

SILICON CHIP



APRIL 2008

ISSN 1030-2662



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9 771030 266001

PRINT POST APPROVED

- PP255003/01272

\$850* NZ\$990

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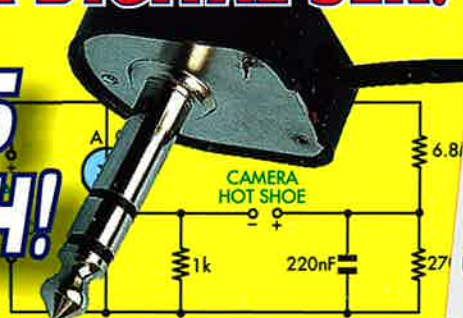
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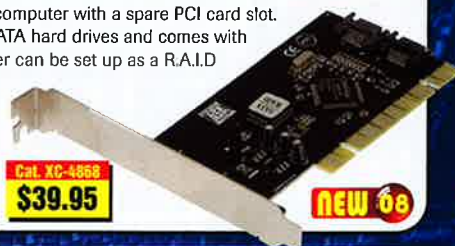
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Cat. MP-3490
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• 180(L) x 82(W) x 55(H)mm



NEW 08

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Battery Powered BBQ Cleaner with Light

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NEW 08

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CHIP**

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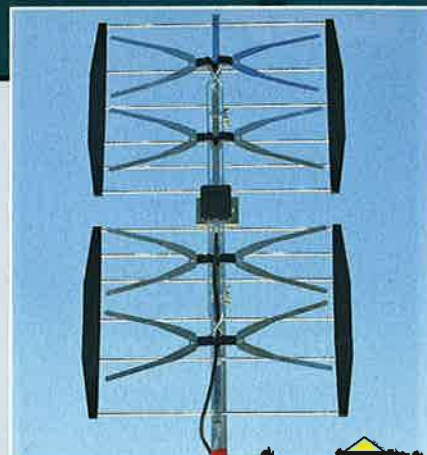
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Printing: Hannanprint, Noble Park, Victoria.

Distribution: Network Distribution Company.

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

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ISSN 1030-2662

* Recommended and maximum price only.

Publisher's Letter

Your future electric car may use ultracapacitors



As it says in one of the letters in Mailbag this month, electric cars are coming. Or at the very least, they are coming closer. A recent issue of *The Wall Street Journal* reported that General Motors and Toyota are now punting on electric cars rather than hydrogen power. Good thing too. We have always thought that fuel cells and hydrogen were a distraction from the main game because fuel cells are very expensive and the distribution and storage of hydrogen was always going to be a major problem.

Part of the change of heart has come about due to recent advances in Lithium-ion batteries whereby future electric cars might have a range of up to 500km before they need to recharge. With a potential range of 500km, car makers will no longer be able to argue that people won't buy electric cars because they cannot go far enough on a single charge.

At the same time, Nissan has just announced that it will release an electric car in 2010. Will it be along the same lines as the Nissan Mixim concept car? Probably not but you can be sure that it will use some of the same technology, with Lithium-ion batteries and a similar power-train. Mitsubishi has also indicated that it will sell an electric sports car.

GM will also release its Chevrolet Volt electric car but since it has a small on-board petrol generator to top up the battery for long drives, we don't think it is a full-on electric car – it's a "pretend" one. It is really just a further refinement of hybrid electric vehicles like the Toyota Prius or Honda Civic. Why don't they revisit the EVA-1 with Lithium-ion batteries?

However, the latest really interesting development is highlighted with the article on ultracapacitors in this issue (page 12). In themselves, ultracapacitors are mind-boggling because of the sheer values of capacitance now being achieved. Years ago, the standard unit of capacitance, the Farad, was always regarded as an academic curiosity, something that would never be a practical device. Yet we are now talking about capacitances of 1000 Farads and huge energy storage.

For anyone who has played with a typical supercapacitor over the last few years, this is an amazing shift. For example, if you have tested how much energy can be stored in a 1 Farad 5.5V supercapacitor (15 Joules), you will know that it is fine for lighting LEDs and powering low-current circuits but compared to a couple of NiMH AA cells, it is like the proverbial 110 pound weakling on the beach! (Oh, and before the metric thought police come to take me away in shackles, is there a better comparison?)

So it is even more amazing just how much energy can now be stored in banks of ultracapacitors. We are now talking about the same amount of energy as would be required for a practical electric car – 30 kilowatt-hours or more. This could be used on its own or combined with a large rechargeable battery bank. Ultracapacitors are even being tried out in electric buses. And it turns out that our very own CSIRO has been researching this area for quite a few years, as reported in our story in this issue.

So the developments are coming thick and fast. In fact, next month we will be reviewing the first really practical electric vehicle for consumer use. It is already available in Australia and they are selling fast.

Leo Simpson

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2685-7	USB to Parallel - Centronics	\$35
2920-7	USB to Serial (RS232) 1 Port	\$59
2929-7	USB to Serial (RS232) 8 Port	\$459
2853-7	USB to RS422/485 1 Port	\$249
2907-7	USB to RS422/485 4 Port	\$560
23025-7	USB to 5.1 Sound Adapter	\$45



Network Switches

Cat. No.	Description	Price
11333-7	5 Port 10/100	\$39
11334-7	8 Port 10/100	\$49
11323-7	16 Port 10/100	\$99
11324-7	24 Port 10/100	\$139
11435-7	5 Port Gigabit	\$89
11436-7	8 Port Gigabit	\$129
11535-7	16 Port Gigabit	\$349



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23001-7	3 Port Switch - Mini Plug	\$39
23002-7	4 Input, 2 Output Switch - Toslink	\$118
23006-7	Toslink to S/PDIF Converter	\$52
23005-7	S/PDIF to Toslink Converter	\$52
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What's New?

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15156-7	USB to VGA Adapter	\$179
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18210-7	Temp Logger Tag Only - 8000 Readings	\$69
18212-7	Temp & Humidity Logger Tag Only - 4000 Readings	\$199
17085-7	USB Temperature Sensor	\$169
17090-7	USB Temperature & Humidity Sensor	\$319
eSATA		
2459-7	PCI Express (PCIe) 1 Port eSATA Card	\$50
2462-7	PCI 2 Port eSATA Card	\$94
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6913-7	SATA 3.5" HD to eSATA & USB Combo Enclosure	\$85
1008319-7	SATA to eSATA Backplane - 2 Port	\$18
1008241-7	eSATA Cable 1m	\$14.50
Digital Microscopes		
3626-7	USB Microscope Basic	\$239
3685-7	USB Microscope with Microtouch	\$269
3686-7	USB Microscope with Microtouch Trigger	\$295
3687-7	USB Microscope PLUS with Measurement	\$359
3688-7	USB Microscope with Microtouch & Measure	\$499
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2450-7	Gigabit LAN	\$89
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2453-7	SATA II - 2 Port	\$99
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1008149-7	USB Barcode Scanner - Laser	\$359
1008178-7	Bluetooth Cordless Barcode Scanner - CCD	\$599
Assorted Hardware		
8264-7	Magnetic Card Reader Track 1, 2 & 3 - PS/2	\$139
5839BLK-7	Thermal Receipt Printer - Parallel	\$569
9512BLK-7	Cash Drawer - RJ12 (Connects to receipt printer)	\$179
5551-7	Mini Label Printer - 54mm Wide	\$239
5751-7	Zebra LP2844 Label Printer - 104mm Wide	\$659
9338-7	Cheque Reader - PS/2	\$718



Gadgets

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1168-7	Car PC 12v - 1Ghz 512Mb 80Gb WinXP	\$1659
3527-7	USB 2.0 Analog TV Tuner & Video Capture	\$119
3102-7	VGA to Video Converter with VGA Pass-through	\$149
2726-7	PCMCIA 2 Port Serial Adapter	\$269
2737-7	PCMCIA to Parallel Adapter	\$269
6741-7	IDE to Compact Flash Adapter - Front Access	\$99
2874-7	Independent RAID Server - Dual IDE HD with Hot Swap	\$569
2959-7	Independent RAID Server - Dual SATA HD with Hot Swap	\$599
1248-7	Windows CE Based Terminal with Wyse Emulation	\$699
1171-7	7" Touchscreen LCD - 12v DC	\$470
1173-7	8" Touchscreen LCD - 12v DC	\$579
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Dual mono 20W class-A amplifier wanted

Could you do a follow up article to the Class-A amplifier with details to make it into a dual mono design? I think that would interest a lot of readers, as that is what I intend on doing.

The only problem I have is that the specified transformer is \$90. So that makes \$180 (one per channel). Could you recommend any other toroidal transformers that will do the job?

**Jeff Heath,
Point Cook, Vic.**

Comment: the extra power transformer will not be your only added expense. At the very least, you will need two power supplies, two chassis and two loudspeaker protectors. Harbush Electronics (02 9476 5854) may be able to supply suitable transformers.

Fair go for tube lovers

As a long-time reader of your magazine from the first issue, I write again for you to reconsider your position on publishing a good tube amplifier design based on the classic Mullard principles.

From "never ever a valve amplifier project stance" at SILICON CHIP we have had everything but, as I recall a project

to convert computer power supplies to use in valve projects, a 12AX7 preamplifier, the Mudlark single-ended valve amplifier, a Nixie clock and even a 3-valve radio.

Please go the whole way and give us a valve amplifier project. You may be pleasantly surprised how popular this would be. Not all of us want to build Class-A amplifiers and many of us would like to express our individuality and not purchase mass-produced commercial items.

Don't forget: nothing too exotic, eg, EL34s, 12AX7, 12AU7, 20-30W per side, negative feedback and on the roll-your-own principle.

**Andrew Prest,
Sunshine, Vic.**

Headphones give too much isolation

The December 2008 issue has an article about an IR transmitter for headphones. All is well there except for the on-going problem of headphone isolation.

When one uses headphones (and they can sound great), they totally isolate the user from external sounds. This is what makes me reluctant to use headphones. For example, if the phone rings or there is a knock on the

door, you wouldn't know. There is a need to hear outside noises as well for headphones to work practically and not disturb others.

**Chris Bebb,
North Ryde, NSW.**

Jim Rowe's comment: Mr Bebb is entitled to his opinion but it is a matter of opinion. Mine is that when I am watching a movie or a TV program, I don't wish to answer the phone or respond to a knock on the door. There's a time and a place for everything.

Mini solar battery charger is not a good design

First, in contrast to my comments below, my praise to SILICON CHIP for a great publication. However, I have serious concerns regarding the "Mini Solar Battery Charger" in the February 2008 issue, from Oatley Electronics.

The "Why a 6V Solar Panel For a 12V Battery?" section does not explain why at all. In fact it goes some way to vaguely hint at why NOT to use a 6V panel to charge a 12V battery. It suggests that running a PV panel at its peak output voltage (thus power) point increases the power available to charge the battery.

This is true but this circuit cannot do that! In my opinion, the design

Project to erase watermark logos

I have been reading the ABC TV forum which has lots of negative views on the use of watermarks in general and the new ABC watermark logos in particular. Australian free-to-air channels are using them now and they are truly annoying to a significant percentage of viewers.

Nobody is listening, it seems and it's time to act. Watch less TV is one solution. Another is to tape a piece of grey paper to the screen! Yet another is to blot the watermark out electronically.

How about a device that takes in the signal (SCART, CVBS, etc) and inserts a rectangle in the picture, then outputs the modified video signal to the TV? Two front-panel pots could set the position and its hue and luminance could be an average of the picture composition in the area near the watermark.

This could be your most popular project! It would be pretty easy too, with an LM1881 sync separator, some line counters, a monostable or two, a video mixer, etc.

P. K., via email.

Comment: watermark logos are very

annoying but there is no easy way to remove them and your suggested cure might be more obvious than the logo. Some stations smear over the logos of overseas networks and then place their own over them (eg, SBS on their news bulletins).

It will also be problematic to do it with component video signals and probably impossible with HDMI signals from HD set-top boxes. We will have a look at the idea though.

We think that your idea of watching less TV may be the best plan and the one that networks would be the most sensitive to.

Compact fluorescent lamps can cause failures in PIR units

CFL lamps can pose some unusual problems. I recently replaced two 40W incandescent globes with two 5W compact fluorescent lamps (CFL) in a circular shaped porch light incorporating an infrared sensor, marketed by a well-known Australian manufacturer. The unit had worked without problems for three years but within a week of replacing the incandescents with CFLs, it failed.

After dismantling it, I found that the onboard switching device, a 4A Triac, had gone short circuit. It seems that the surge current taken by the CFL to charge its capacitors may exceed the rating of the low-power Triac.

A similar scenario occurs in computer switchmode power supplies. Early versions required the main power switch to be replaced

on a regular basis due to the heavy surge currents that could flow at the instant the switch is closed. That problem no longer occurs since manufacturers redesigned their units to ensure that initial surge currents remain at safe values. This is usually done by including a series-connected NTC resistor.

To repair my security light and maintain reliability, I used one such NTC resistor rescued from a faulty computer power supply and fitted it in series with the output of the control unit and the lamp socket.

Since CFLs are intended to be the lamp of the future, I believe that manufacturers of equipment where CFL lamps can be substituted have an obligation to ensure that product works reliably. If not, then it should clearly state that the product is unsuitable for CFLs.

**Heinz P. Harle,
Hinchinbrook, NSW.**

uses poor engineering practice that reduces the efficiency of the system over the conventional series-switched full Mosfet bypass designs.

The voltage drops on the three diodes (D4, D5 & D7) reduce efficiency, mainly at low PV temperatures when V_{OC} is lowest. Some brands of 4093 ICs have a large crossover current when used with input pulses of slow transition times (as in this circuit).

The shunt regulation method is outdated, especially as described in this project where I have serious concerns for the temperature coefficient of the design. Single stage regulation with no voltage adjustment is also poor design.

**Joe Anderson,
Macclesfield, SA.**

Wants a quality gold detector project

In writing this letter, I am hoping that the team at SILICON CHIP could develop a quality and effective gold detector. I say this because gold detectors of any real quality that are sold today, have a price tag of \$6000 to \$20,000 and beyond; see the beautiful units that Minlab and others make.

This pricing is way beyond the budgets of most people. A separate re-

chargeable battery pack, interchangeable coils of different diameters and coil styles are "must have" features in the design concept.

I hope you will consider this project, as cheap gold detectors even up to \$1000 today are absolute rubbish, mostly imported and non-repairable (or tuneable). Friends of mine have bought old detectors from the likes of eBay and other shops and are totally disappointed with the quality and effectiveness of the units.

What we need is a SILICON CHIP "classic", just like the 20W Class-A Amplifier.

**Laurie Lewellin,
via email.**

Comment: these devices should not really be called gold detectors; they are metal detectors and very few are even effective at that task. SILICON CHIP has featured a number of metal detectors over the years but our experience is that few designs can reliably detect anything more than about 10cm below the soil or sand surface.

MPG versus l/km

As an "oldie" I still convert the new-fangled l/km back to MPG to understand the actual fuel usage of a vehicle. To me, a mile is something I

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](http://www.jedmicro.com.au/avr.htm) 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**

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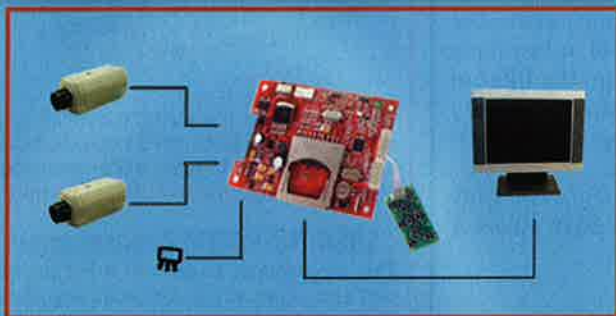
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Mailbag: continued

can visualise, whereas if someone were to ask me how far such a place might be I can always tell them within a couple of hundred yards in REAL measurements but in metric rubbish I am completely at a loss.

Why we ever had to try to change heaven knows. Thank goodness there are still some places in the world where common sense prevails. Thank you SILICON CHIP for presenting figures that are easily understood in your recent fuel consumption article.

John Macdonald,
Highton, Vic.

Imperial units still used in Australia.

I find all this comment on the use of imperial units very amusing given that I was born into the metric system.

If I had to describe myself to someone I would say I am 6ft tall and weigh around 80kg. I can't even visualise 1.83m!

On land we measure speed in km/h yet at sea it is knots (nautical miles/hour). Air pressure is measured in Pascals yet I have always been told to have at least 30 psi in my car tyres.

My grandfather was always talking about the mpg he could get since 40 mpg seems a lot more understandable than 7.062 l/100km. I guess at the end of the day we are always going to use quantities we can visualise. Ask someone to visualise how big a 200l tank would be - that's easy, it's the same size as a 44-gallon drum and we have all seen how big one of those is.

Duncan Wilkie,
East Bentleigh, Vic.

Microcontrollers & obsessions with low distortion

I am writing in response to your invitation in the editorial in the February 2008 issue regarding projects that use microprocessor control.

For me, electronics as a hobby began in the mid-1960s and unfortunately, practically all my early experience was on valve projects. I have a strong mathematics and statistics background (studied at university) but I am not an electrical or electronics engineer, nor do I work in the industry, so I rely very heavily on magazines like SILICON CHIP to give me the knowledge and understanding that I need for my lifelong hobby.

Occasionally I do build a published project but I make extensive use of the examples and techniques to design and build my own projects. For me, microprocessors are a mixed blessing. They are very powerful but the time needed to develop, test and debug the code for a given application is just too great, even though I did work for some years as a computer programmer.

I certainly support the use of a microprocessor in situations where the required functionality warrants it and it is a cost-effective solution. However, it is important that all aspects be taken into account, including the complex-

Radio & TV station listings wanted

Many years ago when "Electronics Australia" was still in publication they published a 3 or 4-page article containing all of the TV and radio (AM & FM) frequencies found in Australia and, from memory, New Zealand.

With the introduction of digital TV and the analog TV signal due to be turned off in 2009, I was wondering whether it might be time for your magazine, having become the leading magazine of its kind in Australia & New Zealand, to again produce a list of all the current TV (analog & digital) and radio (AM & FM) channels and frequencies?

**Paul Myers,
Karabar, NSW.**

Editor's comment: if I remember rightly, it was my decision, as the then-editor of "Electronics Australia", to cease publication of the radio and TV listings. Since then, they have become far more complex and it would take a great many pages to list the broadcast facilities you mention. You will see what I mean if you go to the ACMA website at http://www.acma.gov.au/WEB/STANDARD/pc=PC_9150

There you will see all the station call-sign frequencies. Just to list all the medium frequency AM stations would take four or five pages in SILICON CHIP.

ity, time and cost of using a microprocessor relative to alternatives, and the peripherals that may be needed, such as a PIC programmer or a remote control.

Microprocessors are clearly here to stay and anything that helps hobbyists understand them and use them in projects has my full support. However, their simplicity can be illusory; what goes on inside can be quite complex, as evidenced by some of the code I have seen written to deliver the functionality.

Also, I do think that over the years magazines like SILICON CHIP have made insufficient use of logic ICs and circuitry. These devices are not particularly expensive, a very wide range of types is readily available and many straightforward switching and control applications can be implemented using them. A single push-button, for example, can cycle through a string of on-off devices such as relays.

One frustration for me is that as far as I can recall there has not been a good series of articles on using logic devices and I have yet to find a book that covers the topic at an appropriate level for hobbyists. By contrast, op amps have been done to death and there are plenty of magazine articles and books available on programming and using microprocessors.

I would also like to comment on what sometimes seems like an obsession with low distortion and signal-to-noise ratio in SILICON CHIP's audio designs. For the great majority of people, the purist approach to audio, with its obsession with almost immeasurably low levels of noise and distortion, is just not relevant because the gains are inaudible.

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Mailbag: continued

Enhancing the enhanced voice recorder module

The Enhanced Voice Recorder Module described in SILICON CHIP for December 2007 allows the user to choose different recording times, with a trade-off in quality. The recording time is determined by the value of a resistor between the HK828 pin 7 (OSC R) and ground. This resistor is nominally 47kΩ but can be, for example, 24kΩ or 82kΩ as the article explains (this resistor was incorrectly labelled on the PC board layout and silk-screen overlay as 10kΩ).

Some constructors may want to experiment with different values but to avoid repeated unsoldering and resoldering of resistors, the following process can be used.

Firstly, solder a standard 0.1-inch header pin into each hole on the PC board where the 47kΩ resistor at pin 7 would otherwise be mounted. These two pins will be exactly 0.4-inch apart.

Next, obtain a 7-pin length of standard 0.1-inch single-in-line header socket strip to mate with the two pins. You will also need one resistor each of 24kΩ, 47kΩ and 82kΩ (or other values of your choice).

Wire up the header socket as

follows: solder the 24kΩ resistor between pins 1 & 5, the 47kΩ between pins 2 & 6, and lastly the 82kΩ between pins 3 & 7.

This header assembly will fit in three ways onto the two pins, thus connecting whichever resistor you require. (If required, an 8-pin header socket would allow the choice of four resistors but that is the maximum).

Finally, in response to your February 2008 Publisher's Letter, I believe your balance is about right. One of the strengths of SILICON CHIP is the excellent range and quality of your construction projects, a key reason for my long-standing subscription. I fully agree with your use of microcontrollers as the only practical way for many modern projects. They provide a very cost-effective way of satisfying those who, like me, very much enjoy construction projects and their subsequent testing and measurement.

I would not want to see an increase in articles on new developments in electronics. There are many other sources available for such information but very few magazines producing excellent construction projects.

Garth F. Jenkinson,
Emerald, Vic.

I do not question the desirability of getting distortion and noise down to inaudibly low levels but one should also be realistic. Does the relatively inexpensive NE5532 linear op amp really sound inferior to more expensive alternatives in typical applications?

From what I have read, few if any people can pick the difference between a S/N ratio of 100dB and 120dB, even when listening with high-quality headphones. In addition, distortion levels below 0.01% are inaudible provided that is the case at all power levels and across the full 20-20,000Hz frequency range. Remembering that even top-quality speaker systems will have distortion of 0.5% or more also helps to keep things in perspective.

I have built a number of SILICON CHIP's power amplifier modules that

use discrete transistors and I really cannot pick any audible difference between them, despite wide variations in the specs. Perhaps the golden-ears brigade can hear the difference but I do not belong to that elite! However, the SILICON CHIP modules do all sound audibly cleaner than my two Sony AV receivers (900ES and 1200ES) and one need only look at the specs to see why.

Among good-quality amplifier modules, the only one I have used that sounds audibly better than others is the design using nested differentiating feedback loops (modules) developed by Prof. Cherry of Monash University (now retired) and published in ETI in April 1988 (I believe that one of the major Japanese manufacturers snapped-up the patent and shelved

Not enough microcontroller projects

I don't think that SILICON CHIP is doing enough microcontroller projects and at the same time, is not detailing "pure electronics" projects. This being the 21st century, deliberately shying away from microcontroller projects is not keeping up with trends. Before there are too many objections from the pure electronic camp, please bear with me until the end. I think we might be on the same wavelength in some areas.

As noted in the Publisher's Letter (February 2008), using a micro can make a complex project very simple, in terms of the electronic components used, that is. This means it's cheaper and usually easier to build. I have submitted a couple of project ideas in the past, only to have them rejected as being "too complex", which always surprised me, as in terms of components they were mostly a micro, with some assorted bits attached.

One thing that may make micro projects more palatable would be a greater emphasis on the internal logic in the articles. Diagrams showing what the code is doing and very brief code listings (you can download full code from the website) will help newcomers and oldies alike in

deciphering the project's workings. You could also rip the code block from one project to build a totally new one.

Also, by encouraging more discussion on the internal logic, you'd encourage this better way of programming; much better than having a spaghetti mess of code sludge, which may very well work, but no-one can learn from it, nor utilise it in their own projects.

The idea of explaining how and why a project is put together in code should also extend to the conventional circuitry projects. Too often do I see a project article which has a very complex conventional circuit but very little in terms of the electronic activity going on.

In that sense, putting together a complex conventional circuit is much the same as putting together a micro circuit. At the end of the day, some functionality in code logic or the same functionality in a raft of conventional circuitry ends up being the same. We should be reading about the implementation and theory, not only the construction. I'd encourage writers to have in the back of their mind that they want to teach someone something new.

One thing to note, we are no longer in the days where everyone would have a data book, where you look

up the operation of this chip or the other in conjunction with the circuit and be able to work things out. You can download a data sheet from the internet but how many people would do that for every chip on a conventional circuit? Explaining the operation of the logic of say a divider, 7-segment output or counter can be done easier with a code segment than a pointer to a website data sheet which most people would probably not look up.

As an aside, let's have more SMD projects as well. As someone who builds their own PC boards, I find not having to drill as many holes much nicer. It is not hard to solder SMDs if you select your SMD components for hand solderability.

Philip Pulle,
Bilgola, NSW.

Comment: as always, we need to maintain a balance when it comes to providing lots of information in our projects, whether it is on the electronic circuit or code operation. As it is, many of our project articles do become very long and we are aware that this can be a turn-off for some readers.

Inevitably, we will have more SMDs in our projects in the future and the article on soldering SMDs in the March 2008 issue is a prelude to that.

it). This design also uses group delay in one of the feedback networks so that a low-frequency square-wave is amplified without droop. Keep up the great work.

Brian Knight,
Principal Research Consultant,
National Centre for Vocational
Education Research Ltd,
Adelaide, SA.

Comment: we admit to an obsession

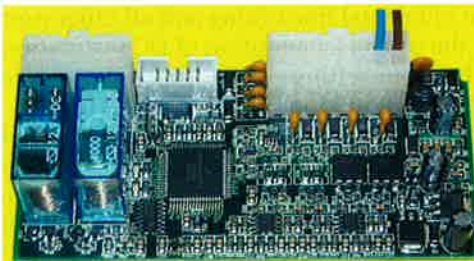
with low distortion and S/N ratios. The aim is to have an amplifier that causes no degradation to the signals from a good quality CD player.

TV restoration followed sound principles

"Restoring a Vintage TV Set" by Timothy Stuart (December 2007) brought back memories of the era. The arrival of polyester capacitors

and modern resistors in 1960/61 was a lifesaver for technicians and the receivers they serviced. If sets had been built with polyesters from 1956, their servicing history would have been much better.

Four years after the initial sales of TVs, when new 17-inch sets were becoming rare and when picture tubes were supposed to be failing but were not, paper capacitors were certainly



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For the first time ever, complete and in one handy DVD, every article and every issue is covered. If you're an old timer (or even young timer!) into vintage radio, it doesn't get much more vintage than this. If you're a student of history, this archive gives an extraordinary insight into the amazing breakthroughs made in radio and electronics technology following the war years. And speaking of the war years, R & H had some of the best propaganda imaginable! Even if you're just an electronics dabbler, there's something here to interest you.

**NB: Requires a computer with DVD reader to view
– will not work on a standard audio/video DVD player**

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Mailbag: continued

showing their failings, especially in the summer time. TVs were pulling 200 watts plus from the mains and a large part of that was being dissipated as heat in a confined space. Faults showed up first in the more critical oscillator circuits and so on, and finally in the audio sections. Capacitor leakage could easily be demonstrated to the customer by squeezing one with pliers and observing the change in the fault condition.

From 1961 on, with the new Philips polyester capacitors available, I began advising customers that for the cost of three or four service calls (being the annual average at that time), we could give their set a complete chassis overhaul for better performance and reliability, as in the article. In all cases, this included realignment of the RF, video and sound circuits. Sometimes it went further to include modifications for better performance such as better video frequency response, video DC restoration, vertical linearity, etc. Then there was the picture tube, a cabinet respray and an antenna system repair as a possible necessity also.

The gratifying outcome was often (a) I was reluctant to let go of the set (they could keep the loan set); (b) their children said it wasn't their set, it was so much better; and (c) a recommendation to a relative which produced a request to "come and pick up my set and make it as good as theirs".

I particularly remember returning five years later to a 21-inch brother of Timothy's chassis. A 5AS4 rectifier was all that was required. Timothy expects reliability to be much improved. I can guarantee it!

As the sets had not been idle for a long time, we did not normally replace the electrolytics or bring them "up to speed" with a variac but we did "variac" them down to about 215V to show up valves that would soon need replacement. Mains voltage drop was still prevalent in the sixties.

