had blown out and was the cause of the burning smell. It is labelled "Rifa PME 271 M" on one side and on another, it says, "0.15µF X2". Can you firstly tell me if I should consider replacing it as I don't know what caused the problem, or is it that these modules can go at any time and for no reason? Secondly, what is this part called?

Is it possible to buy a replacement circuit board in Australia as the plastic back on the board appears to be moulded on. (D. S., via email).

● The component that has evidently failed is a capacitor. It is possible that it failed on its own or maybe because some other component also failed. However, since the mixer is still working, it is likely that the capacitor is the only device to have failed.

X2 capacitors can be purchased from Jaycar or Altronics but they do not have that specific value. You could try a value of 0.22µF (which they do stock) or you could probably purchase a 0.15µF X2 capacitor from Farnell Electronic Components (see **www.farnellinone.com**).

Local service agents should be able to obtain the complete speed control module although the cost may make the repair uneconomic.



Issues Getting Dog-Eared?

Keep your copies safe with these handy binders

Available Aust. only. Price: $A13.95 plus $7 p&p per order (includes GST). Just fill in and mail the handy order form in this issue; or fax (02) 9939 2648; or call (02) 9939 3295 and quote your credit card number.

Buy five and get them postage free!



Problem With Vehicle Multi-Voltage Monitor

I have recently constructed the Vehicle Multi-Voltage Monitor kit (SILICON CHIP, May 2006) and have a minor problem you may be able to assist with.

I have configured the board to display a voltage between 10V and 15V in dot mode. The problem is that as the voltage increases past the lowest reading red LED (the one fed from pin 1 of the LM3914), it does not fully extinguish. The higher LEDs illuminate and extinguish as expected.

When the voltage is decreased below the lowest LED value the offending LED extinguishes fully. I have tried another LM3914, with the same result.

The voltage being monitored is the same as that supplying the board, ie, I have the input line connected to the +12V supply line. In all other respects the circuit appears to be fine. (D. W., via email).

- Place a 10kΩ resistor between the anode and cathode of the first LED (the one that connects to pin 1). This will shunt the residual current that is supplied to this pin 1 output to prevent the LED glowing.

When the LM3914 was introduced more than 20-years ago LEDs were not as efficient as they are today and the LED at pin 1 did not tend to remain lit. But now with modern high-efficiency LEDs, the residual current causes the LED to glow faintly.

(2) Electrolysis is a very energy intensive process. Just as the burning of the hydrogen-oxygen mixture gives off lots of heat (an exothermic reaction), reversal of the process to split water into hydrogen & oxygen needs a lot of energy input (an endothermic reaction). It requires even more energy if platinum is not used as a catalyst. The popular internet process using stainless steel tubes is far less efficient.

(3) Using a car's electrical system to electrolyse water and inject the resultant gas into the cylinders to "improve" combustion is just silly. The energy to electrolyse the water has to come from the engine (to drive the alternator, etc) and there are losses at every stage in the process. Just as an aside, water injection can still be worthwhile in some engines.

(4) Yull Brown's idea to power cars from water fuel was never practical. Apart from the large amount of energy required to electrolyse water, the means of storage was always going to be heavy and difficult. At one stage Queensland's premier Joh Bjelke-Petersen helped promote the idea of a hydrogen car (in association with Steven Horvath) – it never came to anything.

(5) It is interesting that the process is now called "Browns Gas", as if Yull Brown had invented it. Nonsense. The process for electrolysis of water was known for at least a century beforehand. Nor is the hydrogen and oxygen so produced monatomic (HHO), as is claimed by the promoters. At normal temperatures and pressures (as produced in the electrolysis process) hydrogen and oxygen can only exist in the molecular state, ie, as H_2 and O_2.

(6) Any use of hydrogen as a fuel, whether to be directly burnt in an engine to produce power (inevitably an inefficient process) or in a fuel cell to drive an electric motor in a car as promoted by Honda, BMW and other companies, is never likely to come to anything. The process for turning ordinary hydrocarbons into hydrogen is too inefficient and leads to high carbon dioxide emissions.

(7) The suggested schemes and circuit for controlling the field windings of an alternator to somehow increase the electrolysis process are also nonsense. The circuits themselves (based on a 555 timer and a Mosfet) are suspect since they have no protection against transient voltages. Switch-mode control of alternator windings has been in use for at least 25 years and does nothing to increase the output of the alternator – it is just an effective means of control compared to the old electromechanical voltage regulators.

(8) Mention is made in quite a few internet posts about tests done by "Electronics Australia" magazine which purport to validate Browns gas, etc. No such tests were ever done and apart from the article mentioned above, there was never any association between Yull Brown and his Water Fuel Holdings and "Electronics Australia" magazine.

Timed lamp dimmer wanted

I would like to create a switch for a standard light globe that operates off a timer and when activated, dims slowly from low to high brightness. Do you know of any suitable kits? (U. M., Ocean Grove, NSW).