Another procedure was the "five seconds off, then on again" test on the highest frequency channel, to check for an immediate return of the picture and a lack of snow involving the valves in the tuner. There is a resistor, usually about a 1M Ω , in the RF section of the tuner that is worth replacing.

My pet gripe with many TVs of the time and even into early colour was the decision not to incorporate DC coupling from the video output to the CRT. This meant that the set could not be adjusted for the correct black level. I could never figure the reason. It wasn't expense. Was it some attempt at covering user incapability? Timothy's AWA model 229 and other receivers can be modified with some small circuit changes to the video output/CRT circuit.

The elimination of manual fine tuning and all other user adjustable knobs, the universal adoption of DC restoration and factory default colour settings means that most people now view a faithful reproduction of the original video.

This brings to mind the Astor ASK model which had a row of identical small cream and gold knobs across the centre panel. From memory the knobs were brightness, contrast, hor.hold, vert.hold, height and at least one vertical linearity. If somebody fiddled with them, it took some skill and knowledge to get a normal picture back on the screen,

especially if the fine-tuning was into the sound carrier as well. As a solution, I used to put a small pencil mark at the correct 12 o'clock position on every knob for easy resetting.

An example of the woeful pictures that some people watched involved a call to a 17-inch Kreisler (a set capable of very good reception). The picture was a foggy blur. The reason – the brightness and contrast controls were full on in an attempt to get through three layers of cigarette smoke, on both sides of the safety glass and the face of the picture tube.

Fortunately, the glass came out with only the removal of two screws and not the removal of the chassis, picture tube and mask from the rear of the cabinet.

Having cleaned off the muck and turned down the controls, I then adjusted the fine tuning knob. This was followed by exclamations from the three smokers along the lines of “what a beautiful picture!” and “what did you do?” When shown, they said they thought it was just a dummy knob to balance up the volume knob on the other side!

With today's TV we only need to adjust the volume and we get digital high-definition widescreen colour and a remote control. Best of all, we get a ‘mute’ button.

**John Williamson,
Cheltenham, Vic.**

Comment: anyone interested in restoring old TV sets should look to acquire a few as soon as possible. Even old colour sets disappearing very rapidly.

Electric cars are coming

After seeing the Publisher's Letter and the subsequent negative comments in the January 2008 issue, I think electric cars are coming.

For example, use Google to check out reports on the recent Detroit motor show and then have a look at news on the following websites:

<http://www.fiskerautomotive.com/>
http://www.news.com/8301-11128_3-9850711-54.html?tag=nefd.top
<http://www.tomw.net.au/technology/transport/reva.shtml>
<http://www.pluginamerica.org/>

Finally, have a look at the race between an electric car and a Ferrari at: <http://www.youtube.com/watch?v=BqqtJpfZELQ>

**Bob Barnes, RCS Radio Pty Ltd,
Chester Hill, NSW.**

Electric vehicles were suppressed in the USA

I enjoyed the Publisher's Letter about electric cars in the December 2007 issue and thoroughly agree.

Had technological advances been able to take their natural course the internal combustion engine would have been obsolete in the 1950s. Unfortunately, oil was and still remains profitable. Consequently, technology was and is being suppressed.

I was reminded of a documentary called “Who Killed The Electric Car?” It told the story of the General Motors electric car called the EV1 which was produced in 1996. It was fast and had awesome acceleration, over 100 miles

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per charge with NiMH batteries and over 300 miles with Lithium; charging was 80% in an hour and 100% in four hours.

Ten years later all the cars were rounded up and crushed. One remains, disabled, in a museum. Ford, Honda and other electric vehicles also suffered the crushing or shredding fate. I thoroughly recommend that anyone interested in this topic watch this documentary.

I'm also reminded of the small electric car that the Solar Shop here in Adelaide tried to market. It sat forever in a crate waiting for the appropriate government departments to get off their behinds. They claimed lack of a “category” to register it under. In Europe they had a different approach: they just created a new category and got the thing into the market and onto the road.

**Jacob Westerhoff,
Seaford Rise, SA.**

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Beyond the capacitor there is

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And you always thought that the Farad was a ridiculously large unit . . . Start thinking in KILOFarads!

by Ross Tester

Some time in the not-very-distant future you will pick up your cordless drill and start drilling away – with more power than you ever thought possible. And it will keep on drilling for much longer than you thought possible.

The drill will look and feel the same as current cordless drills but it will have one major difference: it won't contain a battery. Instead, it will get its power from a capacitor.

Needless to say, it won't be a "normal" capacitor. In fact, it's so abnormal it has a new name: an ultracapacitor (or sometimes a supercapacitor). While the terms have been somewhat interchangeable, they're starting to be used more selectively, with ultracapacitors denoting the larger values.

Already (at least in the US) there are rechargeable tools on the market which use ultracapacitors instead of batter-

ies, such as the Coleman Flash Cell Screwdriver and the Superior Tool Co Ultracut Cordless Tube Cutter.

And without realising it, you may well be using one already: many computers these days use an ultracapacitor, or at least a supercapacitor, in place of the batteries once used for CMOS backup. They're also found in many other devices doing the same task – video recorders and even digital alarm clocks, for example.

We're already seeing ultracapacitors starting to be used in a wide variety of industrial applications, such as lifts (elevators) and electric forklifts. In both of these, power is used to lift a load and until now, power has been required to limit the downward travel, or at best hydraulics used, with the energy wasted.

Now ultracapacitors are finding their way into new designs. When the lift descends, its motor-generator pumps



A hybrid test car on a test track in England, powered by the CSIRO-developed UltraBattery – a combination of an ultracapacitor and lead-acid battery. Photo courtesy Advanced Lead-Acid Battery Consortium.



power back into an ultracapacitor. When a forklift brings a pallet down from the warehouse shelf, its motor converts to a generator and recharges the ultracapacitor.

Another interesting ultracapacitor application, already in use, is in wind turbines. Some now have ultracapacitors to supply the power needed to turn the blades into the wind or adjust blade angles when they themselves are not supplying power, or to smooth out the variations caused by changing windspeed.

Start thinking big!

The backup supercapacitors used in computers, DVRs etc, are midgets compared with those used in vehicles and industrial tasks.

You can already find supercapacitors at your local lolly shop, with ratings of perhaps 0.5F to 50F and voltages up to (usually) 5.5V. Ultracapacitors are still rather harder to get (and very much more expensive). They tend to start at about 100F and go up into the kFarads – but more importantly, voltage ratings are up into the 100V+ range and if you believe recent publicity from one US manufacturer, well up into the thousands of volts. That becomes very important, as we shall see.

By the way, you did read that correctly: Farads. Not nF or even μ F. Not so long ago, a 10,000 μ F capacitor was regarded as very big. And remember when you started in electronics and wondered why the Farad was the unit of capacitance, when everyone knew it was a huge value and you always had to divide by a million or more to get to useable values? Not any more!

Electric vehicles

In the future, both hybrid electric vehicles (HEVs) and plug-in electric vehicles (PEVs, ie, electric power only) may be powered by ultracapacitors, perhaps instead of batteries but just as likely, as current research suggests, in tandem with them.

The photo on the facing page shows a Honda Insight HEV fitted with an UltraBattery, developed by Australia's CSIRO, built by the Furukawa Battery Company of Japan and tested in the United Kingdom through the American-

siliconchip.com.au

Ultracapacitor + Lead Acid Battery = UltraBattery

Australia's CSIRO has combined a supercapacitor and a lead acid battery in a single unit, creating a hybrid car battery that lasts longer, costs less and is more powerful than current technologies used in hybrid electric vehicles (HEVs).

Tests have shown the UltraBattery has a life cycle that is at least four times longer and produces 50% more power than conventional battery systems. It's also about 70% cheaper than the batteries currently used in HEVs. By marrying a conventional fuel-powered engine with a battery to drive an electric motor, HEVs achieve the dual environmental benefit of reducing both greenhouse gas emissions and fossil fuel consumption.

The UltraBattery also has the ability to provide and absorb charge rapidly during vehicle acceleration and braking, making it particularly suitable for HEVs, which rely on the electric motor to meet peak power needs during acceleration and can recapture energy normally wasted through braking to recharge the battery.

Over the past 12 months, a team of drivers has put the UltraBattery to the test at the Millbrook Proving Ground in the United Kingdom, one of Europe's leading locations for the development and demonstration of land vehicles.

CSIRO's ongoing research will further improve the technology's capabilities, making it lighter, more efficient and capable of setting new performance standards for HEVs.

The UltraBattery test program for HEV applications is the result of an international collaboration. The battery system was developed by CSIRO in Australia, built by the Furukawa Battery Company of Japan and tested in the United Kingdom through the American-based Advanced Lead-Acid Battery Consortium.

UltraBattery technology also has applications for renewable energy storage from wind and solar. CSIRO is part of a technology start-up that will develop and commercialise battery-based storage solutions for these energy sources.

(CSIRO)

The Coleman "Flash Cell" cordless screwdriver, now available in the US, uses a 5.4V ultracapacitor instead of a battery. It has a 90-second recharge.



based Advanced Lead-Acid Battery Consortium.

The most significant aspect of the photo, taken at the Millbrook Proving Ground in the UK, is that this Honda has exceeded 160,000km on the test track.

Like just about all ultracapacitor manufacturers, the CSIRO and the consortium are keeping the details of the UltraBattery pretty close to their collective chests but as we saw in the article in SILICON CHIP February 2008, it is not too-difficult a task to add significant battery capacity (or in this case UltraBattery capacity) to the Honda to give it a much greater range on battery power alone.

Incidentally, Honda has also developed an ultracapacitor in conjunction with a fuel cell in their quest for the perfect HEV/PEV.

Yet another use of ultracapacitors is in electric buses and trains, where ultracapacitors not only supply acceleration-from-rest (ie, peak) power but can also handle and store the regenerative braking energy which batteries find much more difficult, thus saving up to 30% of total energy.

The same system is very likely to find its way into HEVs and PEVs as they start to become more popular. A huge amount of research is currently under way around the world into these vehicles as the search for an alternative to fossil fuels heats up.

Despite the fact that ultracapacitors appear to be a recent development, they have been around for decades – at least in the laboratory and in some specialised (expensive!) applications. They got a big “kick along” late last century when NASA realised that they would be very useful as peak-power enhancers in spacecraft. Fuel cells used in spacecraft are somewhat similar to batteries: great at supplying base-load power but needing help to supply peak-load power. Ergo, ultracapacitors.

Why the hype?

OK, so what is the big advantage of ultracapacitors over rechargeable batteries?

There are several:

(1) They offer much better peak power performance than a battery. A battery's output is basically limited by the rate of the chemical reaction inside it without overheating. An ultracapacitor has no chemical reaction so peak currents can be much higher.

(2) There is less heat to dissipate.

(3) They can be discharged much more deeply than a



Honda's ultracapacitor module was designed for the Honda FCX Clarity hydrogen fuel-cell-powered car (shown right), which goes on limited lease in the US around the middle of this year.



A 2500F (or 2.5kF) Maxwell Power Cache Ultracapacitor. Note the low operating voltage (2.7V) – this means that many of these must be used in series to obtain any type of reasonable voltage rating. The photo at right shows the same capacitors installed in a Honda EV conversion. (Photos courtesy www.metricmind.com).

battery (in fact, usually to zero, long past the point where most batteries will have been irreparably damaged if not destroyed). To be fair, that's also long past the point where the ultracapacitor can supply any useful power.

(4) They can be charged very, very quickly – with many ultracapacitors already in use in road vehicles, the time to charge is not too dissimilar to the time to fill fuel tanks (a few minutes or so). Battery recharge time is usually measured in hours.

(5) They are lighter (sometimes very significantly so) than batteries of similar ratings and occupy no more space (usually less).

(6) They can be cycled many, many more times than a battery. With careful cell management, most rechargeable battery systems are limited to perhaps 10-20,000 charge/discharge cycles. Ultracapacitors are usually rated at between 100,000 and 500,000 cycles (and we've seen some claims of a million).

(7) Overall life expectancy is a lot longer than a battery – the guarantee is usually 10 years but this would be regarded as a minimum. Theoretically, the life of an ultracapacitor is indefinite.

(8) Ultracapacitors do not deteriorate anywhere near as much in performance as they age. With batteries, the chemical reaction decreases as they age.

And the negatives?

Having digested all that, there must be some disadvantages. Yes, there are a few:





(1) Until now, ultracapacitors have not had the energy density of batteries. However, that may be changing – and significantly – if recent manufacturers' announcements come to fruition.

(2) Voltage ratings of the current crop of ultracapacitors are very low. With PEVs operating anywhere up to a few hundred volts, you need to put a lot of ultracapacitors in series. And when you connect capacitors in series, the capacitance decreases.

(3) The moment you start using power from an ultracapacitor, the voltage starts to drop and keeps dropping. It obeys all the usual laws of capacitors! This may or may not be a problem, depending on the device being powered. When used in conjunction with a battery as a peak-load supply, as soon as the peak load is delivered the battery will recharge the ultracapacitor.

(4) They're expensive! So are high-power rechargeable batteries, of course – and the price of both will come down as volumes increase.

(5) Finally, there is a lot of hype. Some amazing claims have been made by ultracapacitor manufacturers (to impress investors?) and in too many cases, they have turned out to be vapourware.

What's inside an ultracapacitor?

No one has re-invented the laws of physics when it comes to ultracapacitors. They are still capacitors and they obey all the rules we've learned long ago.

First, let us refresh your memory about the construction of capacitors. Here, two conductive "plates" are separated by an insulating material which we refer to as a dielectric. The capacitance is directly proportional to the size of the plates and the dielectric constant of the insulating material. At the same time, the capacitance is inversely proportional to the distance between the plates; the smaller the spacing, the larger the capacitance.

In the case of electrolytic capacitors, the "plates" take a different form. The capacitor is a wound element of aluminium foil which has been etched to greatly increase its surface area. At the same time, its surface has a very thin oxide layer produced during manufacture. Finally, it is wound with a porous paper layer which is impregnated with a conductive electrolyte paste and this makes the

TELEGESIS ETRX2



WORLD'S FIRST ZigBee PRO COMPLIANT MODULE

PRESS RELEASE

ZigBee module makes the Pro league

The Telegesis ZigBee module product range has successfully achieved certification based on the ZigBee Pro feature set of the ZigBee standard. The widely-acclaimed Telegesis AT Command layer has been tested by US test house National Technical Systems, where Telegesis was granted ZigBee certification.

This makes the Telegesis ETRX2 the world's first ZigBee Pro compliant module. The ETRX2 is a low-cost low-power ZigBee transceiver that can be embedded in a wide range of devices to produce self-organising self-healing wireless meshes.

All Telegesis ZigBee Pro products are built around the Ember EM250 chip with core mesh networking technology provided by Ember Corporation's EmberZnet 3.1 software.

The new meshing RF module will allow companies to tap into the lucrative ZigBee market for wireless control and monitoring products with no in-house RF engineering experience.

ZigBee is now a technology that is truly ready for use in real-world applications and Telegesis envisage rapid expansion throughout 2008 as ZigBee is applied to a wide range of wireless solutions.

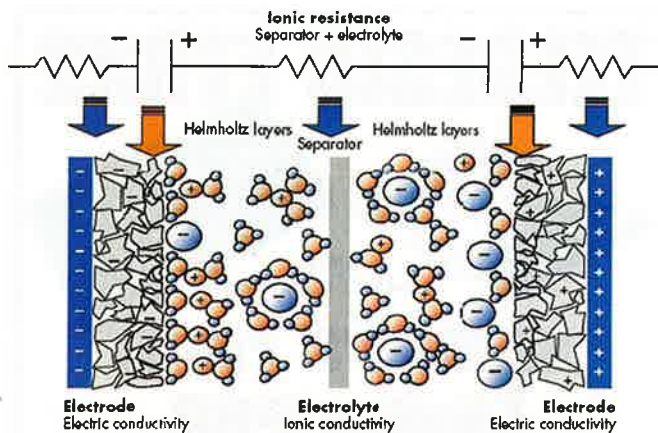
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This illustration, courtesy of electronicdesign.com, shows the inside of an ultracapacitor. It's easy to see why they are regarded as two capacitors in series.

electric connection to the can of the capacitor.

So in an electrolytic capacitor, the positive “plate” is the wound aluminium foil element and the aluminium oxide “skin” is the dielectric. Finally the electrolyte paste is the negative “plate”. This combination of a very large surface area (ie, the etched surface) together with a very thin dielectric (aluminium oxide) layer gives rise to the very large values of capacitance that we have come to expect with electrolytic capacitors. But ultracapacitors far surpass electrolytics!

Ultracapacitors also contain two “plates” of sorts. But the “plates” are formed on the surfaces of nano-porous materials, typically activated charcoal or carbon nanotubes surrounded by an electrolyte. These nano-porous materials have much larger surface areas than the etched aluminium foils of electrolytic capacitors.

Nor do ultracapacitors have a conventional dielectric, as such. They are based on a structure that contains an electrical “double layer”. In a double layer, the effective thickness of the “dielectric” is exceedingly thin – in the order of nanometres – and that, combined with the very large surface area, is responsible for their extraordinarily high capacitances.

When a DC voltage is applied across the porous carbon, compensating accumulations of cations or anions develop in the solution around the charged electrodes. If no electron transfer can occur across the interface, a “double layer” of separated charges (electrons or electron deficiency at the metal side and cations or anions at the solution side of the interface boundary) exists across the interface.

The amount of capacitance depends on the area of those porous carbon electrodes and the size of the ions in solution. The capacitance per square centimetre of electrode double layers is roughly 10,000 times larger than those of ordinary dielectric capacitors.

That's because the separation of charges in double layers is about 0.3-0.5nm, a lot less than the 10-100nm in electrolytics and the 1000nm in polystyrene or mica types.

However, you never get something for nothing. Effectively, you have two capacitors in series. So straight away capacitance is halved.

The double-layer configuration reduces the potential capacitance of a practical device yet again because the ultracapacitor consists of a pair of electrodes, each with half

the total mass. Taken together, that means the ultracapacitor achieves one quarter of the theoretical capacitance based on electrode area and ion size.

The future of ultracapacitors

We alluded to some pretty amazing claims earlier. EECor, one of the up-and-coming performers of the US stock market recently, has been researching nanotube technology and have also announced what amounts to breakthrough technology in their ultracapacitors.

EEcor use barium titanate coated with aluminium oxide and glass to achieve a level of capacitance claimed to be much higher than anything else currently available in the market. While yet to be independently verified, the claimed energy density is a whopping 1.0MJ/kg – actually higher than a battery. Existing commercial supercapacitors typically have an energy density of the order of 0.01MJ/kg and a lithium-ion battery has an energy density of 0.54-0.72MJ/kg.

If true, there is a rather significant downside: a PEV using such ultracapacitors could not, using existing technology and domestic wiring, plug in! To transfer that amount of energy in the times claimed would melt the local substation. OK, slight exaggeration perhaps – but the point is real.

It has been suggested that a second EECor ultracapacitor could be used to slowly charge, using cheap off-peak power – and *that* plug into the PEV to transfer the energy in say 5-10 minutes.

Someone must believe EECor because they have had some significant money invested in them, including the Canadian ZENN motor company (which plans to release an EECor-powered electric vehicle this year) taking an EECor licence worth an estimated \$US3-5 million and venture capitalist house KPBC putting in another \$US3 million.

Incidentally, EECor are not the only ones researching ultracapacitors. Australia's own CSIRO is also one of the main players in the game (see press release earlier) and there are many organisations around the world trying to come up with their version of the holy grail.

The leading manufacturers of ultracapacitors today are Maxwell Technologies in the United States, NESS Capacitor Company in South Korea, Okamura Laboratory in Japan, and EPCOS in Europe.

Energy

Finally, we mentioned earlier that the voltage rating of a capacitor (including, of course, an ultracapacitor) is very important.

The reason for this lies in the formula for energy stored in a capacitor:

$$E = 0.5CV^2$$

It's the V^2 term that makes all the difference. Doubling the voltage doesn't simply double the energy – it quadruples it. So running an electric vehicle, a drill, a forklift – anything – from a higher voltage is very advantageous.

The problem is, as we have seen, ultracapacitors have a very low voltage rating. Ultracapacitor cells must be stacked in series to lift that rating and as every electronics student knows, you get lower capacitance that way.

Some researchers are claiming much higher cell voltage ratings: the world is waiting to see if they can deliver! **SC**

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Frequency: 0.5Hz-3MHz (2.5MHz for Ramp and Pulse) in six steps

Output waveform: Sine, Square, Triangle, Positive Pulse and Negative Pulse

Min output: No Load 0.1V p-p; 50 Ohms load 0.05V p-p

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1/6

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digitor

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NEW



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Camcorder, Digital Camera Battery Charger
Lithium Ion battery charger suitable to use with most digital camera and camcorder batteries. Also can charge AA, AAA NiMH batteries. M9559

\$79⁹⁹

21

Last month, we introduced the topic of Digital TV and strongly advocated the purchase of a High-Definition Set-Top Box or Personal Video Recorder. In this second part, we discuss the antenna installation and what you need to do to ensure the most reliable and interference-free reception.



How to get into Digital TV Pt2: What to do about **THE ANTENNA**

MANY PEOPLE THINK that there is no need to change an existing TV antenna in order to pick up digital TV broadcasts. In some cases, your old antenna may do the job.

In most cases though, you will be better off with a completely new antenna installation, with an antenna selected to suit the digital broadcasts for your area.

First, let's look at the situation where your existing antenna is a VHF Yagi, log periodic or other antenna type such as a phased array. Most likely, this will be sized to cover all the channels in the VHF band, including channel 0. In other words, it will be a large and ugly structure of aluminium tubing that the local bird life has enjoyed for years.

And while this may have done sterling service for the analog channels, the fact that it is large enough to cover channels 0-5 will be a distinct drawback when analog TV broadcasts cease at the end of 2009.

Why? Because the antenna will continue to pick up all manner of extraneous signals which can interfere with digital TV reception, including high-power AM & FM radio transmissions and interference from power lines. The simple fact is that digital TV broadcasts in the VHF band are only on channels 6-12.

So your large VHF array is still an antenna but now it also picks up signals that you don't want!

VHF digital antennas are smaller

A new VHF antenna for the digital channels will be much smaller (because it doesn't have to get down to channels 0 and 2) and less obtrusive. Not only that, because it does not have to cover such a wide frequency range, it will more than likely have slightly more gain than your previous analog antenna.

Perhaps even more importantly, there are some areas of Australia where digital television will only be transmitted on UHF. No VHF antenna will receive UHF properly, despite the anecdotes from "a mate who knows someone" who receives a marvellous UHF picture from the antenna they erected in 1956...

Table 1 shows the wanted channels on the VHF and UHF bands for digital TV in both Australia and New Zealand.

We will discuss the UHF TV bands

AUSTRALIA

Analog		Digital	
Real Channels	Frequency Range (MHz)	Real Channels	Frequency Range (MHz)
0 - 5A	45 - 144	Not used due to interference	
6 - 11	174 - 222	6 - 9A, 10 - 12	174 - 230
28 - 69	526 - 820	27 - 69	519 - 820

NEW ZEALAND

Analog		Digital	
Real Channels	Frequency Range (MHz)	Real Channels	Frequency Range (MHz)
1 - 3	44 - 68	Not used due to interference	
4 - 12	174 - 230	27 - 34	518 - 590
28-34, 38-62	526 - 838	38 - 62	606 - 838

Table 1: comparison between the existing analog channels and their digital counterparts for both Australia and New Zealand. As you can see, in the digital bandplan the bottom end of the band is used in neither country.

later in this article. For the moment, let us compare analog and digital signals and how they perform with varying signal strength.

Signal strength and the "digital cliff"

Over many years, we have all become used to the characteristics of analog TV reception. When the signal is weak, the picture is referred to as "noisy" and this looks like snow. As the signal strength is increased, the snow effects of noise are greatly reduced until they are virtually unnoticeable (except perhaps in dark or poorly-lit scenes - often this is due to noise in the cameras or videotape recorders used in the original program).

With digital signals though, you

either have the right amount of signal or you have no picture.

Fig.1 illustrates this point very well. The red line shows the effect of varying signal strength on analog pictures and it is just as we have noted immediately above.

By contrast, the blue line shows how, if you have a very weak or a very strong signal, the result is the same: no picture.

In fact, the message displayed on your screen will be "no signal". It doesn't necessarily mean that you aren't receiving enough signal (though of course it can mean that) - it can also mean that you are actually receiving too much signal for the receiver to be able to handle and therefore display a picture.

This is referred to as the "digital

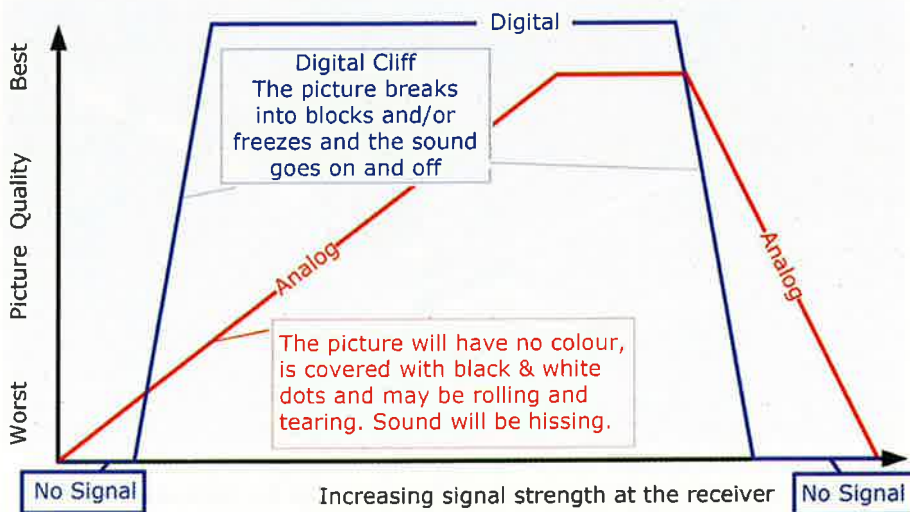


Fig.1: the digital cliff, represented by the blue line, shows how too little or too much signal results in a "no signal" message on your TV screen. For analog (the red line) there will always be something on the screen, even if it is only snow.

Signal Problem	Analog Reception	Digital Reception
Weak Signal	Snow all over the image which becomes stronger as the signal becomes weaker	No effect, until at the cliff edge, picture & sound break up; picture may become jerky in horizontal movement; no picture (no signal indicated on-screen).
Reflected Signals	Multiple images (ghosts). Not generally seen in very weak signals.	No effect.
Impulse Interference	Generally a slow moving pair of horizontal lines of black & white dots.	No effect, until at the cliff edge, picture & sound break up.

Table 2: there is quite a difference in the way TV receivers behave, depending on the type of signal being received.

cliff" whereby pictures are good and completely noise free over a wide signal range but non-existent outside this range.

Ghosting

Table 2 above reinforces the story about the differences between analog and digital signals. We have already talked about weak signals and the effects on analog pictures but possibly a bigger and more common problem with analog is the effect of reflected signals which give rise to ghost images.

These can be very annoying and difficult if not impossible to eradicate, even with a more directional antenna, more judicious aiming, etc. Even when you have an otherwise strong signal, ghosts can spoil the picture.

For example, if you are looking at the ABC weather map with the labelling for all the regions in your state, not only will you see the wanted labelling but you will see "ghost" labelling to

the left and right of the picture.

Even if you are not conscious of this problem, you will often see one, two or more faint vertical lines in the picture. These too are ghosts and in fact are ghosts of the horizontal sync pulses that are part of the transmission.

Aircraft flutter

Then there is "aircraft flutter" whereby TV signals reflected from large aircraft flying over your home cause the picture to shake violently and ghost images rapidly flash on and off the screen.

Even the best antenna installations can suffer from this and the only remedy is to move house to where you are no longer under the flight paths. That's not a realistic option, is it?

The really good part about digital TV is that all these ghosts are banished forever. If nothing else, this is a very worthwhile improvement. And there won't be any snow in the picture either.

All that and you get a sharper picture as well!

Impulse interference

Electrical interference in analog pictures typically takes the form of a slow moving pair of horizontal noise bands consisting of black and white dots although the noise can be coloured as well.

If the interference is coming from power tools or from a food processor, it will often be accompanied by a whining commutator noise in the sound.

Other impulse interference can be caused by the poorly suppressed ignition systems of older cars, motorbikes and even motor mowers. This will cause more widely-spaced black dots in the picture and is accompanied by a characteristic ignition noise in the sound.

These and other forms of electrical and radio interference can be identified in analog TV transmissions by ACMA's "Better Radio & TV - Identify Your Interference Problem" available at www.acma.gov.au/webwr/assets/main/lib100342/btr_handbook.pdf and by "New Zealand Radio Spectrum Management" at www.rsm.gov.nz/cms/reception-problems.

The bad news is that digital transmissions can be more vulnerable to impulse noise than analog. Worse, in most cases of impulse interference to digital transmissions, the effect is the same - loss of picture. So there is no clue as to the cause!

Australian metropolitan viewers note: after December 2009 you will not be able to use analog TV effects to identify the cause of troublesome digital reception. Instead, problem identification will have to be performed using a spectrum analyser and/or a digital meter which can measure signal strength and signal data errors.



This digital-only combined VHF/UHF Yagi from Hills is so new it's not scheduled to go into production until next month! Note the quite short VHF elements on the rear of the antenna - short because they don't have to pick up the low frequency (and therefore longer wavelength) VHF channels which are analog-only. The short UHF elements are on the front of the boom in front of the driven element and corner reflector.

This gear is expensive, even for professional antenna installers.

Fortunately, one good way to reduce impulse interference to digital reception is to avoid using an old analog antenna which will pick up extraneous noise over the frequency range for channels 0-5A. The other strategies involve careful antenna selection and installation.

Just in case we have not made the point strongly enough about the need to upgrade your antenna, here is a further point to consider.

There are 59 viewing areas in Australia which presently have analog TV transmitters using channels 0-5A. This includes all capital cities except Darwin & Canberra.

Ideally, viewers in all of these areas need to replace their antennas with ones designed for the digital channels in their geographic areas to ensure maximum reliability of reception.

Which antenna for you?

The most stable reception comes from antennas designed for the range of channels in your viewing area. Station coverage maps for your area can be found at www.acma.gov.au/postcode/postcode_acma.shtml;

Area Served	Callsign	Network	Power (ERP - kW)	Population
Armidale North	ABN5A	ABC NSW	0.1	690
Bowen shire	ABTQ5A	ABC Qld	10	2213
Bowen shire	TNQ1	10 Qld	8	
SW WA (Bunbury)	SSW3	GWN (Prime WA)	100	200,000
Gordonvale	TNQ2	10 Qld	1	4420
Herberton	TNQ5A	10 Qld	0.04	794
Kambalda	VEW3	GWN	0.02	2705
Leeman	ABW5A	ABC WA	0.06	396
Mission Beach	TNQ5A	10 Qld	0.2	992
Mount Garnet	ABNQ2	ABC Qld	0.024	879
Murrurundi	NBN1	NBN	0.1	805
Wandoan	ABQ5A	ABC Qld	0.16	676
Wynyard	TNT5A	Southern Cross	2	4812
Total affected population excluding SW WA				19,382

Table 3: these are the only sites which require a VHF band 1 and/or 2 antenna.

while the channel numbers used can be found at www.acma.gov.au/web/standard/pc=PC_9150.

For New Zealand, browse to www.rsm.gov.nz/cms/policy-an-planning/current-projects/broadcasting/digital-television-2007-frequency-plan.

It was once popular to install TV antennas inside the roof space (ie, above the ceiling) but this only works well in very strong signal areas – and it's worse for UHF reception. An outdoor antenna is always the best because it will be less affected by reflected signals (which cause ghosting in analog

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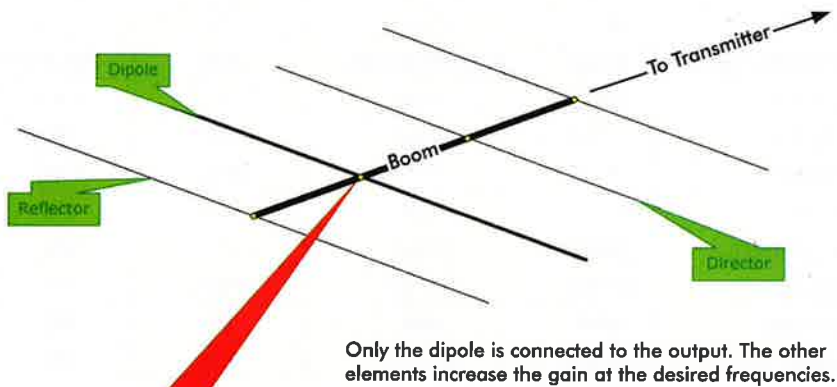
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Yagi Antennas

Horizontally Polarised



Vertically Polarised

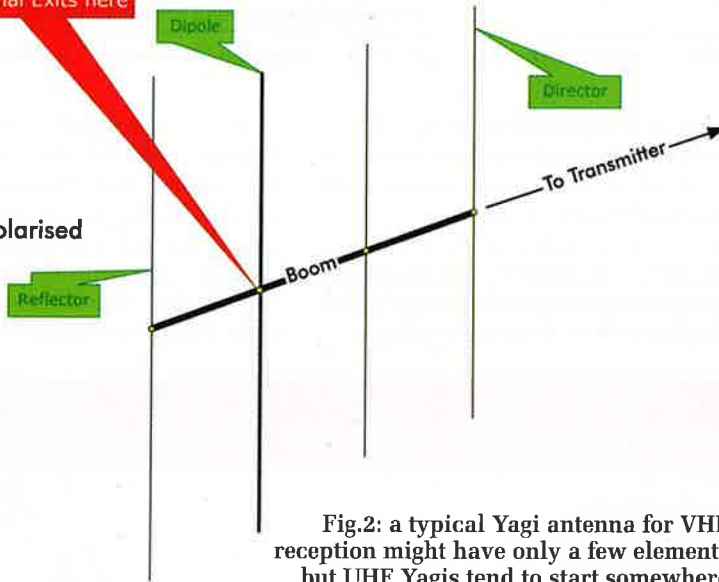


Fig.2: a typical Yagi antenna for VHF reception might have only a few elements but UHF Yagis tend to start somewhere around six or so and go right up to dozens in deep fringe models.

pictures but which should still be avoided for digital reception). They are also less affected by metal roofs, metal sarking under tiles, water on tile roofs, etc.

Indoor antennas

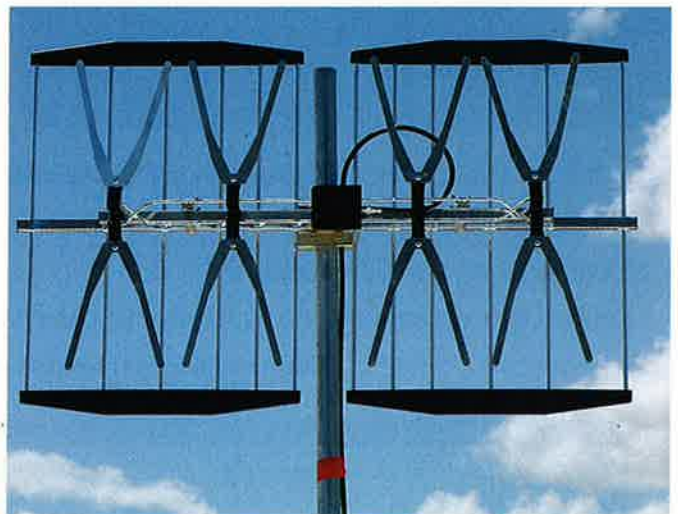
If you live in a home unit which shares a master antenna system, the body corporate may be quite reluctant to spend money on a new digital TV antenna when the old one obviously still works (on analog!). In this case, or if you cannot use the signal from an outdoor antenna for some other reason, an indoor antenna can be tried. However, it is very much a second choice.

The most common style has two telescopic rods and is usually known as "rabbit's ears". All these antennas have similar performance regardless of price.

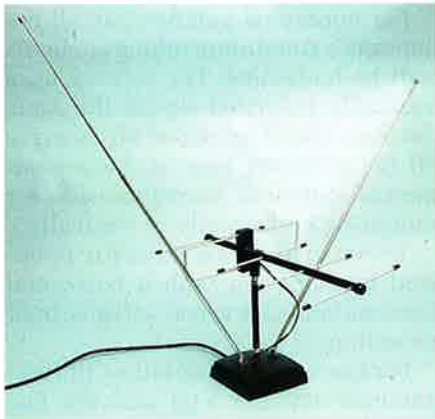
To get the best from these antennas they should be flattened out into a straight line and be the correct length. The ideal lengths are as follows:

- VHF Band 3, Channels 6-12: 745mm tip to tip
- UHF Band 4, Channels 27-36: 270mm tip to tip
- UHF Band 4+, Channels 27-49: 248mm tip to tip
- UHF Band 5, Channels 36-69: 215mm tip to tip

There are also indoor antennas with telescopic rods and a mini Yagi which will perform better at channels 27 and above. Some indoor antennas come with internal amplifiers but unfortu-



Examples of horizontal (left) and vertical (right) polarisation on this Matchmaster 02MM-MDU36 4-bay phased array (also known as a 4-bay bowtie) antenna from Jaycar Electronics. We have to say it's one of the better-made digital TV antennas we have found – so good, in fact that it sits on a short mast on top of the SILICON CHIP offices, aimed at the North Head repeater.



Here's one of those combined rabbit's ears/Yagi antennas. We always thought they were a bit of a joke – but if you're in a strong signal area and don't have access to an outside antenna, one of these might just be all you need!

nately they will amplify interference as well.

Connect the antenna to a long fly lead to get the antenna as far away from the receiver as possible (it is a source of interference) and as close to the outside of the building as possible (preferably on the transmitter side).

For the indoor antenna shown here, you only need to set the long rods to 745mm from tip to tip. Now rotate it so that the thick black boom is pointed at the transmitter.

UHF antennas

If you are installing a new antenna and you can receive signals from a UHF translator, you are far better off going for a band 4 or band 5 UHF antenna. This can be a Yagi design or a phased array (also known as a 4-bay bowtie antenna).

In strong signal areas, you can choose a relatively short Yagi but in weak signal areas where you are a long way from the transmitter tower or the antenna "looks" through a lot of trees

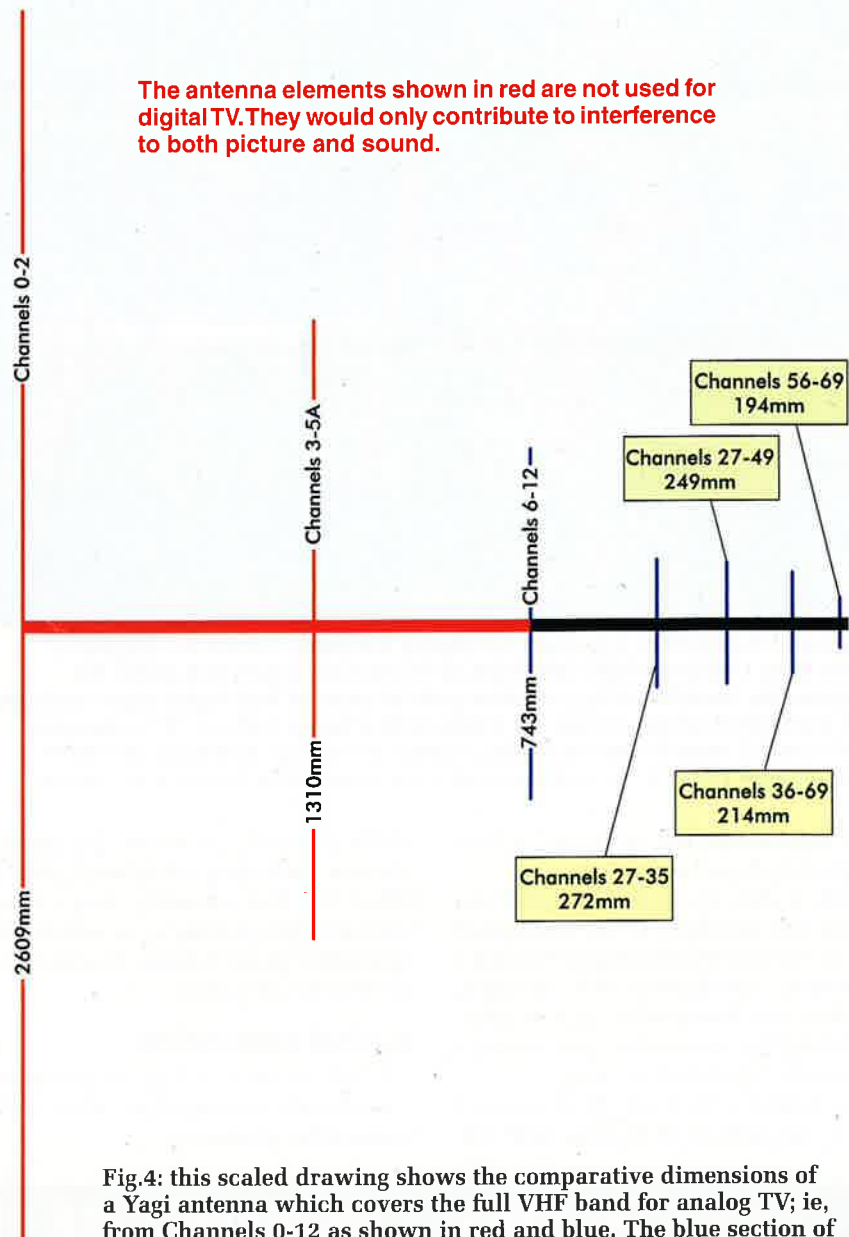


Fig.4: this scaled drawing shows the comparative dimensions of a Yagi antenna which covers the full VHF band for analog TV; ie, from Channels 0-12 as shown in red and blue. The blue section of the diagram shows the equivalent Yagi for VHF digital TV which covers Channels 6-12. As can be seen, the digital antenna is far more compact but it will have slightly more gain for the channels of interest.



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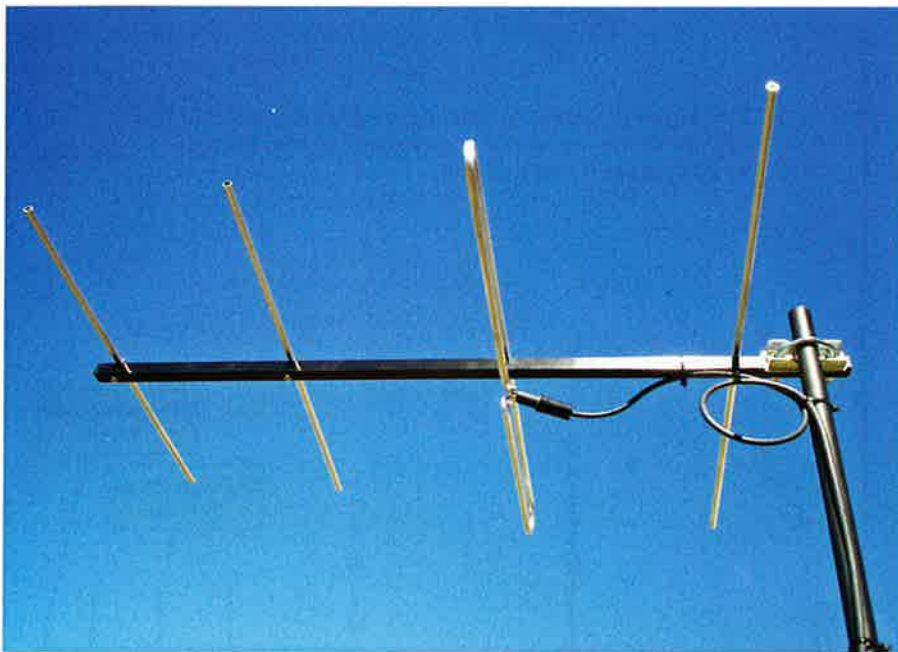
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and vegetation, you will need a long Yagi or a phased array.

Either way, make sure the UHF antenna you purchase is recommended for Australian (or NZ) channels. Don't purchase a European UHF antenna, as these are designed to operate from 470-900MHz, equivalent to Australian channels 20-81 (NZ 21- 69).

In Australia channels 20-26 are used for 2-way radios, including UHF CB,

while channels 70-80 are for mobile phones including wideband CDMA (Next G). You certainly don't want your antenna picking up 2-way radios or mobile phone signals, so don't use a European antenna!

Typical installation

The first point is that your antenna must have the same polarisation as the transmitter's antenna.

For horizontal polarisation, all the antenna's aluminium tubing elements will be horizontal. For picking up a vertically polarised signal, the same antenna would be rotated 90° to make all the elements vertical. Most commercial antennas have provision for mounting horizontally or vertically.

Trying to receive a vertically polarised transmission with a horizontal antenna (and vice versa) will give poor reception.

For horizontal polarisation, the best antennas are the Yagi and the Log Periodic Array. However, for vertical polarisation the best antenna is a phased array.

In general, the bigger the antenna, the greater the signal pick-up but it must only be designed for the digital channels you wish to receive.

The antenna mounting should be at least a metre above the peak of the roof, particularly if the transmitter is on the opposite side of the house. It should not be surrounded by vegetation, particularly between the antenna and the transmitter. This will give poor reception when it is raining.

If you have direct line of sight to the transmitting antenna (in other words, you actually have a clear view of the tower), then the antenna need only be mounted about a metre above the roof guttering.

If you have multi-storey house and you have a clear view of the transmitter in a strong signal area, you could even mount a UHF bow-tie array (ie, phased array) on the wall of your house; to

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obtain an unobtrusive installation.

Mount the antenna as far as possible away from train/tramline wiring and high-voltage power lines. It is a good idea to mount it away from busy streets as well. Use the building as a shield if possible.

If two separate antennas are required for different bands, then a diplexer can be used to mix their signals together onto a single download cable. In such cases, the minimum clearance on the pole or mass is 900mm.

Quad shielded coax cable

The minimum recommended cable for all digital TV installations is quad-shielded RG6 coax. This has relatively low signal loss and four separate layers of shielding to keep signal and interference pickup low. Do not skimp by using cheaper cable intended for analog installations (eg, standard RG59). If you subsequently find that impulse interference is causing your digital reception to break up or give the "no signal" message, you will regret taking the cheap approach.

There are better cables available than RG6 – both lower loss and better screened – but these tend to be rather expensive and are only recommended for particularly difficult installations.

Cable losses increase with both length and frequency. For RG6 cable at channel 6 the loss is around 9dB/100m whereas at channel 69 it is 20dB/100m.

The cable should be routed away from mains wiring but if that is unavoidable, the antenna cabling should cross mains wiring at right angles. Never run antenna cable and mains power cable along close parallel paths.

The stronger the signal from the antenna, the less effect any interfering signals picked up by the cable will be.

What's a dB?

We should explain those signal loss figures for cable, quoted above in dB/100m. These are comparisons of signal power between two points, the most common examples being at the antenna terminals and at the plug going into the TV set, ie, the total cable length.

If the difference is -3dB, for example, that means that half the signal picked up by the antenna is lost along the cable. A figure of -10dB means that

just one tenth of the signal is getting through to your TV set.

TVs, STBs and PVRs all contain automatic gain controls (AGC) which will compensate for these losses unless you are near the digital cliff.

If you have a long cable length, a masthead amplifier can be used to make up for the cable losses. Masthead amplifiers have positive values of dB (ie, gain instead of loss). So if a cable has a loss of -20dB and you insert a 20dB amplifier, you will compensate for the loss although some noise will inevitably be added.

Incidentally, it is a common misconception that a masthead amplifier will perform some miracle and amplify signal that isn't there! If there is no signal at the antenna terminals, no masthead amplifier can make it appear. If the signal is very weak, the masthead amplifier will increase it but it will increase the noise level at the same time, as well as adding its own amplifier noise.

The main task of a masthead amplifier, as described above, is to compensate for losses in the cable (especially over long runs) and, to a lesser extent, losses in the splitters and connectors.

For best picture quality, the masthead amplifier should only boost the signal sufficiently to bring it comfortably into the operating range of the receiver, while adding as little noise as possible.

Splitters & connectors

Most homes have more than one TV set. Indeed, many have three, four or even more and these all need a connection point. To provide these, you need a splitter but this comes with a loss of signal strength. This will be at least -3dB for two outlets (ie, a 2-way splitter), -5dB for three outlets and -6dB for four outlets. Amplified splitters are available if the digital signal is on the "digital cliff".

Be aware that if you also have a masthead amplifier, low-voltage DC (or sometimes AC) power is required to run it. The system is normally designed so that power will only pass through one of the outlets. This is the one with a power socket on it near the receiver.

Only use amplified splitters if you know that the signal strength is marginal. You do not want the situation where the insertion of one or more

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amplifiers in the signal chain actually causes the signal to be too strong and thus force it over the "digital cliff".

Remember, in the case of digital TV, too much signal is as bad as too little. It is better to use a masthead amplifier to boost the signal where it is cleanest, rather than use an amplified splitter.

F connectors & flyleads

The "F" connector is fast becoming the standard, both at the antenna end and at the wall plate. It is the best because the connection is screwed together and there is less possibility of signal reflections being generated at the cable join.

Quite often these days, the coax socket in wall plates makes a very sloppy connection with typical TV "flyleads" and these can be a major source of signal loss and intermittent noise in the picture.

With that aspect in mind, wall plates with F connectors have to be a major improvement. Flyleads from the wall to the TV are now available in quad shielded coax, with a male "F" connector on one end and a male "PAL" plug on the other.

SC



Charge controller for 12V lead-acid or SLA batteries

Upgrade your standard 12V lead-acid battery charger or solar cell booster to a complete 2 or 3-step charger using this Charge Controller. It includes temperature compensation and LED indication. All parameters are adjustable for charging lead-acid or Sealed Lead Acid (SLA) batteries.

MOST LEAD-ACID CHARGERS are very basic and simply pump current into the battery until it is switched off. The main problem with this type of charger is that ultimately it will overcharge the battery and may seriously damage it.

Adding a fully automatic Charge Controller to a basic charger will overcome these shortcomings. It will also prolong the life of your batteries and allow a battery to be left on a float charge, ready for use when required.

A typical lead acid battery charger is shown in Fig.1. It comprises a mains

transformer with a centre-tapped secondary output. The output is rectified using two power diodes to provide raw DC for charging the battery. A thermal cutout opens if the transformer is delivering too much current.

Battery charging indication may be as simple as a zener diode, LED and resistor. The LED lights when the voltage exceeds the breakdown voltage of the zener diode (12V) and the forward voltage of the green LED (at around 1.8V). Thus the LED begins to glow at 13.8V and increases in brightness as the voltage rises. Some chargers may

Main Features

- Suits 12V battery chargers up to 10A rating
- Lead Acid & SLA charging
- Cyclic & float charging
- Optional absorption phase
- LED indication
- Fixed & adjustable parameters
- Temperature compensation

also have an ammeter to show the charging current.

The charging current to the battery is provided in a series of high current pulses at 100Hz, as shown in Fig.2(a).

The nominal 17V output from the charger will eventually charge a battery to over 16V if left connected long enough and this is sufficient to damage the battery. This is shown in Fig.2(b)



By JOHN CLARKE

where the battery voltage required for full charge (called the cut-off voltage) is exceeded when left on charge for too long. By adding in the Charge Controller, we can do much better.

Fig.3 shows how the Charge Controller is connected in between the charger and the battery. The Charge Controller is housed in a compact diecast aluminium case. However, if your charger has plenty of room inside its case, the controller could be built into it.

In effect, the Charge Controller is a switching device that can connect and disconnect the charger to the battery. This allows it to take control over charging and to cease charging at the correct voltage. The various charging phases are shown in Fig.4.

The Charge Controller can switch the current on or off or apply it in a series of bursts ranging from 20ms every two seconds through to continuously on. During the first phase, called "bulk charge", current is normally applied continuously to charge as fast as possible. However, with low-

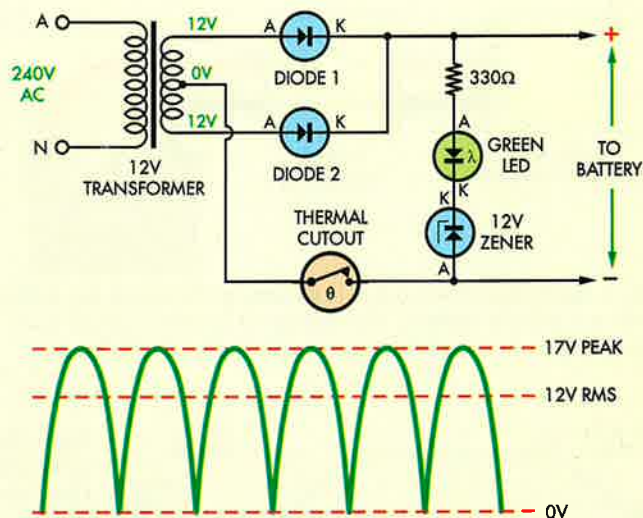
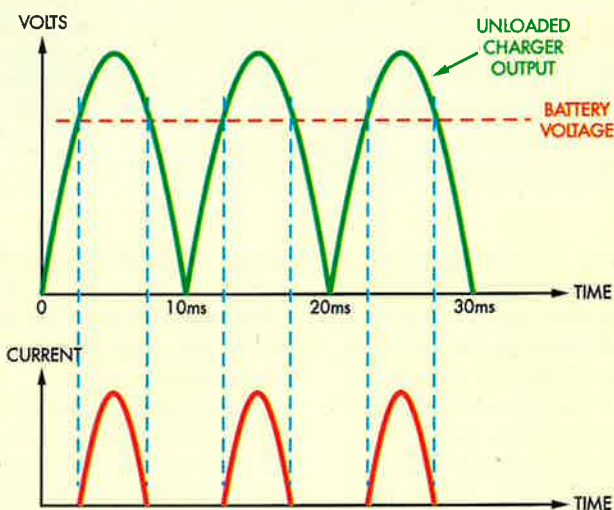
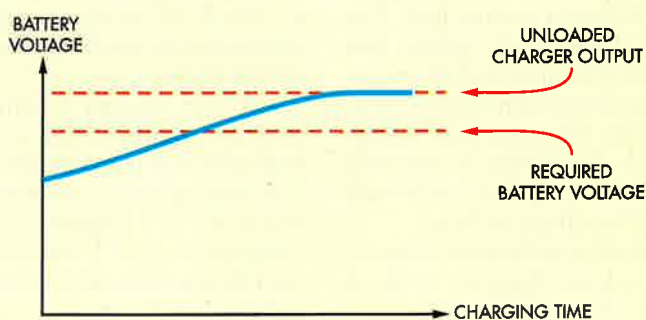


Fig.1: a typical lead-acid battery charger. It consists of a centre-tapped mains transformer and a full-wave rectifier (D1 & D2). There's also a thermal cutout and a LED indicator to show when the battery is charged.



(A) CHARGING VOLTS AND CURRENT



(B) CHARGING CHARACTERISTIC

Fig.2(a): the charging current from the circuit shown in Fig.1 consists of a series of high-current pulses at 100Hz. This can over-charge the battery if the charger is left on long enough, as indicated in Fig.2(b),

capacity batteries where the main charging current is too high, reducing the burst width will reduce the average current. So, for example, if you have a 4A battery charger, the current can

be reduced from 4A anywhere down to 1% (40mA) in 1% steps, using the charge rate control.

After the "bulk charge" phase, the Charge Controller switches to the "ab-

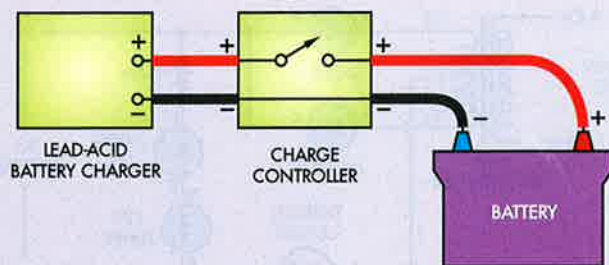


Fig.3: the Charge Controller is connected between the battery charger and the battery. This allows it to take control over charging and to cease charging at the correct voltage.