- We published a remote controlled table lamp dimmer that can dim automatically (SILICON CHIP, July 2005). We have not produced a timer that works with the dimmer but you may be able to use a timer that has low voltage relay contacts to activate the automatic dimming on the remote control for the table lamp dimmer.

Substitute battery for old transistor radio

I have just purchased an old HMV Little Nipper Rangemaster portable transistor radio. Inside there is a little sticker stating that it requires an Eveready 276-P battery.

I don't think those batteries are available any longer and I was wondering if you could tell me the specifications, (volts, amps) of that battery so I can use a modern equivalent. I was thinking about one of those little gel cells that you can get in electronics stores or perhaps a combination of NiMH cells.

I suspect that the modern equivalent would not actually fit in the case of the HMV but an external supply would be OK. (B. H., via email).

- The Eveready 276-P was a 9V 5000mAh battery. There is no current equivalent that could be used.

To make a suitable substitute, you could use a 9V pack made up with six NiMH AA cells in a holder. Jaycar sell six-AA cell holders, Cat PH-9206.

Electric fence has voltage limits

I have built the Jacobs Ladder kit from the April 2007 issue and it works fine. However, could I adapt it to power an electric fence to deter wildlife from eating my gardens? I believe it would have plenty of energy but I notice the article suggests not running the kit

Notes & Errata

Ultra-LD Mk.2 200W Power Amplifier, August 2008: the 470µF 63V capacitor on the -55V rail is shown with reversed polarity on the circuit diagram (Fig.1), ie, its negative lead should go to the -55V rail. As well, the voltages marked across the 0.1Ω resistors are out by a factor of 10. They should be 7-10mV, not 70-100mV.

In addition, the 68Ω resistor in series between the +55V rail and Q7's collector has been reduced to 47Ω, while a 22kΩ resistor has been added in series between Q8's collector and ground (this change has been incorporated onto the PC board patterns sent to the parts retailers).

Finally, the following changes should be made to the parts list: add 1 x 22kΩ 0.25W resistor, add 1 x 47Ω 0.25W resistor, add 1 x 10Ω 0.25W resistor, delete 1 x 68Ω 0.25W resistor and change the two 470Ω 5W test resistors to 68Ω 5W. There should also be 5 x 100nF 63V MKT polyester capacitors (not four).

Water Tank Level Meter, November and December 2007: the transmission repeat periods for the telemetry version for positions 4-7 and 8-B of the BCD switch (BCD2) do not run at the designated 33s and 67s respectively. The software has been updated (rev2) to fix this bug and is available for free download from our website.

Infrared Rolling Code Receiver, October 2007: the A & K labelling on diodes D1-D4, shown at the top righthand corner of the circuit, is incorrect. It should be as shown for diode D5 at the top left corner of the circuit.

DSP Musicolour, July & August 2008: in the component overlay of the DSP Musicolour display board shown on page 26 of the July 2008 issue, the labelling on the ICs is incorrect. IC1 should be IC3, IC2 should be IC4, IC3 should be IC5 and IC4 should be IC6.

Want a real speed controller kit?



If you need to control 12 or 24 volt DC motors and want a speed controller that will easily handle 30 amps, then this is the kit for you.

This controller allows you to vary the speed of DC motors from 0 to 100%. It is also ideal for controlling loads such as incandescent/halogen lamps and heating elements.

This kit makes a great controller for use on small electric vehicle projects, such as electrically assisted bikes and go-carts. We have tested it to over 30 amps without problems—it barely gets warm! *Item code: SPEEDCON.*

We also have solar maximiser kits, Luxeon LEDs, and lots of interesting products and publications.

Go to shop.ata.org.au or call us on (03)9639 1500.

without some discharge in case it internally arcs in the ignition coil. What component changes are suggested? (P. C., via email).

● The high voltage produced by the Jacob's Ladder is far too high for an electric fence. It could easily put out 20kV to 25kV whereas the Australian standard (AS3129) calls for a maximum voltage of 5kV into a 1-megohm load. Nor would it be practical to throttle the circuit back enough to make it suit.

In the past, we produced a similar circuit with a conventional ignition coil which would be suitable for short fence runs (see SILICON CHIP, July 1995). Alternatively, we produced a high-output electric fence in the April 1999 issue. We can supply photostat copies of the articles for $9.50 including postage.

Query on dimmable CFLs

I was planning to replace three incandescent globes in a pendant light fitting with cooler CFLs because after 30 years some plastic and wiring was heat-affected. You state that GE dimmable CFLs tend to fail at 60°C. What is the likelihood of reaching this temperature? (H. W., via email).

● We have never made any specific comment on lamp failure with respect to GE dimmable CFLs. We do not know.

Provided CFLs are not totally enclosed in a lamp fitting, they should have good life, especially if they are normally left on for long periods. SC

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely.

Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

Advertisers are warned that they are responsible for the content of all advertisements and that they must conform to the Trade Practices Act 1974 or as subsequently amended and to any governmental regulations which are applicable.