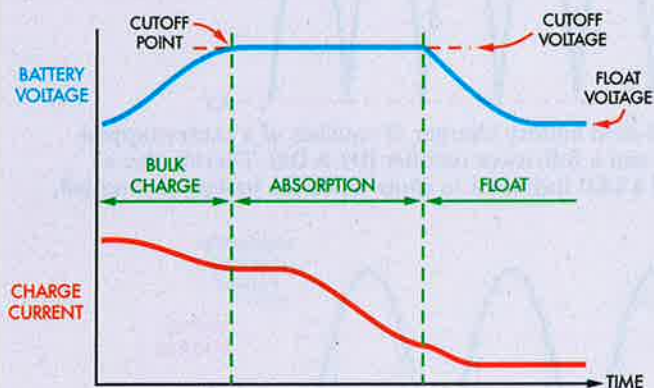


Fig.4: this diagram shows the three charging phases. It starts with a “bulk” charge, then switches to the “absorption” phase for an hour and then finally switches to “float charge”.

sorption” phase. This maintains the cut-off voltage for an hour by adjusting the burst width and it brings the battery up to almost full charge. After that, the Charge Controller switches to “float charge”. This uses a lower cut-off voltage and a low charge rate.

Where the charge rate control is set to less than 100%, the switch from absorption to float will occur when the burst width drops to 1% or after an hour, whichever comes first. The absorption phase is an option that can either be incorporated in everyday charging or you can opt to just go to float charge after the bulk charge phase. When absorption is selected, this phase will be bypassed if the bulk charge takes less than an hour.

This bypassing prevents excessive absorption phase charging with an already fully charged battery.

Cut-off & float voltages

The actual cut-off and float voltages are dependent on the particular battery, its type and the operating temperature. For lead-acid batteries, typical cut-off and float voltages at 20°C are 14.4V and 13.8V. For sealed lead acid (SLA) batteries, the voltages are lower at 14.1V and 13.5V, respectively.

These values are preset within the

Charge Controller using the internal Lead-Acid/SLA jumper shunt.

Alternative values are possible and can be set manually from 0-16V in 48.8mV steps.

These voltage settings can be compensated for temperature changes; as the temperature rises, the voltages should be reduced. Lead-acid batteries typically require -20mV/°C compensation while SLA types typically require a -25mV/°C compensation. These values can be set from 0 to -50mV/°C in 256 steps.

For our Charge Controller, temperature compensation is applied for temperatures between 0°C and 60°C. No charging is allowed at temperatures below 0°C. A Negative Temperature Coefficient (NTC) thermistor inside the Charge Controller is used for temperature measurement.

Four trimpots are used to make the various settings.

LED indicators

There are five LED indicators. LED1 (orange) flashes when the temperature is below 0°C but otherwise does not light unless the thermistor connection is broken.

LED2 (red) indicates the “bulk charge” phase while LED3 (orange)

and LED4 (green) are for the “absorption” and “float” phases. Note that there is an option for the Charge LED to indicate when charge is being applied to the battery during the absorption and float charge phases. If this is not required, it can be disabled so that the Charge LED only lights during the bulk charge.

LED5 (green) indicates that a battery is connected but is not an indication that charging is occurring.

Circuit description

The complete circuit of the Charge Controller is shown in Fig.5. It uses a PIC16F88-I/P microcontroller (IC1) to monitor the battery voltage and adjust the switching of an N-channel Mosfet (Q1) to control the rate of charging.

Q1 connects in the positive supply line between the charger output and the battery. Gate drive for Q1 comes from a transformer-coupled supply that can typically provide 15V to the gate when it is required to switch the Mosfet on.

The transformer-coupled gate drive arrangement allows us to use an extremely rugged but low cost N-channel Mosfet rated at 169A, 55V and with a 5.3mΩ on-resistance.

To switch on the Mosfet, IC1 delivers a 500kHz square-wave signal from its pin 9 (PWM) output to a complementary buffer stage using transistors Q2 and Q3. These drive the primary winding of toroidal transformer T1 via a 3.3nF capacitor. The secondary windings of T1 step up the voltage by just over three times and the resulting AC waveform is rectified with diodes D2-D5 and filtered with a 120pF capacitor. This process delivers a nominal 16V DC to Q1's gate via diode D6. This turns Q1 on to feed current to the external battery.

Zener diode ZD2 is included to prevent the Gate to Source voltage of Q1 exceeding 18V.

While turning the Mosfet on is fairly straightforward, turning it off is more involved because we want switch-on and switch-off to be as fast as possible, to keep switching losses to a minimum.

Hence, to turn off Mosfet Q1, the 500kHz signal from IC1 is switched off. With no signal at T1's secondary, the voltage across the 120pF capacitor is discharged via the 220kΩ resistor. This discharge does not directly bring the gate of Q1 to 0V because it is iso-

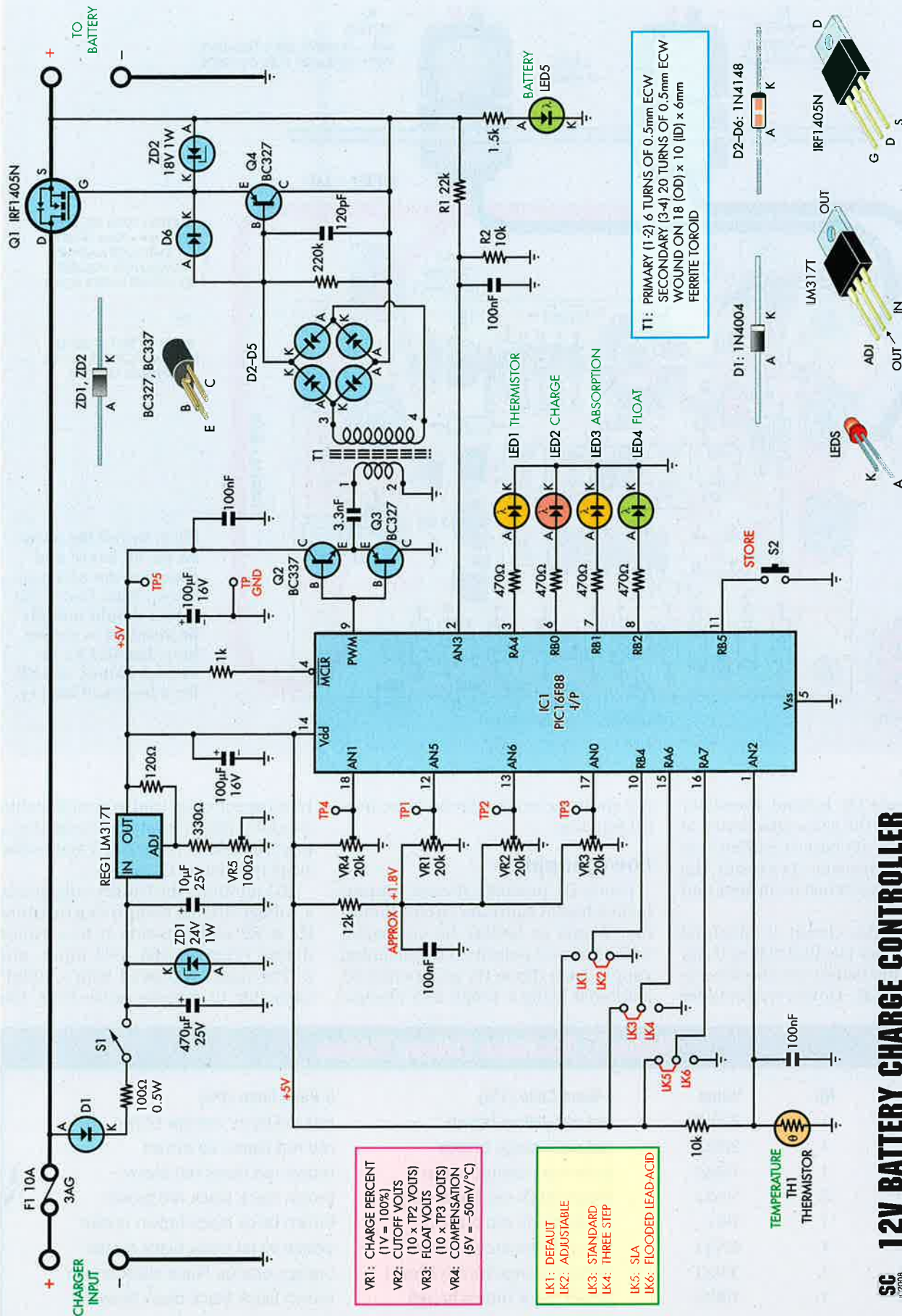
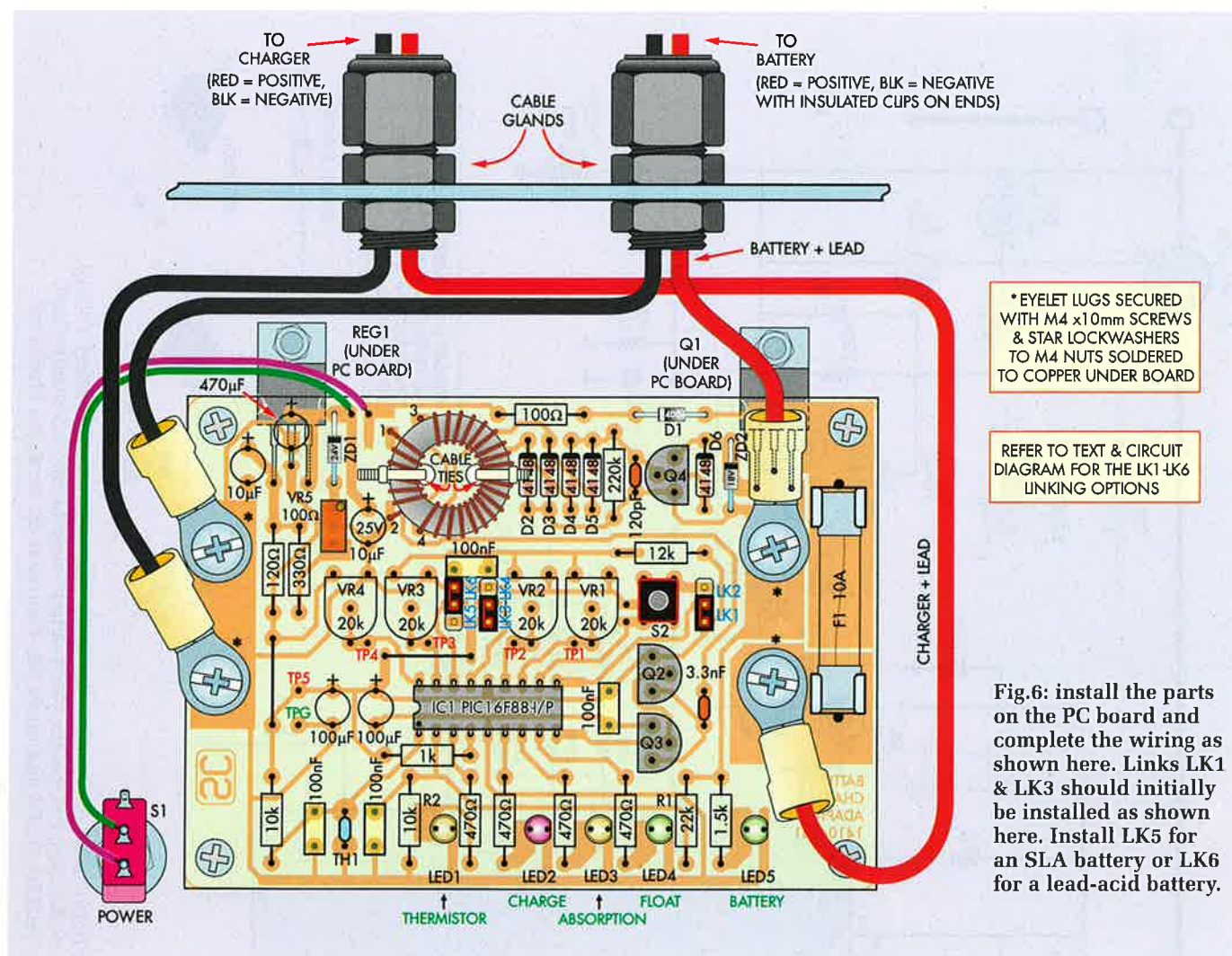


Fig.5: the circuit of the 12V Battery Charge Controller is based on a PIC16F88-1/P microcontroller (IC1). This monitors the battery voltage and pulse width modulates N-channel Mosfet Q1 to control the rate of charging. Pin 9 is the PWM output from the microcontroller and this drives Q1's gate via buffer stage Q2 & Q3, transformer T1, bridge rectifier D2-D5 and diode D6. Transistor Q4 turns the Mosfet off.



lated via diode D6. Instead, transistor Q4 discharges the gate capacitance of the Mosfet, as its base is pulled low via the 220k Ω resistor. As a result, the Mosfet can be switched on in 56 μ s and off in 69 μ s.

Power for the circuit is obtained from the charger via diode D1 or it can come from the battery via the reverse diode within Q1. However, the latter

is a spurious mode which has no useful function.

Power supply

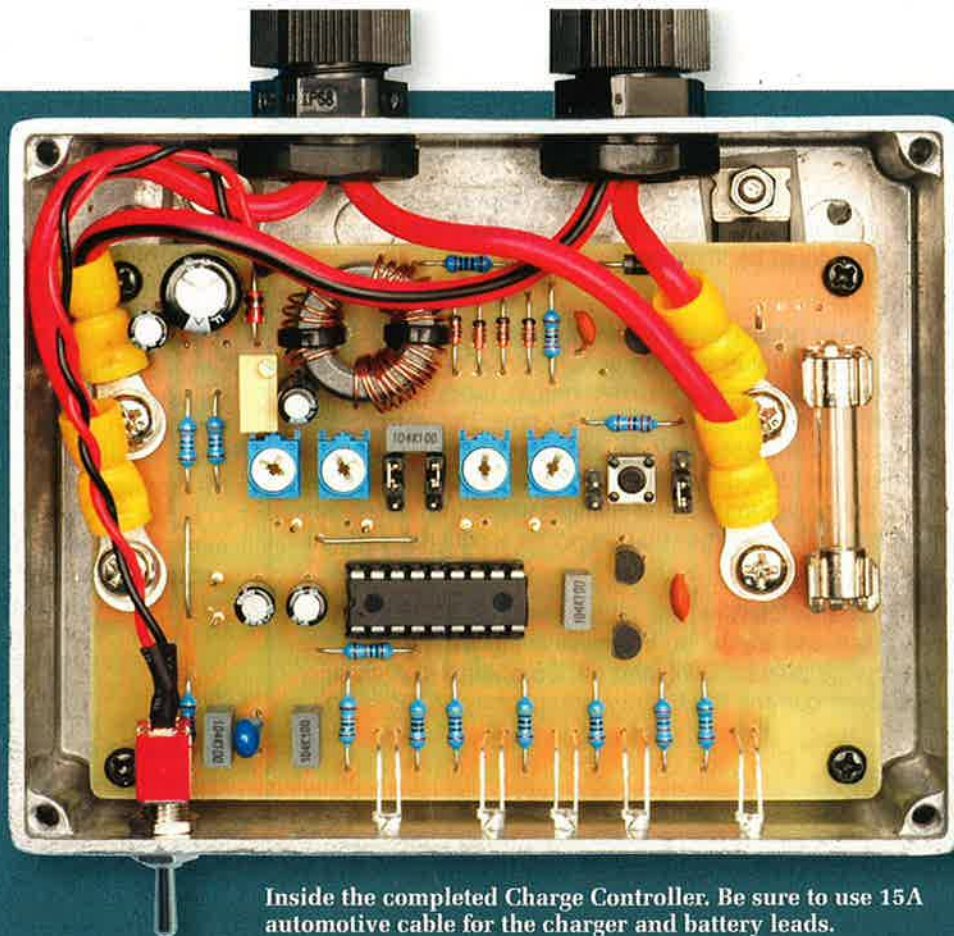
Diode D1 prevents reverse current to the Charge Controller circuit should the charger or battery be connected with incorrect polarity. The incoming supply from diode D1 and switch S1 is filtered using a 470 μ F 25V electro-

lytic capacitor and fed to an adjustable regulator (REG1) that is set to deliver a precise 5.0V. This feeds IC1 and buffer stage transistors Q2 & Q3.

IC1 monitors the battery voltage via a voltage divider comprising resistors R1 & R2 and converts it to a 10-bit digital value via the AN3 input, pin 2. The signal is filtered with a 100nF capacitor to remove noise from the

Table 1: Resistor Colour Codes

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
□	1	220k Ω	red red yellow brown	red red black orange brown
□	1	22k Ω	red red orange brown	red red black red brown
□	1	12k Ω	brown red orange brown	brown red black red brown
□	2	10k Ω	brown black orange brown	brown black black red brown
□	1	1k Ω	brown black red brown	brown black black brown brown
□	4	470 Ω	yellow violet brown brown	yellow violet black black brown
□	1	330 Ω	orange orange brown brown	orange orange black black brown
□	1	100 Ω	brown black brown brown	brown black black black brown



Inside the completed Charge Controller. Be sure to use 15A automotive cable for the charger and battery leads.

measurement. Furthermore, the battery voltage measurements are made after the 500kHz signal from pin 9 is switched off.

In addition, having Q1 switched off also prevents voltage fluctuations due to charging current in the leads to the battery.

Temperature measurement

As already mentioned, an NTC thermistor is used to measure temperature. It is connected in series with a 10k Ω resistor across the 5V supply. The resulting voltage across the thermistor fed to the AN2 input (pin 1) and converted to an 8-bit digital value. IC1 then computes the temperature with a look-up table. IC1 can also sense whether the thermistor is disconnected (pin 1 at +5V) or shorted (pin 1 at 0V).

Analog inputs AN5, AN6, AN0 and AN1 monitor the settings for charge rate percentage, cut-off voltage, float voltage and temperature compensation, as set with trimpots VR1 to VR4.

Switch S2 stores the settings in IC1. S2 is normally open and an internal pull-up resistor within IC1 holds the RB5 input (pin 11) at 5V.

When S2 is pressed, the pin 11 input

is pulled low (0V) and this signals the program within IC1 to store the settings for VR2, VR3 & VR4 as the adjustable values for either SLA or lead-acid batteries. Where the values are stored depends on links LK5 and LK6, connected to the RA7 input at pin 16.

Link settings

If LK5 is in, pin 16 will be high (5V) and IC1 will store the settings as SLA parameters. If LK6 is in place, pin 16 will be low and the settings will be stored for the lead-acid parameters.

Links LK1 & LK2 determine whether the Charge Controller uses the standard Default (LK1) or Adjustable setting referred to above.

Links LK3 & LK4 set the standard or 3-step option. The standard charge selection switches charging to float directly after the main charge is complete.

The 3-step selection will run the absorption phase after the main charge, provided that the full charging process takes more than one hour. For a main charge of less than one hour, the charging will switch directly to float.

Note that these link combinations cannot be used together – you must

Table 2: Capacitor Codes

Value	μ F Code	IEC Code	EIA Code
100nF	0.1 μ F	100n	104
3.3nF	.0033 μ F	3n3	332
120pF	NA	120p	121

use one or the other. For example, you can use LK1 or LK2, LK3 or LK4 and LK5 or LK6.

Construction

The Charge Controller is built using a PC board coded 14104081 and measuring 102 x 72mm. This is housed in a diecast box measuring 118 x 93 x 35mm.

Start by checking the PC board for any defects such as shorted tracks, breaks in the copper areas and for correct sizes for each hole. The holes for the four-corner mounting screws and the toroidal transformer cable tie mounts need to be 3mm in diameter, while the four mounting points for the crimp eyelets need to be 4mm in diameter.

Check also that the PC board is cut and shaped to size so that it fits into the box.

Shortcomings of the Charge Controller

To round out our description of this project, we should also mention its possible shortcomings. In most cases, these will not be a problem but in special charging applications, they could be significant.

(1). Pulsed operation

The pulsed current can cause extra heating within the battery because losses and therefore heat build up are related to the square of the current. So, for example, to develop a 1A charge current from a 4A charger, the duty cycle may be set to 25% so that there is 4A pulsed for 25% of the time. This averages to 1A. However, by pulsing at 4A and 25% duty cycle, the current squared value is 16. When multiplied by the 25% duty cycle the average current squared value reduces to 4. So the power losses and heating within the battery are four times greater compared to a charger that produces a continuous 1A.

(2). Absorption and float charge

Because we pulse the charge current, the battery voltage fluctuates and rises with the current pulse and falls when the pulse is off. We measure the voltage just after the charge pulse is switched off. Compared to a charger that has a continuous lower current, the battery voltage may be maintained at a different value.

(3). Charging indication

Due to the battery supplying the circuit power supply via the reverse diode in Q1, it can appear that charging is taking place even when the charger is not connected. It is important to check that the charger is connected and is switched on.

(4). Battery Discharge

If the charger is switched off with the battery connected, then the battery will eventually discharge due to the 30mA load of the Charge Controller.

3-way headers for LK1-LK6.

Now install the diodes and the zener diodes, with the orientation as shown. IC1's socket can then be mounted and this must also be oriented correctly.

Normally, the NTC thermistor can be mounted directly on the PC board since the Charge Controller is close to the battery and the metal box will not normally heat up. As a consequence, its temperature should be similar to the battery temperature if we ignore heat rise due to charge current within the battery.

If the thermistor is to be mounted externally, then wires can be connected where the thermistor mounts and passed through a cable gland in the box. Alternatively, use a 3.5mm jack socket and plug. For external use, the thermistor can be covered in heatshrink tubing and attached to the side of the battery using Velcro or similar tape.

The capacitors can be installed next. Note that the electrolytic types must be oriented with the polarity shown. Install transistors Q2-Q4 and trimpots VR1-VR5, then install switch S2.

Fuse F1 comprises the two fuse-clips and the fuse. The fuse clips must be oriented so that the end stops are facing outwards, so that the fuse can be clipped into place.

The LEDs are mounted at right angles to the PC board. Bend the leads 12mm back from the front lens of each LED, taking care to have the anode (longer lead) to the left and then bend the leads downward. The LEDs then insert into the PC board and sit 8mm above the top of the PC board.

REG1 and Q1 mount under the PC board with their leads bent up at right angles as shown in Fig.7. They are placed so that the metal face sits at the same depth below the bottom face of the PC board as the spacers (at 9mm).

Transformer T1 is made up using a ferrite toroid and some 0.5mm enamelled copper wire. There are two separate windings. Wind on the primary with six turns and the secondary with 20 turns. The winding direction is not important. The wire ends can be passed through the holes in the PC board, taking care to place the 6-turn winding wire ends in the '1' and '2' holes and the 20-turn winding in the '3' and '4' holes.

The insulation on the wires can then be stripped using a hobby knife and the

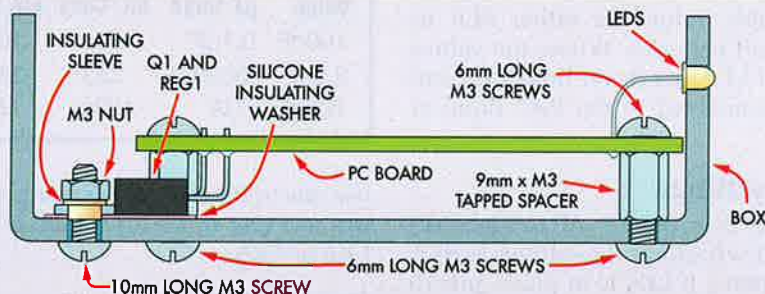


Fig.7 (above): here's how the PC board is mounted in the case. Note that the metal tabs of Q1 & REG1 must be isolated from the case using insulating washers & bushes (see text).

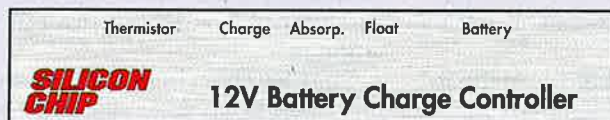


Fig.8: this is the full-size front panel artwork.

That done, the first step is to secure the four M4 nuts to the underside of the PC board in the four eyelet mounting positions using M4 screws. Preheat each nut with a soldering iron and solder it to the PC board. When cool, the screws can be removed.

Construction can now be continued by installing the two wire links and

the resistors. Take care to place each resistor in its correct position. A colour code table is provided as a guide to finding each value but use your digital multimeter to check each resistor before inserting it into the PC board.

Next, install the PC stakes for the test points TP GND and TP1-TP5. Install the 2-way header for switch S1 and the

leads soldered to the PC board. Cut off the excess wire, then secure the T1 assembly using two cable ties which pass through the PC board as shown.

Work can now be done on the metal box. First, position the PC board in the box with the edge closest to the LEDs sitting 3mm away from the edge of the box. Mark out the four corner mounting hole positions, then drill (and deburr) these holes to 3mm and mount the four 9mm standoffs.

Now mount the PC board in position and secure it using M3 x 6mm screws. Mark out the mounting holes for Q1 and REG1 and mark out the LED and S1 positions. Also mark out the two holes for the cable glands. That done, remove the PC board and drill out the holes. Be sure to deburr the two holes for Q1 and REG1.

The PC board can now be mounted inside the box. Isolate the tabs of Q1 and REG1 from the case, using insulating washers and mounting bushes – see Fig.5. Now check that the tabs for REG1 and Q1 are insulated from the metal box by measuring the resistance with a multimeter. The reading should be high; above 1MΩ. **The box is totally isolated from the electrical connections so that accidental contact of the box to a battery terminal will not cause a short circuit.**

Install the two cable glands and pass the figure-8 cable through them, ready to attach the crimp eyelets. We used the striped wire as the negative and the plain red wire as the positive. Connect the crimp eyelets using a crimping tool and secure them to the PC board using the M4 screws and star washers. Make sure the eyelets are not shorting to adjacent parts especially the fuseholder. The battery leads will need the large insulated clips connected to the end – use red for positive and black for negative.

The Charge Controller leads can simply be bared at their ends and connected to the charger clips or they can be permanently wired to the charger.

Switch S1 can now be wired to the PC stakes on the PC board and covered with heatshrink tubing. Finally, fit the stick-on rubber feet to the underside of the box.

Testing

Install links LK1, LK3 & either LK5 (SLA) or LK6 (lead-acid). Do not place a link onto the 2-way header adjacent to S2, as this is for an optional front

panel-mounting switch for S2.

Now connect a multimeter set to read 5V DC between TP GND and TP5. Connect a supply to the charger input and adjust VR5 for a 5.0V reading on the multimeter. Check that the voltage between the pin 5 and pin 14 pin on IC1's socket is also 5V. If so, switch off power and insert IC1, taking care to orient it correctly.

Charging

For most large batteries you would set the charge rate to 100%. In this case, simply set VR1 fully clockwise.

Specifications

Under-voltage burst charge: 10.5V (inoperative if the selected cut-off voltage is below 12V).

Under-voltage burst rate: approx. 200ms burst every 2s with charge rate set to 100%. Burst width is reduced with a lower charge rate. Charge, absorb and float LEDs all flash. Battery LED flashes with no battery and charger connected. The LED lights continuously when battery connected.

Under temperature: 0°C; no charge. Thermistor LED flashes on and off at 1s rate.

Temperature measurement resolution: 0-60°C in 1°C steps.

Thermistor out: Thermistor LED fully lit; no charge.

Compensation: 0°C to 60°C

Adjustable compensation: 0-50mV/°C in 256 steps (separate SLA and lead-acid battery adjustments)

Adjustable cut-off and float voltage: 0-16V in 48.8mV steps. Separate SLA and lead-acid battery adjustments

Fixed value: SLA cut-off 14.1V, float 13.5V and -25mV/°C compensation with respect to 20°C. Lead-acid 14.4V, 13.8V and -20mV

Charge rate: adjustable from 100% to 0% in 1% steps. Pulses are adjusted in approximately 20ms steps.

PWM drive signal: 500kHz.

Mosfet gate rise-time for an on pulse: 56µs (10-90%) for a 16V gate voltage

Mosfet gate fall time for an off pulse: 69µs

LEDs

Bulk Charge: Charge LED flashes at a duty that equals the % charge rate.

Absorption: Absorption LED lit (optional charge LED shows whenever charge is on to maintain battery voltage).

Float: Float LED lit (optional Charge LED indication).

Charging

Charge: charges at the charge rate (%) until the cut-off voltage is reached.

Absorption: adjust current pulse duty cycle to maintain cut-off voltage.

Float: adjusts current pulse duty to maintain float voltage.

Float and absorption current control

Charge duty cycle is reduced at a fast (15% every 2s) if the battery voltage is above the required value by more than 0.25V and reduced by 1% every 2s if the battery voltage is above the required value by up to 0.25V. Conversely, charge duty cycle is increased at a fast (3% per 2s) if the battery voltage is less than 0.25V below the required value and increased at a slow rate (1% per 2s) if the battery voltage is no more than 0.25V below the required voltage

You can use the 100% setting for all batteries that can accept the charge rate from your charger. Most batteries can accept up to 30% of the quoted Ah capacity as a current. So a 100Ah battery can accept 30A.

If your charger supplies less than 30A, then the 100% setting can be used. If your battery is rated in RC (reserve capacity) you will need to convert to Ah.

Reserve capacity is a specification in minutes and specifies how many minutes a fully-charged battery can deliver 25A before the voltage drops

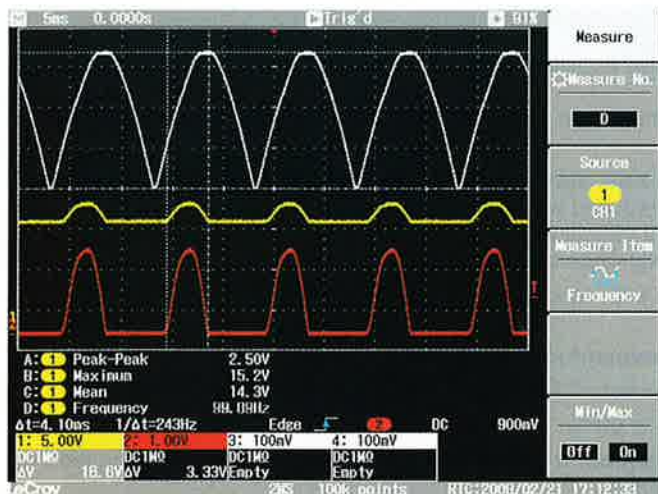


Fig.9: this scope shot duplicates the waveforms shown in Fig.2(a). The white trace is the charger input while the red trace shows the 100Hz current pulses into the battery.

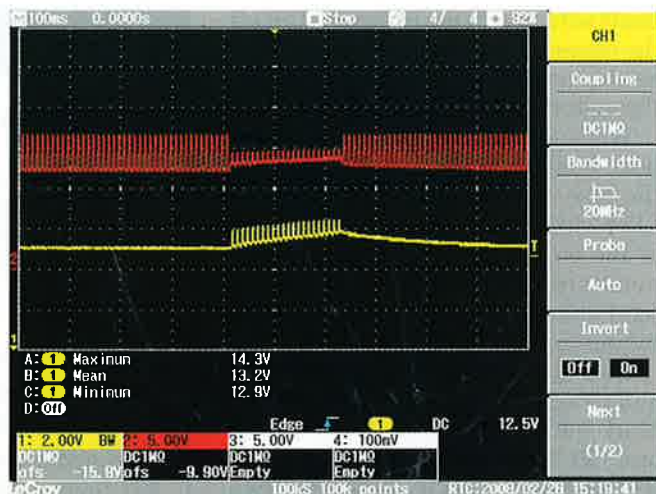


Fig.10: this shot shows the Charge Controller operation. The red trace is the 100Hz input from the charger while the yellow trace shows the current into the battery.

to 10.5V. A battery with an RC of 90 will supply 25A for 90 minutes. The amp-hour specification (Ah) refers to the current that can be supplied (usually over a 20 hour period). So a 100Ah battery can supply 5A for 20 hours.

To convert from RC to Ah, multiply the RC value by 0.42 (derived by multiplying by 25A to get the capacity in Amp minutes and dividing by 60 to convert from minutes to hours).

In practice, because the RC capacity specification uses 25A, the conversion from RC to Ah often gives a lower Ah value than the battery's actual Ah capacity. This is because the Ah capacity usually requires much less

current from the battery over a longer period.

For batteries that require a lower current than that supplied by the charger, the charge rate can be reduced from 100%. So for a charger that is rated at 4A and a battery that can only accept a 2A charge current, set the charge rate to 50%.

The charge rate is set using VR1, where the voltage at TP1 represents the percentage. Voltages of 1V or more give 100% while values below 1V provide lower percentage charge rates. For example, a 0.5V reading gives a 50% charge rate duty cycle.

Note that when charging a battery

that has less than 10.5V across its terminals, the charging will be in a specific burst mode with the burst at 200ms every two seconds when the charge rate is set to 100%. At lower charge rates, the burst length will be reduced accordingly. During under voltage burst, the Charge, Absorption and Float LEDs flash.

As mentioned, the charge LED can be set to flash when charge is applied during the absorption and float phases. This is the initial setting.

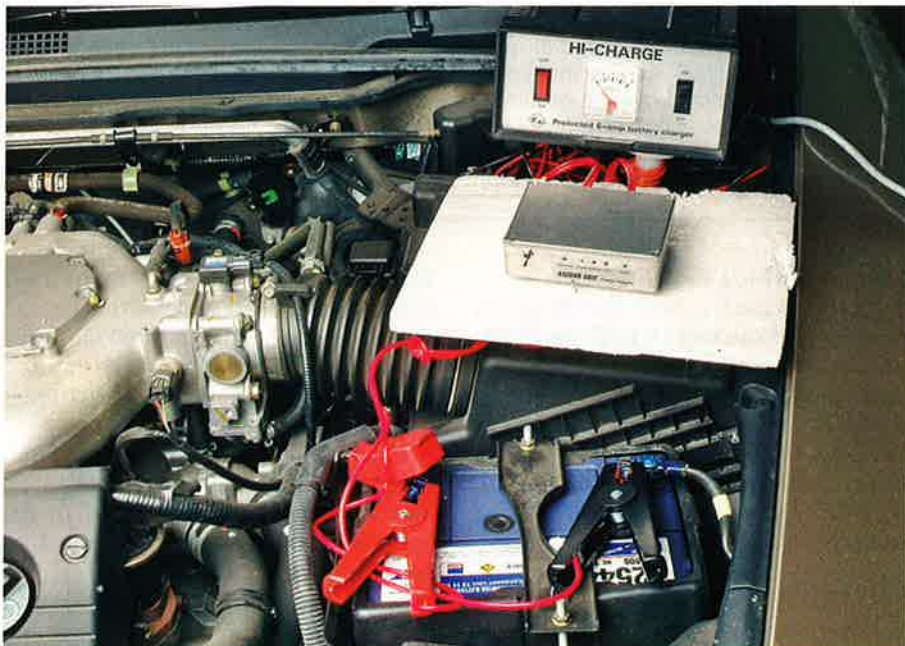
If you do not require the charge LED to show during these phases, you can disable this. Switching off power and pressing S2 while the power is re-applied will disable this feature. The change is acknowledged by a minimum of two fast (2/second) flashes of the Charge LED. The acknowledgement flashing continues until the switch is released.

You can re-enable the feature by pressing S2 at power up again.

Setting the parameters

Most battery manufacturers will specify the required cut-off (also called the cyclic voltage), the float (also called the trickle voltage) and the temperature compensation for each battery. Note that the cut-off and float voltages must be the values for 20°C.

The temperature compensation required by manufacturers is usually shown as a graph of voltage versus temperature. You need to convert this to mV/°C. To do this, take the difference between the voltages at two different temperatures and divide by the temperature difference.



You will need to fit a couple of heavy-duty clips to make the connections to the battery. And yes, you can use it to charge your car's battery.

Parts List

1 PC board, code 14104081, 102 x 72mm
 1 diecast box, 118 x 93 x 35mm
 1 SPDT toggle switch (S1)
 1 SPST micro tactile switch with 0.7mm actuator (S2)
 2 cable glands for 4-8mm diameter cable
 2 TO-220 silicone insulating washers and mounting bushes
 4 small adhesive rubber feet
 2 PC-mount 3AG fuse clips
 1 10A 3AG fuse (F1)
 1 ferrite ring core 18 x 10 x 6mm (Jaycar LO-1230 or equivalent) (T1)
 1 NTC thermistor (10k Ω at 25°C) (TH1)
 1 DIP18 IC socket
 4 9mm long M3 tapped spacers
 8 M3 x 6mm screws
 2 M3 x 10mm screws
 2 M3 nuts
 4 M3 x 10 screws
 4 M4 nuts
 4 M4 star washers
 4 insulated crimp eyelets
 2 100mm cable ties

1 1m length of 15A figure-8 automotive cable
 1 100mm length of medium-duty red hook-up wire
 1 100mm length of medium-duty black hook-up wire
 3 3-way headers with 2.54mm spacing
 1 2-way header with 2.54mm spacings
 3 jumper plugs
 8 PC stakes
 2 insulated battery clips (red and black)
 1 600mm length of 0.5mm enamelled copper wire
 1 50mm length of 0.7mm tinned copper wire

Semiconductors

1 PIC16F88-I/P microcontroller programmed with 1410408A (IC1)
 1 IRF1405 N-channel Mosfet (Q1)
 1 BC337 NPN transistor (Q2)
 2 BC327 PNP transistors (Q3,Q4)
 1 24V 1W zener diode (ZD1)

1 18V 1W zener diode (ZD2)
 1 1N4004 1A diode (D1)
 5 1N4148 diodes (D2-D6)
 1 LM317T adjustable regulator (REG1)
 2 orange 3mm LEDs (LEDs1&3)
 1 red 3mm LED (LED2)
 2 green 3mm LEDs (LEDs4&5)

Capacitors

1 470 μ F 25V PC electrolytic
 2 100 μ F 16V PC electrolytic
 1 10 μ F 25V PC electrolytic
 3 100nF MKT polyester
 1 3.3nF ceramic
 1 120pF ceramic

Resistors (0.25W, 1%)

1 220k Ω	1 1k Ω
1 22k Ω	4 470 Ω
1 12k Ω	1 330 Ω
2 10k Ω	1 100 Ω 1/2W

Trim pots

4 20k Ω horizontal mount trim pots (code 203) (VR1-VR4)
 1 100 Ω multi-turn top adjust trim pot (code 101) VR5)

For example, a battery graph may show the cut-off or cyclic voltage at 0°C to be 14.9V. At 40°C it may be 2V. So (14.2 - 14.9)/40 is -17.5mV/°C.

Where the float temperature compensation is different to the cyclic temperature compensation, a compromise between the two values will have to be made. Note that the graph can be interpreted over a smaller temperature range that is consistent with the temperatures under which you expect to be using the charger.

To set the adjustable parameters, apply power to the Charge Controller via a battery or charger and select the battery type with LK5 or LK6. That done, connect a multimeter between TP GND and TP2 and adjust the required cut-off voltage using VR2.

Each volt represents a 10V cut-off so 1V at TP2 sets a 10V cut-off, 1.44V sets a 14.4V cut-off, etc. Now connect the multimeter to TP3 and adjust VR3 for the required float voltage. Each volt at TP3 represents 10V float.

For the temperature compensation, monitor TP4 and adjust VR4 for the required compensation. Here,

5V represents -50mV/°C and 2V represents -20mV/°C. Press S2 to store the values. The Thermistor, Charge and Float LEDs will all flash twice to acknowledge the setting and that the cut-off, float and compensation values have been stored.

You can store the parameters for the second battery type by changing the settings for LK5 and LK6 and readjusting the trim pots. Store the values using switch S2. Note that adjusting the trim pots without pressing the store switch will not store new values. **SC**

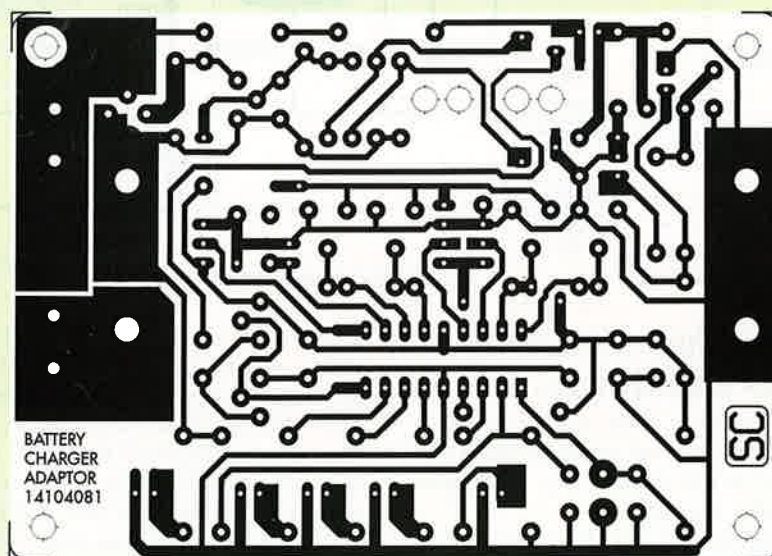


Fig.11: check your etched PC board for defects before installing any parts by comparing it with this full-size artwork.

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.

Regenerative shortwave radio receiver has audio limiter

This receiver combines simplicity with good performance and can be configured to cover any or all segments of the MW and SW bands, with AM, SSB/CW and FM modes. Selectivity is very sharp, sensitivity is high and short-term stability is very good.

The RF signal is fed through an input attenuator consisting of D1 & D2 and several 1kΩ resistors. Forward bias for the diodes is obtained from the voltage across LED1.

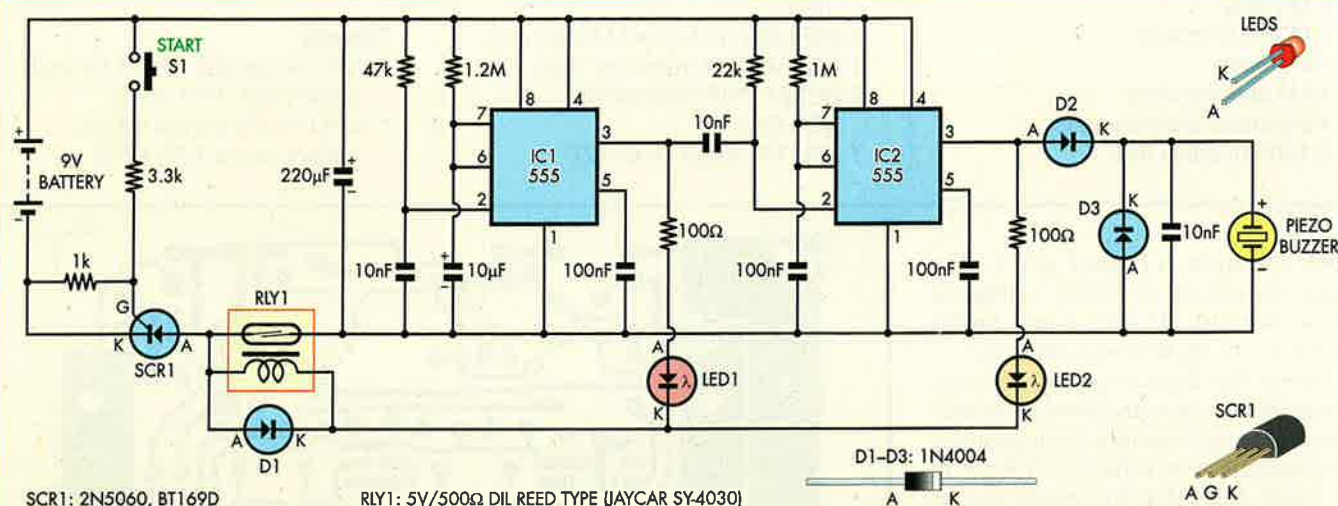
VR1 provides an adjustable countervailing voltage which varies the dynamic resistance of the two diodes and therefore provides smooth control of the RF signal, preventing overload from strong local stations and also acting as a volume control.

The signal from the attenuator is fed to the emitter of PNP transistor Q1, a grounded base buffer providing little gain but isolating any loading effects from the antenna and input stage. The signal from Q1's collector

is fed via the tuning stage involving coils L1, L2 and the associated tuning gang VC1a & VC1b.

FET Q2 operates as an infinite impedance detector, with the detected audio appearing across the source load resistors. A small amount of residual RF appearing at the source of this FET is returned to tuning coil L2 via diode D3 and the 10nF capacitor. Potentiometer VR2 is the regeneration control and it varies the dynamic resistance of D3.

The resultant positive feedback effectively cancels all losses in coil L1, greatly increasing its "Q", so that



Timer has zero current after shutdown

This timer gives a short beep at the end of a set interval and then shuts down completely, with zero standby current.

The circuit uses two 555 timers connected in monostable mode. IC1 determines the delay, which is about 15 seconds with the components connected to pins 6 & 7. It triggers the second timer, IC2, which determines the beep duration of about 0.5 seconds. Both timers operate from a +9V rail and an intermediate rail which is connected to the 0V rail via relay RLY1 and SCR1.

It works as follows: to start the timer, pushbutton S1 is pressed to trigger the SCR into conduction and current flows via LED1 and the relay's 500Ω coil from pin 3 of IC1 which is already high, being connected to the +9V rail. IC1 then self-triggers and keeps pin 3 high after switch S1 is released.

At the end of the 15s interval, pin 3 of IC1 goes low and triggers IC2. IC2's pin 3 immediately goes high so that current continues to flow through the relay coil via LED2.

At the end of the beep time, pin 3 of IC2 goes low and the current through the relay coil ceases and the SCR turns off. No further current

can flow until switch S1 is pressed again.

LED1 & LED2 provide indication that the circuit is working, as well as providing isolation between the outputs of the two timer ICs.

To vary the time setting of either timer, use the formula $T = 1.1RC$ where T is time in seconds, R is resistance in megohms and C is capacitance in microfarads. Remember though, that while resistor values are typically 1% tolerance or better, electrolytic capacitors have a wide tolerance and you may need a trimpot to set an exact time.

A. J. Lowe,
 Bardon, Qld, (\$40)

the gain and selectivity of this stage is increased accordingly.

IC1 operates as an inverting amplifier and provides most of the audio gain. D4 & D5 in the negative feedback network provide audio limiting to prevent loud signals deafening the operator.

Transistors Q3-Q5 function as a simple "totem pole" amplifier to drive headphones or a speaker. (Editor's note: the 680kΩ bias resistor for Q3 may need adjustment to obtain half supply [ie, 6V] at the junction of the emitters of Q4 & Q5).

It is recommended that the circuit be built on a PC board. This will guarantee component rigidity, greatly enhancing stability and performance.

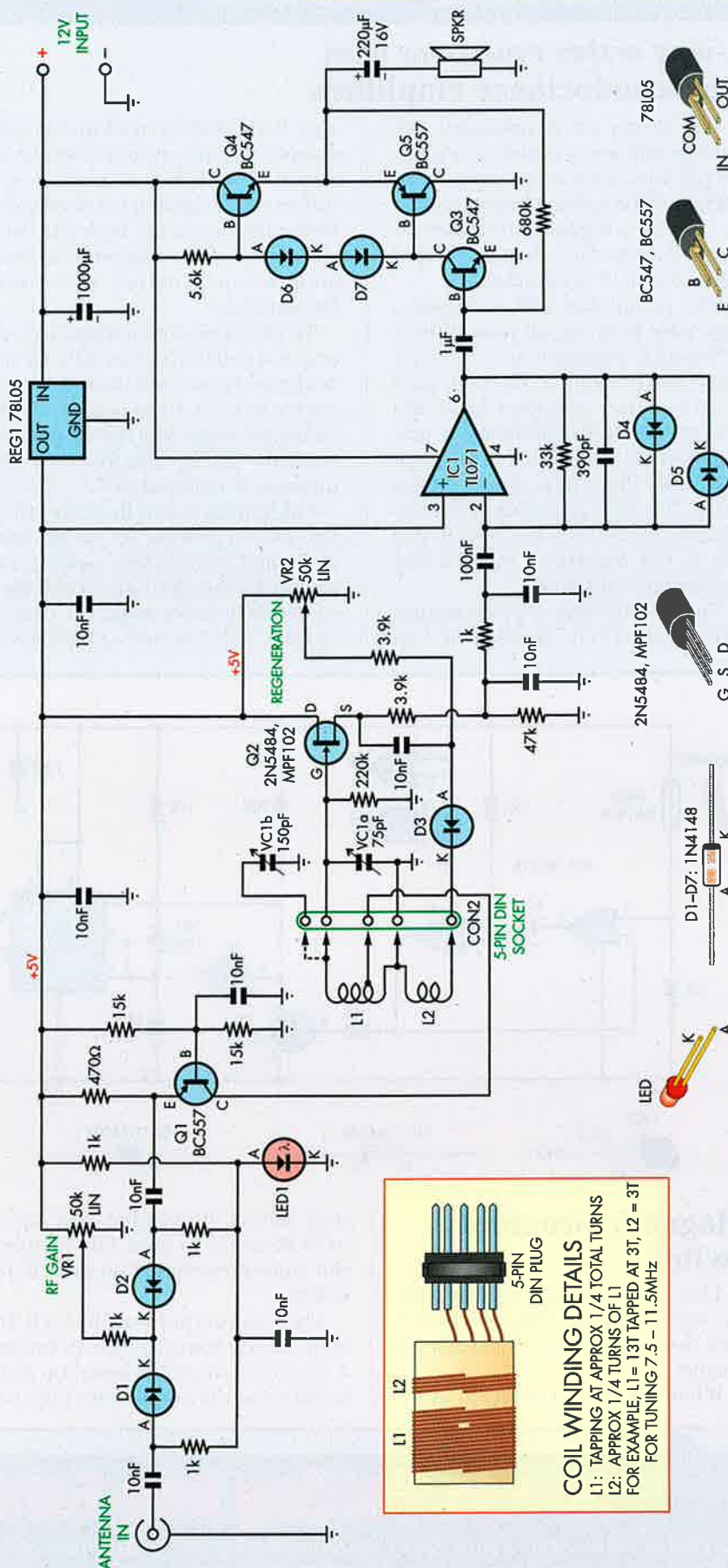
The prototype used a 5-pin DIN socket to facilitate coil changing. VC1 is an AM/FM polycon tuning capacitor from a defunct radio-cassette player which also furnished the tuning pulleys and shaft.

It is recommended to use the largest tuning reduction possible, to ease tuning, especially when attempting to cover a large shortwave segment with one coil. The smaller FM capacitor section is available at the coil socket, as well as the 150pF MW section; use the latter for greater coverage.

A few metres of wire will suffice as the antenna, as the receiver is very sensitive. In use, rotate RF gain control VR1 fully clockwise and rotate regeneration control VR2 clockwise until background or atmospheric noise is heard. By rotating the tuning control, stations will be heard, possibly as heterodynes at this stage. Reduce the regeneration to the point where the station becomes audible and reduce the RF gain for a suitable listening level.

The plug-in coils are wound on a pen case which, after the internals have been removed, is then glued to a 5-pin DIN plug. A full set of coils can be wound to cover all of the HF ranges and a link to the 150pF gang will extend coverage at the lower frequencies. The prototype was capable of resolving SSB on 8867kHz, the aircraft net, for periods of more than 30 minutes without retuning, once stabilised. This level of performance requires good construction practice, with rigid mounting of the PC board into a metal cabinet.

D. S. Edwards,
Taylorville, NZ. (\$70)



2-way active crossover uses transconductance amplifiers

This 2-way active crossover can have its frequency adjusted by a single potentiometer over a range from 75Hz to 5kHz and the frequency can be read by a digital multimeter set on a DC range. One channel (left) of a stereo circuit is depicted.

The circuit has four sections: a high-pass filter, an all-pass filter, a differential amplifier and an exponential current source. The high-pass filter uses two cascaded LM13600 operational transconductance amplifiers (OTA) connected as identical first-order high-pass filters (IC1a, IC1b). The high-pass output (for treble frequencies) is taken from IC1b's pin 9, the emitter of the internal Darlington transistor.

The all-pass filter is based around IC2a (another OTA package) and op

amp IC3a (IC2b is used in the right channel). IC3a's output is fed to op amp IC3b which is connected as a differential amplifier to take the difference between the high-pass and all-pass filters to obtain the second-order low-pass output, ie, for bass frequencies.

To set the crossover frequency, op amp IC4 and transistors Q1 & Q2 are configured as an exponential current source to OTA stage IC1a. It works on the principle that the output current from Q2 doubles for every +1V increase at its input (VR1).

Calibration is as follows: set trimpot VR1 to provide 0V on the base of Q2 and record the crossover frequency for this setting (you will need a frequency meter or oscilloscope to do this). Then connect a DMM across

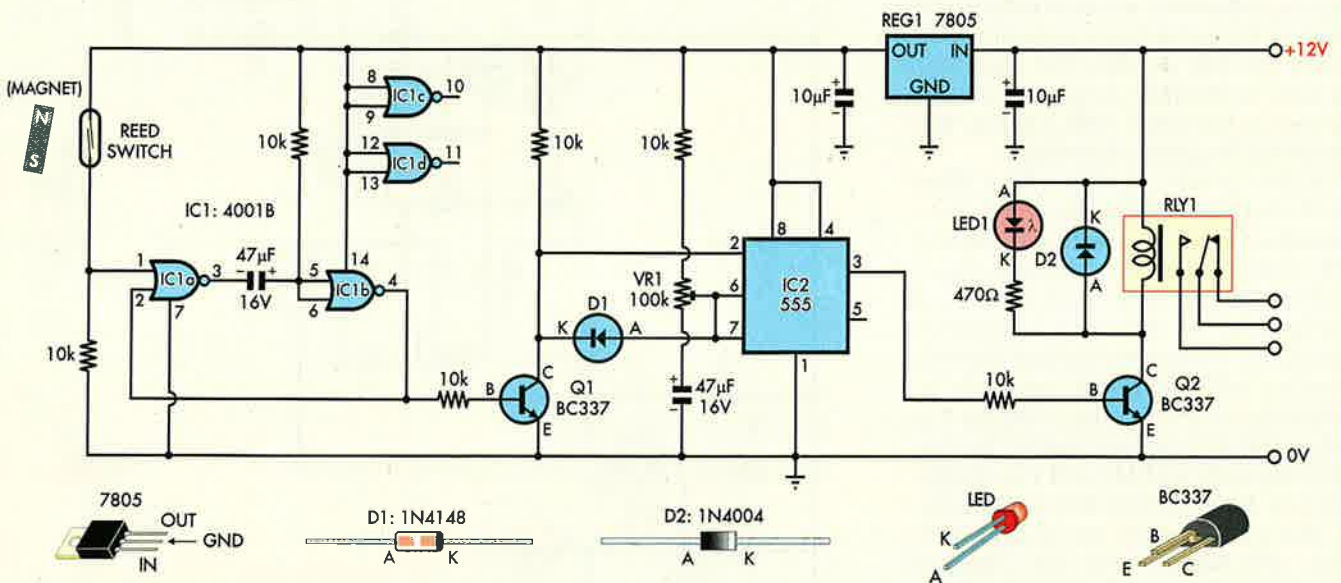
VR3 (5k Ω) and the associated 20k Ω resistor on the collector of Q2 (as shown on the circuit). Adjust VR3 so that the DMM reads the crossover frequency recorded earlier; eg, if the recorded crossover frequency was 240Hz, the DMM should read 240mV DC.

After calibration, you simply adjust VR1 to set the crossover frequency as indicated on the DMM. Accuracy depends on calibration and is typically <2%.

Note that once the crossover frequency has been set, the DMM must be disconnected from the circuit, otherwise it can cause odd modulation effects at low frequencies.

Editor's note: The LM13600 is now an obsolete component but it can be obtained from www.futurlec.com.

Malcolm Sharp,
Berala, NSW.



Magnetic proximity switch

This circuit is a magnetic proximity sensor and can control a motorised door using a small permanent magnet.

When a magnet is detected by the

reed switch, it closes to pull pin 1 of NOR gate IC1a high. This enables the monostable based on gates IC1a & IC1b.

The resulting pulse at pin 4 of IC1b switches on transistor Q1 to trigger a second monostable based on IC2, a 555 timer. Its output goes high for

between 0.5 and five seconds, as set by trimpot VR1.

This second monostable controls the "on" state of relay RLY1 which is switched by transistor Q2. LED1 is lit when the relay is turned on.

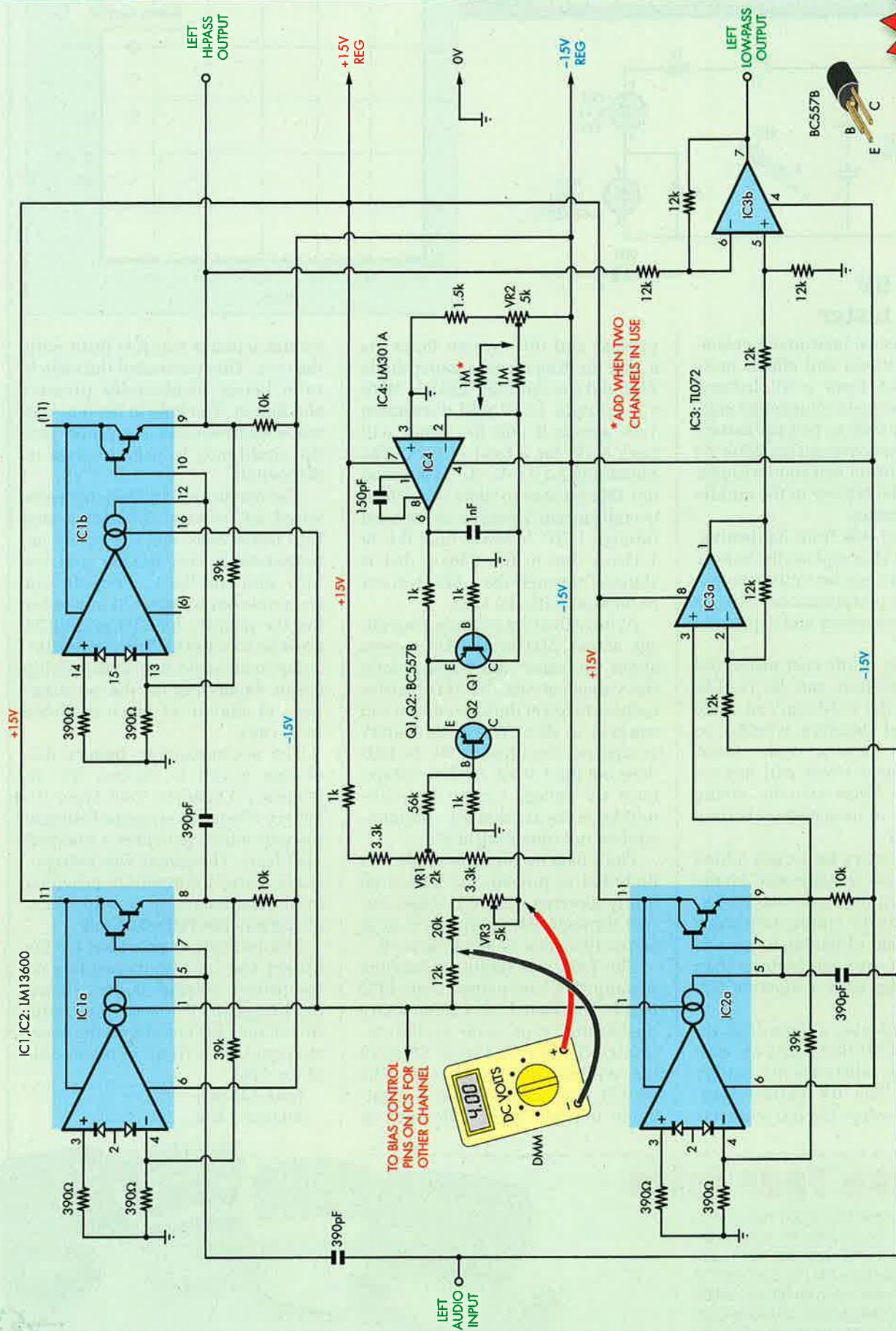
T. K. Hareendran,
Kerala, India. (\$30)



Issues Getting Dog-Eared?

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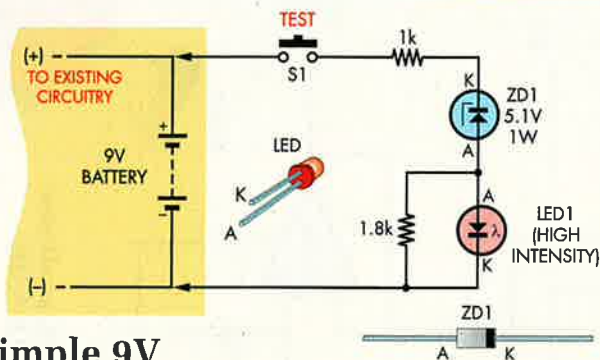
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Malcolm Sharp is this month's winner of a Peak Atlas Test Instrument

The circuit can be split into four sections: a high-pass filter based on operational transconductance amplifiers (OTAs) IC1a & IC1b, an all-pass filter based on OTA IC2a & op amp IC3a, a differential amplifier based on op amp IC3b and an exponential current source (IC4, Q1 & Q2).

Circuit Notebook – Continued



Simple 9V battery tester

Many musical instrument preamplifiers, DI boxes and effects units are powered from a 9V battery. However, rarely do commercial units include any way to test the battery condition. And without knowing the battery condition you may be caught out with a flat battery in the middle of a performance.

To prevent this from happening, many musicians replace the battery frequently, to ensure uninterrupted use during performances. This is often an unnecessary and expensive exercise.

By adding a low-cost tester, the battery condition can be readily checked so the musician can make an informed decision whether to replace the battery. With proper use, the battery tester will pay for itself many times over by saving the expense of unnecessary battery replacement.

This 9V battery tester was added to a "Fishman Transducers" Model B Bass Preamplifier. It enabled battery checking by simply pressing a button instead of having to remove four screws and the battery snap before testing with a separate battery tester.

The circuit uses a 3mm high intensity red LED that lights up with a brightness reflecting the battery condition. The 9V battery supplies power when the test switch is

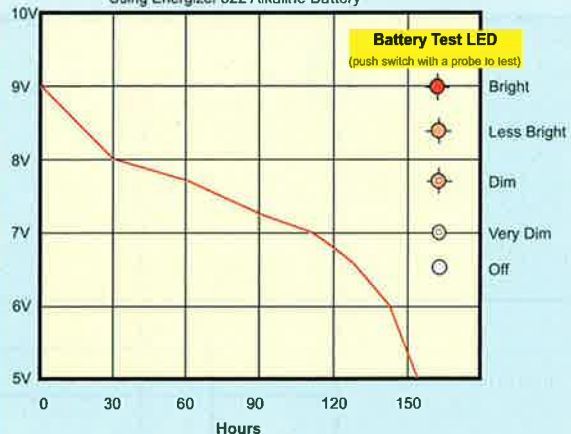
pressed and this current flows via a 1k Ω limiting resistor, zener diode ZD1 and the red LED (LED1). With a 9V supply, LED1 will have about 1.6V across it and the zener will have 5.1V, for a total of 6.7V. The remaining 2.1V (9V - 6.7V) is across the 1k Ω resistor so there is a 2.3mA overall current. However, the current through LED1 is lower than this at 1.41mA due to the 888 μ A that is shunted through the 1.8k Ω resistor in parallel with the LED.

At lower battery voltages, the voltage across ZD1 and LED1 remain about the same and consequently the voltage across the 1k Ω resistor reduces to lower the LED current and cause it to dim. When the battery voltage reaches about 6.5V, the LED does not light at all. At this voltage, most 9V battery operated circuits will be seriously down in performance or not operating at all.

The 1.8k Ω resistor across LED1 is included to prevent the LED from dimly glowing due to leakage current through ZD1 when the voltage across the zener is less than 5.1V.

The LED was mounted into the preamplifier case using a 3mm LED bezel. The switch is a momentary pushbutton type such as the Altronics S-1405 or Jaycar SP-0712 but without the switch cap. The switch was mounted on a right-angle bracket so that the end of

Battery Voltage vs Time for a 2k Ω (4.5mA down to 3mA) Load Using Energizer 522 Alkaline Battery



switch actuator was just flush with the case. This prevented the switch from being accidentally pressed and left on. The hole in the box was made small enough so a probe (pen tip) could only be used to press in the switch.

The remaining components were wired up between the switch and LED leads. Note that the circuit arrangement is very flexible and the LED, ZD1 and the 1k Ω resistor can be connected in series in any order but the polarity for ZD1 and LED1 must be adhered to. Rearranging the component order may make wiring easier depending on the positioning and amount of space available in the box.

The accompanying battery discharge graph is shown for an Eveready Energizer (522 type) 9V battery when powering the Fishman preamp which provides a nominal 2k Ω load. The graph was extrapolated using information provided by the manufacturer at <http://data.energizer.com/PDFs/522.pdf>

The indication provided by the battery test LED (ie, depending on the battery voltage) is also shown on this graph. The very dim condition of the LED just shows the small rectangular die lit up in the middle of the LED.

John Clarke,
SILICON CHIP.

Choose Your Prize

There are now five great reasons to send in your circuit idea for publication in SILICON CHIP. We pay for each item published or better still, the best item in "Circuit Notebook" each month will entitle the author to choose one of four prizes: (1) an LCR40 LCR meter, (2) a DCA55 Semiconductor Component Analyser, (3) an ESR60 Equivalent Series Resistance Analyser or (4) an SCR100 Thyristor & Triac Analyser, with the compliments of

Peak Electronic Design Ltd. See their website at www.peakelec.co.uk.

So now you have even more reasons to send that brilliant circuit in. Send it to

SILICON CHIP and you could be a winner.

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



→53



12-24V High Current Motor Speed Controller Kit

Ref: Silicon Chip Magazine March 2008

Want to control a really big DC motor? This design will control 12 or 24VDC motors up to 40A continuous. The speed regulation is maintained under load, so the motor speed is even under heavy load. It also features automatic soft-start, fast switch-off, a 4-digit LED 7-segment display to show settings, an overload warning buzzer and a low battery alarm. All control tasks are monitored by a micro-controller, so the functionality is extensive. Kit contains PCB and all specified electronic components.



NEW 08
Cat. KC-5465
\$99.95

Wireless Digital Rain Gauge with Anemometer

Keep track of important weather parameters like wind speed and rainfall. It also has a calendar and a clock with alarm function. In addition, it measures indoor and outdoor temperature and humidity.

- Wind speed in km/h or mph
- Max min and rainfall history in mm or inches
- Temperature in Celsius or Fahrenheit
- Indoor & outdoor temperature
- Humidity
- Requires 2 x AA and 2 x AAA batteries
- Display: 180(H) x 104(W) x 24(D)mm



NEW 08

Cat. XC-0338
\$99.95

1500VA Uninterruptible Power Supply

Guard your computer and peripherals from the shortfalls of mains power and interruptions. This UPS protects against low/over voltage, surges, short circuits and power overloads. The battery power, load, input/output voltage is displayed on an easy to read orange backlit LCD.

- 4 mains sockets
- Microprocessor control for high reliability
- Telephone/Fax/Modem protection
- Dimensions: 337(L) x 192(H) x 116(D)mm



NEW 08

Cat. MP-S206
\$319.00

Compact 8 Zone Alarm Panel

Designed for home or office this system has 8 zones, of which up to two can be used for panic/duress signals and has local alarm warnings, entry/exit delays, programmable user codes, delays and alarm duration. Supplied with one alarm control panel and control keypad.

For Full technical specifications see catalogue or website.

Dimensions:

Alarm Panel: 168(H) x 168(W) x 78(D)mm

Keypad: 117(H) x 117(W) x 27(D)mm

Cat. LA-S361
\$199.00



NEW 08

Hi-End Home Audio/Theatre Speakers

NEW 08

Introducing our new range of high-end midrange and subwoofer speakers. Equipped with:

- Light and rigid Kevlar/paper yellow cone,
- A strong CNC machined magnesium-aluminium basket,
- Oversized Neodymium magnet and
- High temperature Kapton voice coil,
- Vented pole piece design for effective heat transfer.

This range has extremely high power handling and long cone excursion. The range features 4" to 10" drivers. Perfect for centre channels, bookshelf, computer or part of a multi speaker system and home audio/theatre applications. For details on the full range and individual specifications see our website or new catalogue. Two examples shown below

6.5" Woofer / Midrange

The Kevlar/paper cone construction is incredibly rigid making this unit not only capable of enormous bass power handling it is quite linear well into midrange frequencies. Suitable for Hi-Fi and home theatre applications where space is at a premium.

Specifications:

- Nominal impedance: 8 ohms
- Power handling: 60 WRMS
- Sensitivity: 85dB 2.83V at 1m



Cat. CW-2154
\$89.95ea

8" High-End Woofer

This is one of the most rugged 8" drivers we have ever seen. It is recommended for high performance but compact vented woofer systems. Massive power handling capability for an 8" unit.

- Nominal impedance: 8 ohms
- Power handling: 150WRMS
- Sensitivity: 86dB 2.83V at 1m



Cat. CW-2156
\$139.95ea

3.5" Security Camera Installers Monitor

Take the hard work out of camera installation with this portable video monitor. The unit connects to the camera being installed and lets you adjust and align the camera, while you are still up the ladder. The monitor can run from internal batteries or the camera's 12 volt power source. Very handy.

Specifications:

- Screen size: 3.5 inches (diagonal)
- Input signal: 1.0Vp-p composite video
- Video format: PAL



Cat. OM-3421
\$299.00

Record Carry Case

NEW 08

Designed for storing and transporting vinyl records, the interior is padded with a soft foam material that will absorb the shock of minor bumps and jolts. The top cover can be completely removed to give the mobile DJ quick access to a collection of records or other equipment. The case features a sturdy travel handle.

- Case Dimensions: 365(L) x 365(H) x 265(D)mm
- Internal Dimensions: 335(L) x 240(W) x 320(H)mm



Due Early April

Cat. HB-6345
\$69.00

Also available separately
HB-6379 ABS Roadies Case \$69.95
HB-6347 19" Rack Mount Road Case \$129.95

45

Security Savings

Doorbell for the Hearing Impaired

When this doorbell rings, the sound is accompanied by bright flashes from the receiver's built in strobe light so a hearing impaired person will know that someone is at the door. Can be taken from room to room and used

outdoors. Choose from seven melodies. 210mm long. Requires 4 x C cells (Use SB-2320)

Was \$49.95

Cat. LA-5002
\$39.95

SAVE \$10

Visitor Door Chime Alarm with Counter

Perfect for shop, office or home use. A 'ding-dong' chime alerts you to an entry, and records the customer in its digital tally count.

- 5m range
- Free standing or wall mountable
- Requires 3 x AA batteries (Use SB-2425)

Was \$19.95

Cat. LA-5009
\$14.95

SAVE \$5

Child / Pet Door Annunciator

Keep your children safe with this PIR sensor alarm. Simply mount at any entrance and the alarm will sound for 30 seconds every time your child or a pet passes through, but not when an adult goes through the door. Unit measures 1 metre when assembled.

- Requires 3 x AA batteries (Use SB-2425)

Was \$49.95

Cat. LA-S166
\$34.95

SAVE \$15

Home Security Alarm and Telephone System

An advanced, full-featured telephone combined with a sophisticated wireless security system. The alarm can have an unlimited number of wireless sensors including PIRs, reed switches, and panic buttons. The system can dial a series of preset telephone numbers and deliver a recorded message that varies with the type of sensor that triggered the alarm.

Features

- Phone dialler
- Unlimited sensor capacity
- Remote control
- User recordable messages
- Home & away arming modes
- Remote arming/disarming via telephone line
- Measures 230(W) x 60(H) x 210(mm)

See website for full feature list, accessories and technical specifications.



Cat. LA-5200
\$199.00

SAVE \$50

4 Zone Security Alarm System with 2 Wire Technology

This alarm is so simple you DIY enthusiasts will love it! All system components (sensors, sirens) are connected to the control unit via a two core flat wire. The unit has a built-in keypad with status LED and three modes of operation (Home, Out, Off). All sensors and sounders are line protected so any attempt to interfere will sound the alarm.

Supplied with

- Main control unit
- Two PIRs
- Four door or window contact switches
- External switch
- 240VAC Adaptor
- 50m two-core flat wire clips
- Screw/wall plugs
- Main unit: 160(H) x 180(W) x 35(D)mm
- Extra PIR to suit. LA-5476 \$29.95

Cat. LA-5475
\$149.00



Don't forget to ask about our NEW 2008 CATALOGUE - OUT NOW!



PIRs to Expand Your Alarm System

Advanced design incorporates Motion Signal Discretion (MSD) processing and pulse width analysis to ensure fast detection and superior performance.

- 100° angle
- Intelligent pulse count
- Coverage of up to 15m
- Simple installation

Dual Element PIR Motion Detector LA-5036

• Selectable pulse count 2-3

Quad Element PIR Motion Detector LA-5038

- Selectable pulse count 1-2-3

Pet Tolerant PIR Lens LA-5037

Helps reduce the amount of false triggers caused by roaming pets \$4.95 Suitable for LA-5036 & LA-5035

Dummy Surveillance Cameras

Dummy Dome Camera with Metal Case



It looks just like the real thing - but it isn't. This unit will fool anyone with its blinking battery operated LED.

- Camera measures 60(W) x 55(H) x 190(L)mm

Cat. LA-S316
\$34.95

Mini Dome Dummy Camera

Make your business / home / office look like it's under surveillance, includes the metal camera case inside (with no lens).

- Dimensions: 88mm(dia) x 68mm(high) approx.

Cat. LA-S317
\$9.95

12 Volt Photoelectric Smoke Detector

Ideal for permanent wiring in homes, boats, caravans or motorhomes, it only draws 5mA from a 12V source. If smoke appears it will close a set of contacts inside the unit which can trip an external mounted alarm siren, via an existing burglar alarm system. Supports NO and NC circuit configuration and is supplied with test, reset buttons and all mounting hardware.



Cat. LA-S045
\$19.95

PIRs to Expand Your Alarm System

Advanced design incorporates Motion Signal Discretion (MSD) processing and pulse width analysis to ensure fast detection and superior performance.

- 100° angle
- Intelligent pulse count
- Coverage of up to 15m
- Simple installation

Dual Element PIR Motion Detector LA-5036

• Selectable pulse count 2-3

Quad Element PIR Motion Detector LA-5038

- Selectable pulse count 1-2-3

Pet Tolerant PIR Lens LA-5037

Helps reduce the amount of false triggers caused by roaming pets \$4.95 Suitable for LA-5036 & LA-5035



Cat. LA-5038
\$39.95

Cat. LA-5036
\$29.95

Mini Strobe Lights

Designed to be mounted on siren covers or other exposed locations to provide a visible indication of the alarm condition. These mini strobes are weatherproof and rustproof. They utilise a long-life xenon tube and are very bright for their size. Surface mount, single cable entry hole.

- Voltage: 12VDC
- Strobe rate: 90 flashes per minute
- Size: 70(dia) x 30(H)mm

Blue

Red

Orange



Cat. LA-5302
\$24.50

Cat. LA-5303
\$24.50

Cat. LA-5304
\$24.50

Solar Wireless Bellbox Siren/Strobe

This siren/strobe combination includes an integrated solar panel to charge a 6V SLA battery and uses wireless RF technology to communicate with an ordinary alarm panel.

Wireless receiver included.

- SLA battery available separately. (SB-2495 \$12.95)
- 110dB siren
- Tamper protection
- White ABS weatherproof box



Cat. LA-5307
\$199.00

Surveillance Cameras

Colour CCD Dome Camera - Sharp Sensor

This affordable 350TV line dome camera has a Sharp CCD sensor and is ideal for shop surveillance applications.

- 100mm diameter, 60mm high



Cat. QC-3292
\$69.00

Weatherproof Day/Night Colour CCD Camera with Sony Sensor

This 350TVL camera features a water resistance rating to IP57 so can be mounted in extreme weather conditions. The camera will operate down to 0-lux, courtesy of 12 automatically triggered infrared LEDs mounted behind a protective glass shield. The camera housing is made of a lightweight alloy and is supplied with a swivel mount base and mounting screws. A removable light/rain shield is also included to provide basic protection to the CCD lens from the elements when mounted outside. Use our MP-3011 12VDC regulated plugpack.



Cat. QC-3492
\$199.00

Economy 4 Channel Multiplexing DVR

A combined multiplexer and digital video recorder with Ethernet port, which allows control via a web browser. Features MPEG-4 compression, advanced motion recording, covert recording, video loss detection, remote network record and back-up support. Supplied with a 250GB HD and can be expanded up to 400GB. See website for specifications. 340mm wide.

- MPEG-4 compression
- 250GB HDD included

Cat. QV-3079
\$499



**DON'T FORGET
TO CHECK OUT OUR
FULL RANGE OF
DVR'S**

RFID Access Control System

Control entry to a doorway, or an entire building. The unit can be used in a network of locks administered by a central location or just to control access through a front door. It is 12V powered, so you can use it in remote locations, and the reader unit is splash proof.

- 5 RFID cards included
- NO and NC relay contacts



Cat. LA-5120
\$199.00

RFID Keypad Access Controller

A card capacity of up to 500 RFID cards. It is designed to control door strikes in home or business access control installations. The unit allows 4 entry method, password, proximity card, password + proximity card and egress push button entries. See our website for full specifications



Cat. LA-5123
\$149.95

2.4GHz Colour CMOS Wireless Camera System - up to 4 Channels

This 2.4GHz 4 channel transmitter/receiver package can monitor locations up to 100m from the receiver with video and audio capture. The camera can be plugged into mains power with the included plugpack or via the 9V battery attachment, also included. It has infrared LED's built-in for night vision.

- Supplied with one camera and receiver

Additional cameras available separately QC-3585/6 \$99.00 each



Cat. QC-3584
\$229.00

DVR Camera Kit

The DVR is fitted with a 250GB hard drive, can accommodate up to 4 cameras with power derived from the DVR and will allow you to record and view up to 4 cameras simultaneously. Package includes the DVR with a dome and outdoor IR camera with bracket, mounting hardware, power supply, 14m camera connect cable, software, USB interface lead and user manual.

Was \$949.00

Cat. QV-3085
\$699.00

SAVE \$250



RFID Tags

Each tag transmits a unique 40 bit code that is pre-programmed and subsequently recognised by the receiver module.

Keyfob Style RFID Tag

Measures 31(W) x 40(L) x 5(H)mm. Cat. ZZ-8950



Clear 21mm Diameter RFID Tag

Cat. ZZ-8954



RFID Card

Standard credit card size. Cat. ZZ-8952



RFID Card - Lanyard Type

Hangs on a lanyard or belt clip. Cat. ZZ-8953



Cat. ZZ-8950 \$9.95ea	Cat. ZZ-8954 \$4.95ea	Cat. ZZ-8952 \$5.95ea	Cat. ZZ-8953 \$3.95ea
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Mini Personal Alarm

This tiny personal alarm has a loud 100dB (A) siren and is small enough to fit in your purse or around your neck. Batteries included.

- Measures: 40(L) x 25(W) x 16(H)mm

Cat. LA-5182
\$9.95



More Security Savings

Stor-A-Key Key Safe

Never get locked out again. This unit mounts directly onto a wall or flat surface, holds up to 5 keys and the combination can be easily changed when needed. Great for the caravan or holiday home as well.

Was \$99.95

Cat. LA-5356
\$79.95

SAVE \$20



2 Station Wireless FM Intercom

Great for communicating around your home.

Transmits through the electrical cable already laid in your house. Additional units can be added for multi-point communications.

- 2 Channels
- Sold as a pair

Was \$74.95

SAVE \$10



Cat. AI-5500
\$64.95

Gooseneck Inspection Camera with LED Illuminator

There's hundreds of applications for this 380TV line gooseneck camera, including checking under vehicles, inside cupboards, behind wall cavities, up chimneys etc. It also has built-in IR LEDs for use at night or low light areas. It is completely portable, requiring only 2 x CR123A batteries to operate.

Was \$199.00

Cat. QC-3389
\$169.00

SAVE \$30



Multimeter Madness

Autoranging DMM With USB Datalogging Interface

- Backlit LCD
- Duty Cycle
- Frequency
- Dual Temperature
- Capacitance
- Continuity Buzzer
- 4000 Count
- Diode Test
- Holster Included
- Cat III 1000V

Was \$139.95

SAVE \$40

Cat. QM-1462
\$99.95



RS-232 Auto Range DMM

- Auto Range
- 3.75 Digit 3999 Count
- Diode Test
- 10A AC & DC Current
- Data Hold
- Continuity Buzzer
- Temperature
- Capacitance
- Frequency
- Relative Measurement
- Auto Power Off
- Software Data Logging
- Includes CDROM
- Software
- Includes Holster
- Cat II

Was \$49.95

SAVE \$20

Cat. QM-1538
\$29.95



Cat III Auto Range DMM

- Auto Range
- 3.75 Digit 4000 Count
- Diode Test
- 10A AC & DC Current
- Data Hold
- Continuity Buzzer
- Capacitance
- Frequency
- Relative Measurement
- Auto Power Off
- Cat III 600V
- Double Moulded Holster
- Includes Temperature Probe

Was \$59.95

SAVE \$15

Cat. QM-1539
\$44.95



IP67 Rated DMM for Harsh Environments

- IP67 rated
- Auto range
- Large 4000 count display
- Frequency / % Duty
- Data Hold
- Relative Measurements
- Backlight
- 10A AC/DC Current
- Capacitance
- Temperature
- Continuity Buzzer
- Cat III 1000V, Cat IV 600V

Was \$99.95

SAVE \$20

Cat. QM-1541
\$79.95



AC/DC Current Clamp Meter

AC/DC Current Clamp Meter

Ideal for car stereo installations and electrical trades people.

- 200A AC/DC
- Frequency
- Capacitance
- Autoranging
- Auto power off
- Data hold
- Zero function
- Duty Cycle
- Continuity Buzzer
- Carry case included
- 4000 count

Was \$139.95

SAVE \$40

Cat. QM-1562
\$99.95



Mini AC/DC Current Clamp Meter

With Non-contact Voltage Sensor available separately

Was \$99.95

SAVE \$20

Cat. QM-1564
\$79.95



Digital Lightmeter

A handy lightmeter for photography, lab work, architectural, engineering and construction. 3 ranges to .01 to 50,000 lux. Battery and sensor cover included.

Features:

- 1999 Count LCD
- 3.5 Digit Readout
- Auto Zeroing
- Data Hold
- 3 Ranges
- Separate Photo Detector

Cat. QM-1567
\$49.95

HANDY FOR PHOTOGRAPHY LAB WORK CONSTRUCTION



Telescopic AC Voltage Detector

Test for mains voltage in confined or inaccessible areas such as wall and ceiling cavities, behind furniture, under floors etc. Batteries included. Folds to a handy pocket size for easy storage.

- LED indicates mains voltage
- Cat II rated
- Extends to over 1.2m
- Size folded: 180(L) x 32(W) x 16(D)mm

Cat. QP-2279
\$19.95

Due April



Compact Digital Sound Level Meter

Featuring a wide dynamic range from 30 to 130dB, it can measure both A and C weightings and can have fast or slow responses to get an 'ambient' reading or a short noise. Includes data hold and min/max functions, as well as tripod mount. Supplied with carry case and wind sock.

- Battery included
- Dimensions: 210(H) x 55(W) x 32(D)mm

WIDE DYNAMIC RANGE 30 TO 130dB

Cat. QM-1569
\$99.95



Economy Digital Sound Level Meter

Available separately

Cat. QM-1591
\$49.95



Getting The Most From Your Multimeter

This book is primarily aimed at beginners, and those with a limited knowledge of electronics. It covers the basics of analogue and digital multimeters, various methods of component checking, and circuit testing.

- 102 pages



Cat. BB-7034
\$17.95

Multimeter Carry Case

Hard wearing and good looks make this multimeter case perfect for protecting your valuable multimeter from harm. With foam lining to cushion the meter, it zips up tight guarding it from dirty dusty conditions.

Size: 190(L) x 125(W) x 45(D)mm

Cat. HB-5351
\$5.55



Probe K-Type Thermocouple

Measure external temperature readings on DMMs. It will measure from below minus 50°C to above 1200°C, depending on the DMM it's used with. Suitable for gas and liquid, accuracy of 0.75%.

Cat. QM-1282
\$12.95



DMM Leads with Blade Fuse Fitting

DMM leads with fittings for standard or mini blade fuse sockets. A must for auto electricians or installers. Length 750mm.

DMM Lead Banana Plug to Blade Fuse

Cat. WT-5348
\$9.95

DMM Lead Banana Plug to Mini Blade Fuse

Cat. WT-5342
\$9.95



10MHz Velleman Personal LCD Hand-Held Oscilloscope

The Velleman Personal Oscilloscope is a complete portable unit at the size and cost of a good multimeter. It's an ideal oscilloscope for hobbyists, students, service people, automotive applications and general development. Features include high contrast LCD with wide viewing angle, full automatic setup for volt/div & time/div; true RMS and dB measurements, screen hold function; low battery detection and auto power off.



Cat. QC-1916
\$349.00



10MHz Single Trace Cathode Ray Oscilloscope (CRO)

This entry-level oscilloscope is ideal for the tradesman or advanced hobbyist who is working with audio equipment or other low frequency applications.



Cat. QC-1920
\$155.00



Backlit Temperature DMM

- 19 Range
- 3.5 Digit
- Transistor Test
- Diode Test
- 10A DC Current
- Data Hold
- Continuity Buzzer
- Temperature
- Backlight
- Includes Holster
- Includes Temperature Probe



TEMPERATURE PROBE



CAT II 600V

SAVE \$10

Cat. QM-1526
\$14.95



Flammable Gas Detector

This detector will alert you to the presence of flammable gas and warn you via its built-in buzzer and LEDs. It is perfect for checking around gas bottles while camping, caravanning, or boating.

- 2 x AAA batteries (included)
- Detectable gases: LNG and LPG

DETECTION OF LNG & LPG GASES

Cat. QM-1060
\$59.95



Low Cost DMM

- 19 Range
- 3.5 Digit
- Transistor Test
- Diode Test
- 10A DC Current
- Ideal First Meter
- Compact Size

Cat. QM-1500
\$7.95



Moisture Level Meter

When it comes to seeing if there's moisture ingress on walls or ceilings, you can't go past a quality instrument like this one. Featuring a simple to use and easy to read display, this unit can be used on timber, cardboard, paper, and even on hardened materials such as concrete and mortar.



FEATURES AN INTEGRATED CALIBRATION CHECKER IN THE LID!

Cat. QP-2292
\$59.95



12dB Noise-Cancelling Headphones

These headphones generate an "anti-noise" sound wave. When this soundwave combines with sound external to the headphone, it creates a destructive interference effectively cancelling out sound from the outside. Perfect for noisy environments such as airports, construction/demolition zones, shipping docks or train stations.

- Maximum noise reduction level: 12dB at 100Hz
- Requires 1 x AAA battery (Use SB-2426)



NEW

Cat. AA-2058
\$99.95

Piezo Ignition Butane Gas Torch

Ideal for brazing, silver soldering, jewellery work, heat shrinking, and a whole lot more. It has a 1300°C adjustable flame and includes a stand.

- Dimensions 150(H), base 69 x 69mm

Was \$39.95

SAVE \$10

Cat. TS-1660
\$29.95



Low Cost Gas Soldering Iron

This butane gas soldering iron features adjustable tip temperature and a foldout stand. Remove the soldering tip and you have a flame torch.



Cat. TS-1111
\$19.95

Duratech Solder

60% Tin / 40% Lead

Two sizes available, 1.0mm and 0.71mm diameter.

- 0.71mm is ideal for work with IC's and all fine soldering
- Both types are resin cored



1kg Reels

Cat. NS-3002
\$39.95

Cat. NS-3015
\$39.95

200G Reels

Cat. NS-3005
\$8.95

Cat. NS-3010
\$8.95

Digital Mobile Microscopes

Enter the micro realm with ease. These portable pocket-sized microscopes are surprisingly powerful with a magnification range of 24x - 90x. They use 3 bright-white LEDs to light up your objects and feature an adjustable focus to sharpen your image.

- 3 x AAA Rechargeable Ni-MH batteries included

Two versions available:

Digital Mobile Microscope

Dimensions: 120(L) x 55(W)mm

Cat. QC-3245
\$249.00



Digital Mobile Microscope with Image Capture

Viewed images can be easily transferred to a PC (QC-3246 only) for use in reports, articles, projects etc. (Capable of taking JPEG images at a resolution of 320 x 240).

Dimensions: 120(L) x 55(W)mm

Cat. QC-3246
\$299.00



Short Circuits Book and Parts

This full colour 96 page book has over 20 projects and over 100 drawings and diagrams. The projects are fun to build and relevant to the electronics scene in the new millennium. Included with the book, you get the baseboard, plenty of spring terminals and ALL the components required to build every project in the book, INCLUDING the bonus projects. Book measures 205mm x 275mm

• Available separately

BJ-8504 Short Circuits Volume II - 20+ projects \$13.95

BJ-8505 Short Circuits Volume III - 30+ projects \$19.95



Cat. KJ-8502
\$36.95

Soldering Starter Kit

After Short Circuits 1' the next two series require you to start soldering components to the printed circuit board. So you'll need a good soldering iron and this one is ideal for beginners. This kit contains:

- 1 x KC-5178 Clifford the Cricket Kit
- 1 x TH-1886 Precision Cutters
- 1 x TH-1502 Soldering Stand
- 1 x TS-1465 240V 25W Soldering Iron
- 1 x 15g pack 60/40 0.71mm solder

Cat. TS-1655
\$44.95



Versatile Regulated Voltage Adaptor

Ref: Electronics Australia August, 1997

A very handy little kit!

A low-powered DC converter suited for many applications such as a peripheral computer power supply, powered speakers, modems, music/MIDI keyboards, etc. Just plug its input into your PC's internal power supply cable and have selectable regulated voltage out from 3 to 15VDC. Output current capability is around 1.5 amps depending on the size of heatsink used (heat sink sold separately).

- Kit includes PCB plus all electronic components



Cat. KA-1787
\$6.95

10A 12VDC Motor Speed Controller

Ref: Silicon Chip June, 1997

Use this kit for controlling 12V DC motors in cars such as fuel injection pumps, water/air intercoolers and water injection on performance cars. You can also use it for headlight dimming and running 12V DC motors in 24V vehicles. The kit will control loads up to 10 amps, although the addition of an extra MOSFET transistor will double that capacity to an amazing 20 amps.

- Kit includes PCB plus all electronic components to build the 10A version.
- Extra MOSFET available separately, ZT-2450.

Cat. KC-5225
\$23.95



The 'Flexitimer'

Ref: Electronics Australia March 1991

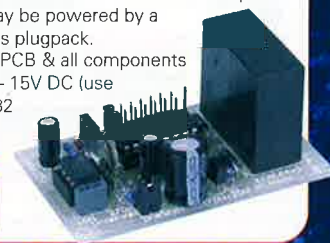
We have revised the original design and now provide two modes of operation.

The original on-shot count down mode is retained and we have added an interval mode with a 50% duty cycle.

The kit can switch a number of different output devices and may be powered by a battery or mains plugpack.

- Kit includes PCB & all components
- Requires 12-15V DC (use Cat. MP-3282 plug pack).

Cat. KA-1732
\$18.95



IR Remote Extender MKII Kit

Ref: Silicon Chip October 2006

Operate your DVD player or digital decoder using its remote control from another room. It picks up the signal from the remote control and sends it via a 2-wire cable to an infrared LED located close to the device. This improved model features fast data transfer, capable of transmitting Foxtel® digital remote control signals using the Pace 400 series decoder. Kit supplied with case, screen printed front panel, PCB with overlay and all electronic components.

- Requires 9 VDC power and 2-wire cable



Cat. KC-5432
\$24.95

"The Champ" Audio Amplifier

Ref: Silicon Chip Feb, 1994

This tiny module uses the LM386 audio IC, and will deliver 0.5W into 8 ohms from a 9 volt supply making it ideal for all those basic audio projects. It features variable gain, will happily run from 4-12VDC and is smaller than a 9 volt battery, allowing it to fit into the tightest of spaces.

- PCB and all electronic components included.

Cat. KC-5152
\$5.95



Fuel Mixture Display Kit

Refer: Silicon Chip November 1995

This very simple kit will allow you to monitor the fuel mixtures being run by your car. This type of sensor is also known as an E.G.O. (exhaust, gas, oxygen) monitor. You can use it as a tuning tool, to help in vehicle modification or simply to see the behaviour of the engine control module. Indication is via 10 LEDs to show mixtures rich, lean and normal. The circuit connects to the EGO sensor mounted in the exhaust manifold and the car's battery.

- PCB, LEDs and all electronic components supplied.

THOUSAND SOLD

50
Cat. KC-5195
\$14.95



12VDC Relay Card

This kit will close a relay's contacts with as little as 5mA to trigger the circuit. Literally any kit that uses an LED as a trip-condition indicator, can be used with this nifty project. Use the relay to sound buzzers, switch on lights, operate solenoids, trigger alarms, etc.

- Kit includes Kwik Kit PCB, relay plus electronic components.

Cat. KG-9142
\$7.95



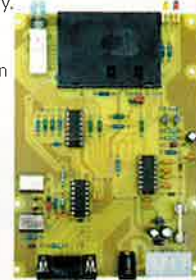
Full Function Smart Card Reader / Programmer Kit

Ref: Silicon Chip July 2003

This full function programmer allows you to program both the microcontroller and EEPROM in the popular gold, silver and emerald wafer cards. It hooks up to the serial port of your PC and can be operated as a free-standing unit or installed in a PC drive bay. Cards used need to conform to ISO-7816 standards, which includes ones sold by Jaycar. Powered by 9V via a 9-12VDC plugpack (use MP-3030) or 9V battery.

- Instructions outline software requirements that are freely available on the Internet.
- Kit supplied with PCB, wafer card socket and all electronic components.
- PCB measures: 141 x 101mm

Jaycar Electronics and Silicon Chip Magazine will not accept responsibility for the operation of this device, its related software, or its potential to be used for unlawful purposes.



Cat. KC-5361
\$49.95

Three Stage FM Transmitter

This is a

Three-Stage radio transmitter that is so stable you could use it as your personal radio station and broadcast all over your house. Great for experiments in audio transmission. It includes a microphone but you can transmit other material as well. Includes a mic, PCB with overlay and all other parts.

- Requires 9V battery

Cat. KJ-8750
\$19.95



Portable 3.5" Digital LCD Television

Catch all the digital TV broadcasts with crystal clear reception and audio quality. Rechargeable battery, plugpack, headphones, full function remote control and AV lead included allowing connection to a DVD or VCR etc.

- 3.5" TFT LCD
- Telescopic and magnetic car roof antennae included
- Resolution: 480 x 234 pixels
- AV decoding: MPEG2
- Plugpack: 9V 1.66A
- Dimensions: 135(L) x 85(H) x 30(D)mm

Was \$299

Cat. QM-3776
\$249.00



5.8GHz AV Transmitter and Receiver

Don't want to miss a minute of the football! Indoors outdoors, even if you're sent to the kitchen to do the dishes you won't miss any of the action when you send high quality audio and video signals from your main viewing source to another with this powerful 5.8GHz model. Avoids all the interference on the crowded 2.4GHz ISM band without the inconvenience and cost of running wires.

- Additional receiver available separately - AR-1841 \$159.95

Cat. AR-1840
\$199.00



50W 6.5" Powered Subwoofer

The subwoofer integrates a 50WRMS amplifier housed in a solid black wooden enclosure. Perfect for use with a mini component system, computer multimedia applications or use with our Retro Wooden CD/Turntable Player (GE-4063) available separately.

Specifications:
Speaker Size: 6.5"
Power Output: 50WRMS
Dimensions: 250(W) x 350(H) x 420(D)mm

Cat. GS-2458
\$99.95



Home Cinema Leads and Adaptors

Listed below is just a few of what we stock in probably the biggest range of audio and video leads under one roof. Jaycar prices are a fraction of the high street shop leads and WE GUARANTEE they are just as good. So compare and save yourself a fortune.



Type	Description - End 1	Description - End 2	Length	Cat.	RRP
Audio	Toslink Plug	Toslink Plug	1.0m	WQ-7260	\$15.95
Audio	RCA x 2 Plug	RCA x 2 Plug	1.0m	WQ-7226	\$15.75
A/V	RCA x 3 Plug	RCA x 3 Plug	1.5m	WQ-7234	\$29.95
A/V	S-Video + RCA x 2 Plug	Scart Plug	1.5m	WQ-7246	\$29.95
Video	S-Video Plug	S-Video Plug	1.5m	WQ-7214	\$15.95
Video	RCA Plug	RCA Plug	1.5m	WQ-7222	\$9.50
Video	HDMI Plug	HDMI Plug	1.5m	WQ-7400	\$39.95
Video	Coaxial Plug	Coaxial Socket	1.5m	WV-7376	\$6.95

RC 4 Channel HDTV Input Selector

This four input HDMI selector routes HD video and audio signals from the selected input to the HDMI output. The switcher also supports optical and coaxial audio inputs which are switched in unison with the HDMI channels.

- Includes remote control and mains adaptor
- Fully HDMI and HDCP compliant
- 165MHz bandwidth

Cat. AC-1694
\$199.00



Indoor TV Amplifier/Splitters

Boost your TV signal indoors. The antenna lead is plugged into the amplifier, and there are two outputs for two TVs, both which have a 12dB boost. One outlet can be used for FM stereo if desired.

- Mains powered

Cat. LT-3288
\$47.95



Variable Attenuator

May reduce ghosting in some cases. In certain situations you can actually receive too much TV signal. This attenuator (signal reducer) goes in line and has a variable control. Supplied with two F-sockets, maximum attenuation is 20dB.

Cat. LT-3950
\$9.50



Hang It Up!

Light Duty TFT or Plasma Wall Brackets

If you're updating your Home Theatre System, don't forget the mounting hardware. Jaycar's range will help you place your equipment in the best position for the best possible picture or sound.

CW-2813 LCD Monitor wall bracket - Double Arm Swing

Max weight : 8kg
Mount system : ESA 75/100mm
Tilt: 90 All directions

Cat. CW-2813
\$59.95



CW-2814 TFT/Plasma Screen Wall Bracket

Max weight: 22kg
Mounting System: ESA 50/70/100mm
Tilt angle: 5 up & 20 down

Cat. CW-2814
\$39.95



CW-2816 Plasma Screen bracket

Max Weight: 75kg
Mounting system: Universal
Tilt Angle: 20 Down

Cat. CW-2816
\$149.95



Projector Ceiling Mount Universal Mounting

Cat. CW-2817
\$69.95

This projector mount will fit the majority of projectors on the market, handling models up to 20kgs. Adjustable swivel and tilt.

- Projector not included



Heavy Duty Ceiling Projector Mount

Supports up to 15kgs & suitable for projectors up to 47cm wide. Adjustable arm length from 500mm 700mm

Cat. CW-2818
\$99.95



TV Wall Bracket

Suited to portable and smaller TV sets, PC monitors & small speakers etc.

- Load capacity is 30kgs

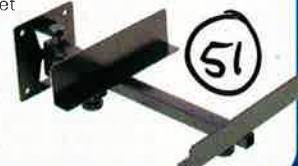
Cat. CW-2810
\$42.95



Adjustable Wall Speaker Bracket

- Horizontally and vertically adjustable
- Speaker depth adjuster
- Holds speakers 165mm - 300mm deep
- 10kg per bracket
- Sold per pair

Cat. CW-2840
\$34.95



Power Products

SLA Deep-Cycle Gel Batteries

They can be operated and charged in any position, are leak proof and completely sealed. Gel batteries are ideal for solar power, camping, 4WD, auxilliary applications and anywhere deep discharge and recovery is required.

Two types available:

SB-1696
2V 200Ah

- Weights: 14.5kg
- Size: 170(W) x 110(D) x 362(H)mm

Cal. SB-1696
\$269.00



SB-1698
12V 26Ah

- Weights: 8.5kg
- Size: 165(W) x 172(D) x 110(H)mm

Cal. SB-1698
\$109.00



Not stocked in all stores.

Call first or order via Techstore

Bulk Alkaline Battery Packs

Never run out of batteries again!

- SB-2320 - 4 Pack C
- SB-2321 - 4 Pack D
- SB-2333 - 12 Pack AA
- SB-2334 - 12 Pack AAA



Cal. SB-2320
\$6.95

Cal. SB-2321
\$8.25

Cal. SB-2333
\$7.95

Cal. SB-2334
\$7.95

1/2hr Battery Charger

Fast charge 4 x AA or AAA Ni-Cd or Ni-MH batteries in just 30 minutes! Microprocessor controlled with LED charge indicators, fan assisted cooling, and individual charging slots.

Was \$49.95

Cal. MB-3541
\$44.95



SAVE
\$5

Keyboard Video Monitor (KVM) Switches

KVM switches allow you use one keyboard, mouse and monitor to control several computers. Several models are available in both USB and PS/2 configurations.

The 2 Port units have integrated cables on the PC side and the 4 port USB unit incorporates a USB share hub.

Common Specifications:

Max Resolution 2048 x 1536 pixels
Video Bandwidth 400MHz

2 Port version
YN-8095

PS/2 Versions:

PC Port Connections:

- Keyboard: PS/2
- Mouse: PS/2
- Monitor: D15HD



Console Port Connections:

- Keyboard: PS/2 x 1
- Mouse: PS/2 x 1
- Monitor: D15HD x 1

4 Port version YN-8096
Was \$114.95



SAVE
\$25

USB Versions:

PC Port Connections:

- Keyboard / Mouse (or other): USB 2.0
- Monitor: D15HD



SAVE
\$10

Console Port Connections:

- Keyboard / Mouse (or other):
- 2 Port: USB 2.0 x 2
- 4 Port: USB 2.0 x 3
- Monitor: D15HD

2 Port version YN-8091
Was \$89.00



4 Port version
YN-8092

Cal. YN-8095
\$59.00

Cal. YN-8096
\$89.95

Cal. YN-8091
\$79.00

Cal. YN-8092
\$139.00

Light it Up!

Economy Head Torch

Light, compact, very efficient on batteries and comes with a fully adjustable head strap.

- 12 LEDs • 4 lighting modes
- Requires 3 x AAA batteries
- ST-3287 17 LED head torch also available

Cal. ST-3286
\$9.95



Solar Powered Torch

Featuring 10 high brightness LEDs and internal rechargeable batteries that are charged by the solar panel on the handle.

- Torch 210mm long

Cal. ST-3077
\$24.95



X-Glow Cree® LED Torch - 136 Lumens

Featuring a nifty tactile switch that allows a light touch to temporarily illuminate or a heavier press to completely switch on, the Cree® X-LAMP LED is not only powerful but very efficient.

- Water resistant • Multi-facet reflector
- Burn time up to 25 hours • Batteries included
- 211(L) x 27(Dia.)mm

4 models available - see website or in-store for details

Cal. ST-3374
\$49.95



24W HID Rechargeable Torch

This is one of the brightest torches we have ever seen. It uses the same Hi-Intensity Discharge (HID) technology that is used in expensive European luxury car headlights to produce a staggeringly bright beam that seems to go forever. Several models are available. See our website for full details.

- Dimensions: 72(Dia.) x 380(L)mm
- Light output: 1800 Lumens
- Burn time with full charge: 120mins
- Mains and car charger supplied
- Battery, lanyard and filter lens supplied

Was \$499.00

SAVE
\$50



Cal. ST-3362
\$449.00

• HID Head Torch also available ST-3366
Was \$399 Now \$349 Save \$50

Outdoor Communications

38 Channel UHF CB Twin Pack

This 2 pack of mini UHF CB communicators can keep you clearly in touch up to 3km. They feature electronic volume control, monitor functions and an integrated blue LED torch.

- Requires 3 x AAA batteries per unit
- Scan channel, call tone and monitor functions

Was \$49.95

Cal. DC-1005
\$39.95



SAVE
\$10

38 Channel UHF Pocket CB Radio

Keep in touch while hiking, fishing or bushwalking. Hands free kit also available.

- Green backlit LCD screen
- Up to 5km range
- Batteries included

Cal. DC-1010
\$34.95



3W UHF CB Transceiver

Up to 10km transmission range. Maximum output is 3 watts with 1W battery saver mode. All 38 legal channels are utilised as well as CTCSS sub channel calling, automatic muting, and scrambling. Supplied with a high gain (168mm) antenna fitted with an SMA connector to allow the use of external antennas

- AC/DC charger included

Was \$169.00

Cal. DC-1060
\$154.00



SAVE
\$15

38 Channel UHF Pocket CB Radio

Upgrade your UHF radio and save money while out and about.

- Up to 5km range
- Built-in scrambler
- Includes 2 charging bases and one handset

Was \$59.95

Cal. DC-1025
\$49.95

SAVE
\$10



DC-1028 Extra handset

Was \$49.95

Now \$39.95

Save \$10

YOUR LOCAL JAYCAR STORE

Australia Freecall Orders: Ph 1800 022 888

NEW SOUTH WALES

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Bankstown	Ph (02) 9709 2822
Blacktown	Ph (02) 9678 9669
Bondi Junction	Ph (02) 9369 3899
Brookvale	Ph (02) 9905 4138
Campbelltown	Ph (02) 4620 7115
Erina	Ph (02) 4365 3443
Gore Hill	Ph (02) 9439 4759
Hornsby	Ph (02) 9476 6222
Newcastle	Ph (02) 4965 3799
Parramatta	Ph (02) 9683 3377
Penrith	Ph (02) 4721 8337
Rydalmere	Ph (02) 8831 3151

Silverwater	Ph (02) 9741 8557
Sydney City	Ph (02) 9267 1614
Taren Point	Ph (02) 9531 7033
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Springvale	Ph (03) 9547 1022
Sunshine	Ph (03) 9310 8066
Thomastown	Ph (03) 9465 3333
QUEENSLAND	
Aspley	Ph (07) 3863 0099
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Ipswich	Ph (07) 3282 5800
Maroochydore	Ph (07) 5479 3511
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Townsville	Ph (07) 4772 5022
Underwood	Ph (07) 3841 4888
Woolloongabba	Ph (07) 3393 0777
AUSTRALIAN CAPITAL TERRITORY	
Belconnen	Ph (02) 6253 5700
Fyshwick	Ph (02) 6239 1801
TASMANIA	
Hobart	Ph (03) 6272 9955
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Adelaide	Ph (08) 8231 7355
Clovelly Park	Ph (08) 8276 6901
Gepps Cross	Ph (08) 8262 3200
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Maddington	Ph (08) 9493 4300

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Palmerston Nth	Ph (06) 353 8246
Wellington	Ph (04) 801 9005
Freecall Orders	Ph 0800 452 9227

Jaycar
Electronics

SERVICEMAN'S LOG

Are things getting too complicated?

Do you ever get the feeling that things are just getting too complicated? That's certainly the case with TV sets, particularly when it comes to servicing.

Recently, I have had a deluge of Philips 43PP9225/79 Rear Projection TVs using the A10PTV2 chassis. I don't know whether this is down to their popularity and age (they are now around seven years old) or whether they are unreliable in a beachside environment (where I am located).

The most common fault by far is due to the Small Signal Board (SSB) or Panel (SSP).

Before I continue, I have to clear up a confusing point here as Philips have been using both "SSB" and "SSP"

loosely in their service manuals and literature for years, as though the terms were interchangeable. Unfortunately, this is not really true because in this rear projection model chassis they use both terms to refer to quite different assemblies.

In this case, the analog SSB is the small E1-E7 module that plugs into an 80-pin "RAM-type" socket (1026) on the SSP (sometimes also called the Small Signal Module or SSM). LSP still remains as Large Signal Panel (thank goodness) but what defines the difference between them? Presumably it's their size but what then is the definition of a module?

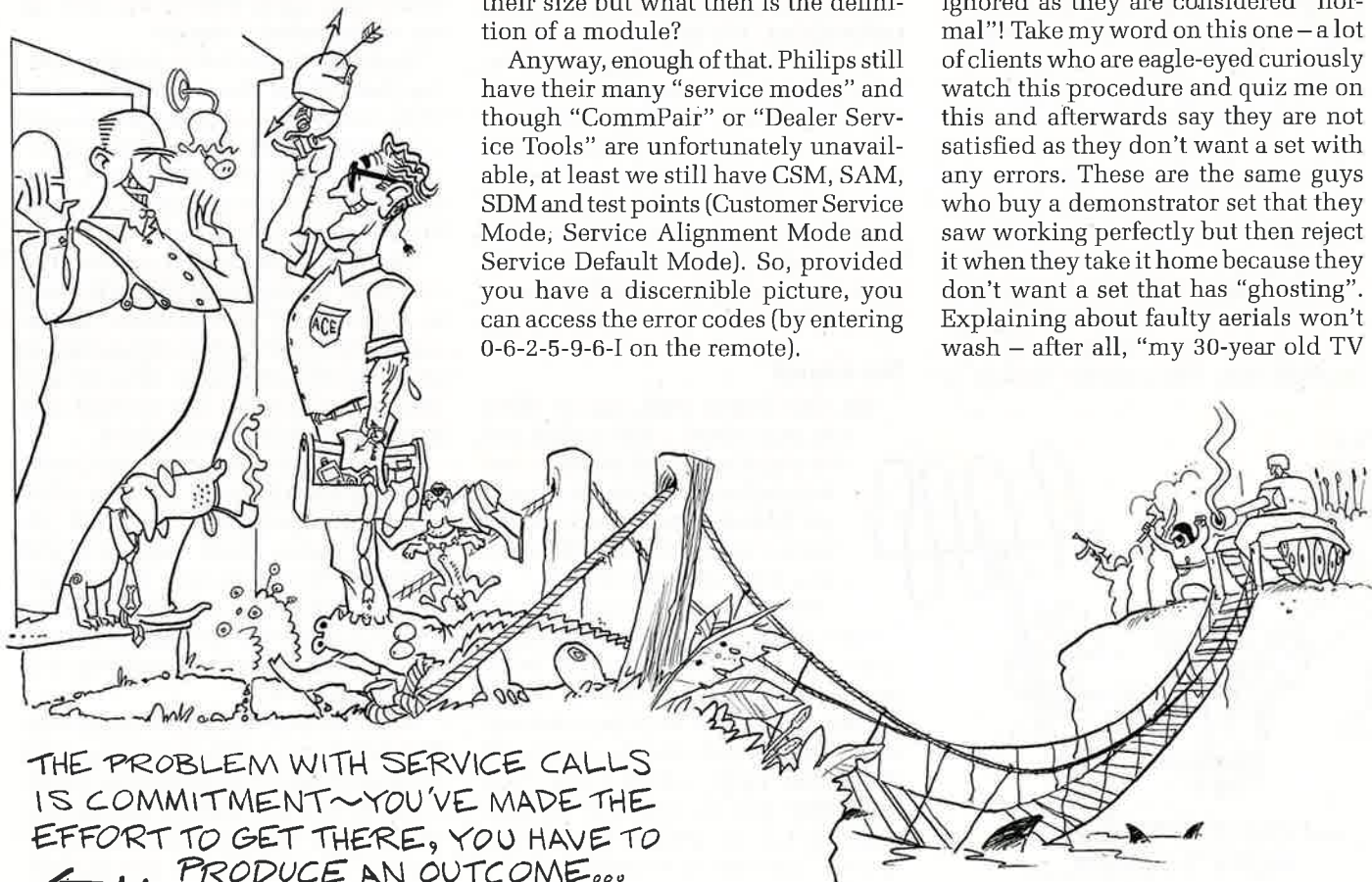
Anyway, enough of that. Philips still have their many "service modes" and though "CommPair" or "Dealer Service Tools" are unfortunately unavailable, at least we still have CSM, SAM, SDM and test points (Customer Service Mode, Service Alignment Mode and Service Default Mode). So, provided you have a discernible picture, you can access the error codes (by entering 0-6-2-5-9-6-I on the remote).

Items Covered This Month

- Philips 43PP9225/79 Rear Projection TV (A10PTV2 chassis)
- Philips 42FD9953/69S plasma TV (FM242 chassis)
- Grundig Elegance 82 Flat MFW82-31110 MV/Dolby (CUC1935 chassis)

Once the OSD (On Screen Display) shows the error codes, you should really clear the buffer and turn the set off with the remote. When you repeat this procedure, the set will now show only the current error codes and not the complete history.

Error codes 17, 23 & 33 can all be ignored as they are considered "normal"! Take my word on this one – a lot of clients who are eagle-eyed curiously watch this procedure and quiz me on this and afterwards say they are not satisfied as they don't want a set with any errors. These are the same guys who buy a demonstrator set that they saw working perfectly but then reject it when they take it home because they don't want a set that has "ghosting". Explaining about faulty aerials won't wash – after all, "my 30-year old TV



THE PROBLEM WITH SERVICE CALLS IS COMMITMENT~YOU'VE MADE THE EFFORT TO GET THERE, YOU HAVE TO PRODUCE AN OUTCOME...

Serviceman's Log – continued



PLASMA SETS CAN DOUBLE UP
AS HEATERS IN WINTER...

always gave perfect pictures".

Many of the error codes are also duplicated in the "Blinking Standby Red LED" so that you can deduce the error code even if there is no picture. This can be quite helpful on occasions.

It all makes servicing sound so simple – a bit like the "valve jockey" days of black and white television.

Well, unfortunately, this is where this system falls down. The SSB that generates these codes is often the cause of them too and they can be intermittent. As a result, it has got to the stage that when in doubt, change the SSB first. The current version is

2AP1-2.56, part number 3139 127 20331 exchange.

However, before sending it off for replacement, it's best to write down (if possible) all the settings stored in it for the TV, including 40 Options, 6 Tuner, 16 White Tone, 19 Geometry, 7 Sound and 24 Smart Settings. This can save a great deal of time later. If you are subsequently lucky enough to get an exchange that matches your TV, then you have no worries as it will have the same values or will be pretty close to those already stored.

No sound

My first drama with one of these sets was when I was called out for a no-sound fault (definite, not intermittent). Of course, when I got there and switched it on, the sound was perfect so Murphy was well and truly at work.

Now the problem with service calls is that you are now committed – you have made the effort to get there and so you want a result. In this instance, I decided to do my next call which was a few blocks away and then come back, which I did. This time there was no sound at all (permanently). I checked the error codes several times but there were none.

Next, I checked that the fault was the same for all TV and AV inputs which it was. I then removed the lower back and with difficulty confirmed that there was +41V on pin 12 of connector 1017 – the very furthest one away from me (naturally)!

That done, I plugged a pair of headphones into the side headphone socket and was surprised when this gave perfect sound. This told me the problem had to be the audio output IC (IC7402, TDA7265) which naturally I didn't have with me and in fact, would have to order in. In the meantime, to keep the customer happy, I pinched one of the amplified loudspeakers from their PC and plugged this into the TV's headphone socket to give sound. This worked well.

The next week, I called back, removed the SSP/SSM (whichever you prefer) and fitted the new audio IC. I also checked for any signs of stress in the old IC and its surrounding parts but could find nothing, so there was nothing to indicate why it had failed.

When I finished and switched it on, full sound was restored to the main loudspeakers. I checked for error codes again and all was sweet but not for long. Would you believe it? – the sound died again while I was writing out the customer's receipt.

Back into the set I dived again, having checked the error codes yet again. Well, obviously something was wrong and my suspicions turned to that blankety-blank little SSB. The sound, after all, is controlled by the SSB so this had to be a good place to start.

This time, I left a loan set with the customer while I took the SSB away to send off for an exchange. In the meantime, I had another of these beasts arrive in my workshop. This set was identical to the first but its fault was that it was intermittently dead.

Eventually, I managed to get it working long enough to get into the SAM mode and apart from the usual 17, 23 & 33 codes, there were no errors reported. However, as I hadn't sent the first SSB off yet, I decided to swap modules and see if the faults changed too. Eureka! – finally something was working to plan.

Now that I had confirmation of both the symptoms and their causes, I sent both modules off for exchange. While I was at it, I had noticed the 10-lead cable from the "Double Window" board F to the SSB was one of those



...FAULTY AERIALS
WON'T WASH...

flat-wire wafer thin membrane types which, after many insertions, develops a kink near the ends and eventually breaks. So I thought that as I was ordering the modules, I would just hang the expense and also replace these membrane connectors.

Eventually, the replacement SSBs arrived along with some new leads. These looked different from the originals in that they had a metal screen all down one side and were also slightly longer. Otherwise, they looked perfect and were of better quality.

This would all be a snack I thought. I was about to fix two rear projection TVs in one afternoon, so off I went to the first customer's house.

I plugged the new SSB into the first set and was delighted to get sound again but now there was no picture. I could get OSD and Teletext etc but no picture and no error codes showed anything to be faulty.

Perhaps one of the new boards was faulty so I fitted the second with the same result as before.

This, as Bugs Bunny would say, was a revolting development. I was by now thoroughly annoyed – this was definitely not on the agenda for the afternoon.

The only other thing that had changed since I last looked at this set was that I had replaced the flat cable with a new one. That couldn't possibly be faulty too – could it? I tried the other one but this gave the same symptom.

In the end, I replaced the old mangled one (with difficulty) and the picture reappeared. I checked all the



VERY PLEASANTLY SURPRISED WHEN
A GORGEOUS CHICK PHONED ME ...

adjustments and left with the sound still working.

So what was wrong with the new leads? I examined one of them closely. It was a 10-way flat lead with screening down one side. And that was when I noticed a couple of indentations on the screened side near one end. What the heck were they for?

Well, to cut a long story short, I found with my ohmmeter that this was how the screen made contact with some of the other connectors on the other side, thus shorting the video signals to ground. So the cables weren't the correct ones and had to be sent back for a credit.

I made a few further enquiries but no-one knew the part number for the correct cables.

Well, so far, so good. That left only one more to go – the set that was intermittently dead.

Now the guy that owned this was extremely interested in everything that was going on and seemed to be a very competent and intelligent bloke. I was still feeling pretty good about the previous job, so I replied to his rather searching questions in some detail while working on his set.

Most of his questions were about the picture quality, which on these sets, if they have been used a lot, starts to become rather poor. What happens in that the picture becomes streaky, with poor focus and poor greyscale. And his was pretty poor, probably because someone in his home smoked a lot.

Anyway, I chatted on about cleaning



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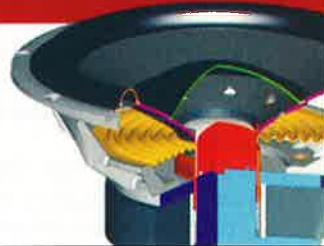


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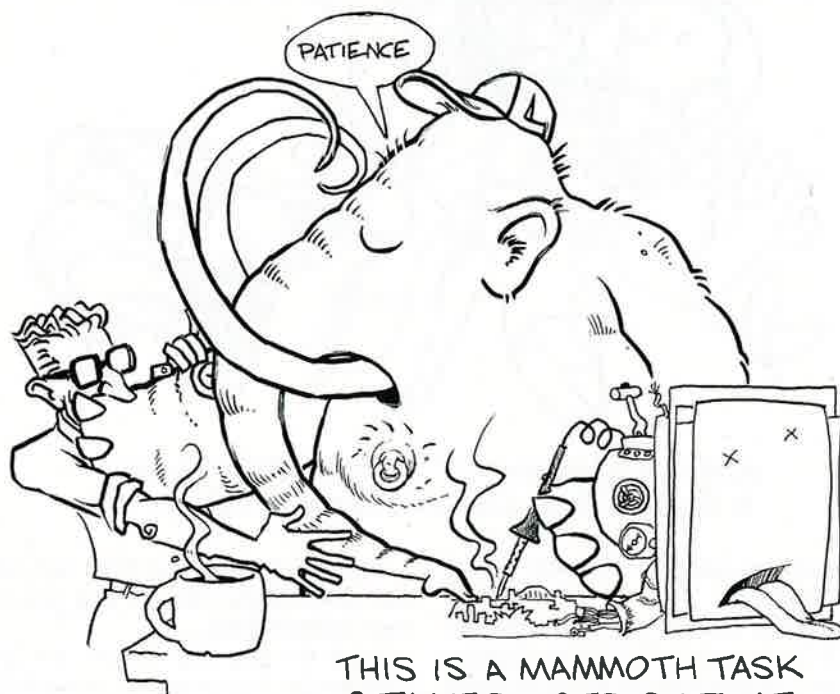
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the lenses and the mirror (and how to be very careful not to scratch it) and also mentioned the CRT lens coolant (ethylene glycol). He was an attentive listener and asked many questions on how to do this and why it need to be changed.

I told him that algae grows in the coolant on the green and blue guns but rarely on the red and that if there is insufficient coolant, the phosphor can wear out.

I also told him that the job was quite labour intensive and required a lot of care, otherwise the coolant could spill onto the circuits below and destroy them.

Anyway, I completed the job and left, satisfied that all was well. But it wasn't – one week later he phoned me to say that the set was dead again.

Well, these things happen I guess but why do they always seem to happen to me? Anyway, I arranged to go back as soon as possible and take another look.

When I got there, I switched the set on and sure enough, the set was dead. But that wasn't all – smoke was coming out of the lefthand side where the sound IC is.

I removed the SSP/SSM and examined the audio output IC. It was a blackened charred mess but there was

something else there too. It looked like an emulsion of water but when I got closer to it, I saw that it was ethylene glycol.

Someone's been fiddling

Now the truth came out. He had tried to remove the lens from one of the cathode ray tubes and coolant had leaked out. No wonder the set was dead.

I took the board back to the workshop and cleaned it up before installing a new audio IC. I then went back and reinstalled it but when I tried to turn it on, the set wouldn't start. But at least there was no smoke this time.

Fortunately, I had another identical set which had just arrived in the workshop, so I decided that the best course of action would be to take the entire chassis with me.

Once there, I swapped the boards one by one, carefully examining each for more fluid as it was removed. I did find quite a few more spots but it wasn't until I re-seated the SSB board back into its 80-pin slot on the SSP/SSM that I finally got the set going.

I went back to the client and reassembled his set. I found yet more fluid on the focus assembly but when that was cleaned up, the set burst into life. However, the remote control still

wouldn't work and neither did half the front control buttons.

I quickly put two and two together and asked him how he had cleaned the mirror. As I suspected, he had disassembled the rest of the cabinet – all by himself.

Although recognising his initiative, I knew from experience that you really need two people to handle the heavy cabinet. The front control panel is attached to the front escutcheon and the lead to it needs to have its harness properly released.

I could have bet money on the spot that he had cracked the control PC board (N) due to the strain from the trapped lead. Sure enough, when I removed it, I found three hairline cracks. I jumpered these, re-assembled the set and checked the error codes and adjustments before leaving.

You have got to keep your wits about you when dealing with these monsters – and their owners.

Philips plasma TV

I was pleasantly surprised when a gorgeous chick phoned me about her 2003 model Philips 42FD9953/69S plasma TV. This set uses an FM242 chassis and apparently, it had died during a storm.

The display in this plasma is a Samsung unit and consequently it uses lots of Samsung boards as well, including the power supply – for which no circuit was available.

In this set, the front red LED was continuously flashing and on the power supply board, the green LED8002 and LED8003 would both come on. However, both LED8001 (Power Drv) and LED8004 (Protection) remained off.

With these two symptoms, the troubleshooting flowchart says "change the board". So \$900 went down the drain – what a waste! Still, it was well worth fixing and a plasma set can double as a heater in winter (well, almost).

Impure Grundig

A friend brought in his Grundig Elegance 82 Flat MFW82-31110 MV/Dolby using a CUC1935 chassis. He was mostly complaining about the purity patches of incorrect colour on the picture.

I have written about this symptom before on this TV, as it is not the usual PTC (R22501) type problem. The automatic degaussing circuit is



IMPURE GRUNDIG

controlled via a Triac (TC22503) and an optocoupler (OK22505), so that the set can be degaussed via the microprocessor every time you switch on from Standby. However, the Triac becomes faulty, leading to intermittent purity patches.

The easiest answer is to remove the Triac and fit link BR22503 (already drilled), so that degaussing only takes place on switch on with the main power switch.

Having fixed this problem, I also noticed east-west pincushion distortion in the picture. Unfortunately, though, the correction circuit is in the least accessible part of this chassis,

with tall metal heatsinks surrounding it.

The first thing I did was remove the chassis far enough to gain limited access to the PC board. I then resoldered as much as possible around the whole area of the correction circuit.

When that didn't fix it, I began checking east-west modulation diodes D53571 and D53572 and the adjacent coils and resistors. It was while I was doing this that I found R55514 (4.7Ω) to be open circuit. I replaced this and noticed it fed IC55510 (TDA8145), the 8-pin east-west correction power IC, which I also replaced.

I thought that this would crack the problem but although replacing these parts improved the distortion, it still didn't fix it. There was nothing for it now but to check the tuning capacitors.

This is a mammoth task and takes lots of time. You not only have to remove each capacitor and measure it but also then refit it down in the works. Eventually, after a lot of work, I found two red block MK capacitors (C53506 & C53507) which were marked $0.25\mu\text{F}$ 400V. These looked as though they had been slightly cooked and were somewhat distorted. In addition, their capacitance had nearly vanished.

It's typical of Grundig to choose a

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value such as $0.25\mu\text{F}$ which as almost everyone knows, is not readily available. I wasn't about to order one from Grundig and wait for it to arrive, so I settled for $0.22\mu\text{F}$ for each capacitor. Installing these again improved the distortion but it still wasn't the complete cure.

Eventually, I found that D55512, a ZPD33 zener diode on the output (pin 5) of IC55510, was the remaining culprit. I had in fact previously checked this diode in-circuit with an ohmmeter but it was only when I checked it out of circuit that it showed up as being slightly leaky. A new one fixed the problem.

So that was how most of one day was ruined by tedious work until the problems were all tracked down. Unfortunately, I couldn't see my friend being inclined to pay for all this work for such a small improvement, so I gave him a discount. SC

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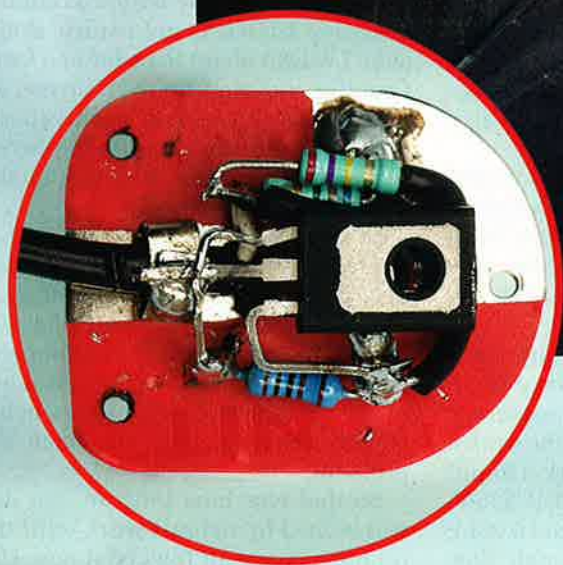
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SAFE-T-FLASH: A *Safe* Flash Trigger for



Many of today's digital SLR cameras risk serious damage if used with an external electronic flash, whether that is a portable type or a large studio "strobe". We found this was the case here at SILICON CHIP so we have produced a flash trigger to ensure the camera's safety. You can do likewise – but beware of the JISP!

We use a relatively ancient but perfectly serviceable Balcar studio flash and softbox for all in-house photography, coupled with a Nikon DSLR (digital SLR). The Nikon replaced my three much-loved but 40-year-old Minolta (film) SLRs.

When we changed to the Nikon, there was a minor problem: no sync connector (commonly known as a PC connector but it has nothing to do with personal computers). There was a hot shoe connector though and we obtained a hot shoe-to-PC-socket adaptor to solve that problem.

The second thing we checked was the instruction manual for any warnings about using studio strobes. There were

two: (a) the maximum strobe firing voltage that could be applied to the camera was 250V DC and (b) the polarity of the sync lead had to be tip positive.

Hmm! Both of these could be problems. The second certainly was because the phone-type plug which connected to the Balcar flash was tip negative. At least that problem was easily solved.

Then we wanted to know the voltage at the sync terminals. That's easy, right? We connected a digital multimeter to the sync terminals and it gave a reading of 224V. But a day or so later, when I repeated the test (to be sure, to be sure, etc) it was down to 103V.

By Ross Tester

your Digital SLR Camera

Hang about, nothing had changed, so what was happening? Surely not even a large mains variation could make that much difference? Something had changed and I took a few minutes to realise that I had used a different DMM. The first one was a $10\text{M}\Omega$ Tektronix TX3 DMM while the second was a much cheaper model which, as it turned out, had an impedance of only $3\text{M}\Omega$.

Could a digital multimeter be loading the camera's sync circuit by so much? Well, yes it could, since the sync circuit is essentially a capacitor discharge circuit to fire the Xenon flash tube. When the camera's flash contacts close, they discharge the capacitor to fire the flash tube.

In essence then, the sync circuit is just a capacitor which is charged from a high voltage source. So to find out the open-circuit voltage from the sync circuit and the charging impedance, we decided to make a few more voltage tests with loads of $10\text{M}\Omega$ (ie, with the Tektronix DMM) and $5\text{M}\Omega$ (Tektronix DMM in parallel with a $10\text{M}\Omega$ resistor). This gave results of 224V and 171V, respectively.

We then set up a pair of simultaneous equations (see panel). When the equations were solved, the results were that the open-circuit voltage was about 324V and the impedance around $4.5\text{M}\Omega$!

Well, 324V was quite alarming and could certainly do damage to any camera. To confirm this high voltage calculation, we decided to make a further voltage measurement using a $50\text{M}\Omega$ high-voltage probe with our LeCroy oscilloscope. The scope revealed that the voltage was around 310V. In fact, we had quite a few problems trying to make sensible measurements with the oscilloscope and its $50\text{M}\Omega$ probe because the Balcar's trigger circuit was floating with respect to mains earth and any connections to the scope tended to upset its operation.

However, we were able to confirm that the open-circuit trigger voltage from the Balcar flash was well in excess of 300V.

The answers are on the 'net . . . NOT!

As part of the research for this feature, we spent many hours on the internet looking for the experience of others. Several websites (including www.botzilla.com/photo/strobevolts.html, http://photo.net/bboard/q-and-a-fetch-msg?msg_id=00KBWJ and <http://aaronlinsdau.com/gear/articles/flashvoltage.html>) had pages and pages of strobe sync voltage readings. These were taken by photographers all around the world on a huge variety of strobes and off-camera flashguns (many of which we've never heard of).

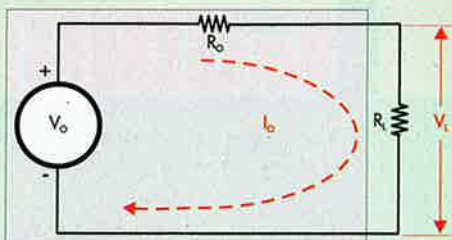
After our investigations, we would bet London to a brick that *all* of the sync voltage readings are wrong. Most were



It's an oldie but a goodie – our Balcar A1200 Studio Flash power pack which mates with the flash head and softbox diffuser at top left. The SAFE-T-FLASH trigger we made is in the black 6.5mm plug (highlighted) – it reduces the sync trigger from 300V to around 7.5V (and could go even lower).

How DO you determine the source voltage and impedance?

The sync source of the Balcar electronic flash described in this article is the classic "black box". It had an unknown (high) source voltage and an unknown (high) source impedance. When you have two unknown values, how do you proceed? The first step is to draw the equivalent circuit, as shown below.



Inside the "black box" is a voltage source V_0 , connected in series with the output impedance R_0 . This is connected to the "outside world" to the load R_L . The next is to measure the voltage across R_L . Then repeat that step for a different value of R_L . We now resort to Kirchoff's Voltage Law which states that the sum of the electrical potential differences around a closed circuit must be zero.

So we draw up an equation based on that law (also known as Kirchoff's loop or mesh rule):

$$V_0 = I_0 R_0 + V_L \quad (1)$$

Since the same current (I_0) flows around the whole loop, we can calculate:

$$I_0 = V_L / R_L \quad (2)$$

and we substitute that into equation (1) to get:

$$V_0 = (V_L / R_L) R_0 + V_L \quad (3)$$

We then take the voltage measurements for $10\text{M}\Omega$ (224V) and $5\text{M}\Omega$ loads (171V) and substitute them into equation (3) to get two new equations:

$$V_0 = (224\text{V} / 10\text{M}\Omega) R_0 + 224 \quad (4)$$

$$V_0 = (171\text{V} / 5\text{M}\Omega) R_0 + 171 \quad (5)$$

We then calculate the value for I_0 in each of the equations and substitute its value into (4) and (5). This gives:

$$V_0 = (2.24 \times 10^{-5}) R_0 + 224 \quad (6)$$

$$V_0 = (3.42 \times 10^{-5}) R_0 + 171 \quad (7)$$

To solve these simultaneous equations to find a value for R_0 , subtract equation (6) from (7) to get:

$$0 = 1.18 \times 10^{-5} R_0 - 53 \quad (8)$$

Therefore: $R_0 = 53 / 1.18 \times 10^{-5} = 4.49\text{M}\Omega$

We can then substitute this value for R_0 into equations (6) or (7) to calculate the value of V_0 and the result is 324V.

This is the true value for the open circuit voltage of the sync circuit; something that could not be obtained by any direct measurement.

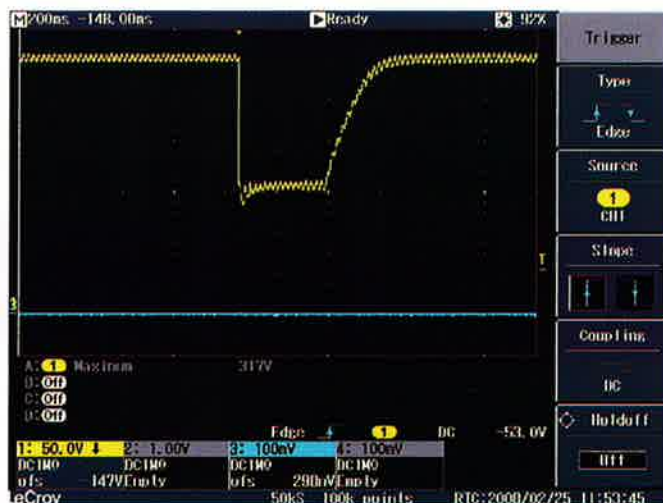


Fig.1: here's the actual firing of the Balcar strobe flash, with only the high impedance ($50\text{M}\Omega$) probe of our LeCroy DSO connected. The ripple on the trace is actually 50Hz hum. Note the maximum voltage reading of 317V.

recorded as being done with a DMM, usually of unknown pedigree. By the web posters' own admission, at least a few of them were done with an analog multimeter.

To prove the point, we measured the Balcar sync voltage with two different analog multimeters.

One, a typical model with $20,000\Omega/\text{V}$ impedance, gave us a reading of 210V on its 500V range and 160V on its 250V range. The second, nominally $20,000\Omega/\text{V}$ but dropping to $10,000\Omega/\text{V}$ on its highest (300V) scale, gave us readings of just 70V on the 300V scale and 54V on its 100V scale. Table 1 shows the actual voltage readings with various analog meters.

These results are further confirmation of the high charging impedance of the Balcar sync circuit and of course, are utterly misleading as an indication of the true voltage.

But based on their meter readings alone, most internet posters would say (and do say!) it would be safe to use the Balcar flash with a Nikon. However, we know the true voltage is over 320V and most definitely not safe.

The conclusion? You simply cannot use a multimeter – analog or digital – to accurately measure voltage in such a high impedance circuit. They load the circuit too much to produce an accurate reading.

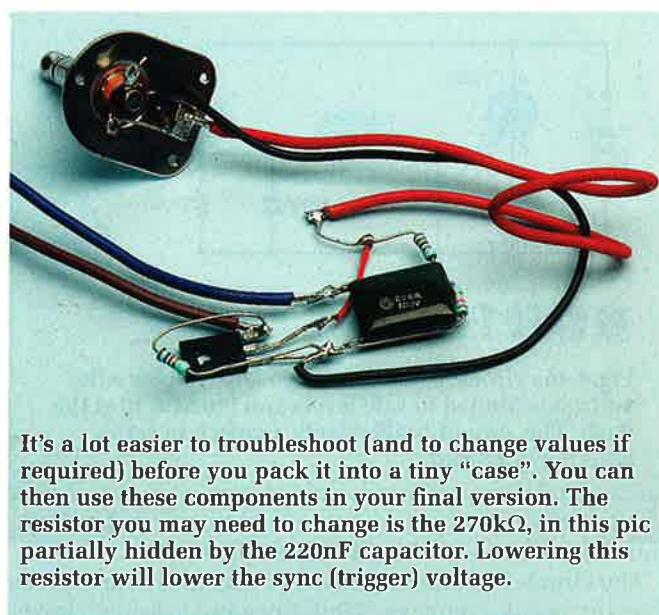
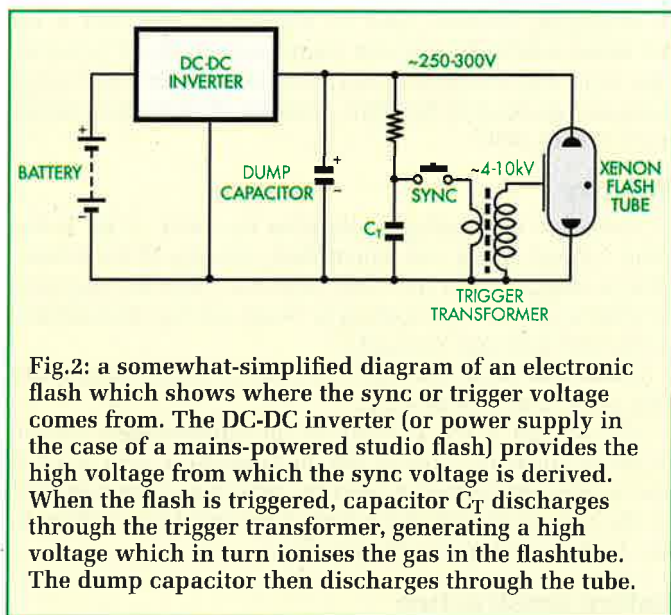
(Old timers may remember the same problem when trying to measure screen voltages in valve circuits. It was even worse back then when the average meter was just 1000Ω or $2000\Omega/\text{V}$!)

Beware of JISP

By the way, if you spend much time trawling through websites, as we did, you'll find there is a LOT of serious misinformation on the internet – JISP ("Jumbled Interpretation of Scientific Phenomena") as a SILICON CHIP sub-editor used to call it.

Like this gem: "beware of flash units with trigger (sync) voltages of 300V because these can kill you!" Or "there is no way that (brand X flashgun) trigger voltage can exceed 6V because it is powered by four "AA" batteries and $4 \times 1.5 = 6\text{V}$." Hmmm!

One chap even put into print "I am a graduate electronics engineer from such-and-such university, so I am competent



in what I am doing" and then proceeded to measure sync voltages with a multimeter!

But it gets worse . . .

So far we've been talking about our particular set-up with a Nikon Digital SLR. But other brands, such as Canon, Olympus, etc have rather significantly lower maximum sync voltages – in fact, the two brands mentioned have a maximum of just 6V.

And the net is full of tales of woe about fried digital SLR cameras where their owners have unwittingly connected a flash or strobe with a high-voltage sync. If the camera can be repaired (and apparently that's often a big IF!), the repair bill can be huge: one report I read said that it was virtually as much as buying a new camera body!

We've singled out Canon and Olympus because they appear to have the lowest sync voltages. But we've seen others in the 6-12V range and yet more stating a maximum of 20V.

If you own a digital camera, we strongly recommend you look in the instruction manual for its maximum before using any off-camera flash. If the manual doesn't tell you, call the local distributors and ask them!

By the way, there is an international standard for sync voltages – ISO10330 1992-11. It states the sync voltage should be between 3.5V and 24V. Most new flashguns and strobes are made to this standard so a brand new set-up should be fairly safe – unless you happen to be using a DSLR with a 6V limit and a strobe with 20V+ sync!

Not just digitals

You might think the problem is confined to digital

cameras, with their solid-state flash sync circuitry (in most cases, an open-collector transistor circuit). But you would be wrong.

Film cameras, at least until quite recently, almost always had a mechanical flash sync, with a pair of very fine contacts brought together at the appropriate moment to fire the flash once the shutter opened.

I mentioned my Minolta film cameras earlier. Despite being over 40 years old, they had done sterling service (in a former life I was a wedding photographer) and I had a very good lens collection to suit them.

The main reason I managed to extract such a long life out of them was that every year, each of these went in for service and a good clean-out. The last time I put them in, I mentioned to the technician that one in particular sometimes had unreliable flash firing.

The technician returned that camera in a plastic bag in pieces, the bag labelled as being "BER" – beyond economic repair. I was told that the flash sync contacts were essentially missing in action and that it would cost much more than the camera was worth to obtain the spare parts and replace them. The other two cameras were cleaned and repaired but I was told that they too were way beyond reliable service life. Their contacts were still operational – but only just.

Having now found that there has been over 300V across those flash contacts ever since I started doing SILICON CHIP photography, I'm not surprised they were pitted and burned. I'm actually surprised they weren't welded!

Incidentally, it was this that convinced us to make the switch to digital at SILICON CHIP. That and the time it took to scan 35mm slides or negatives for use in the magazine!

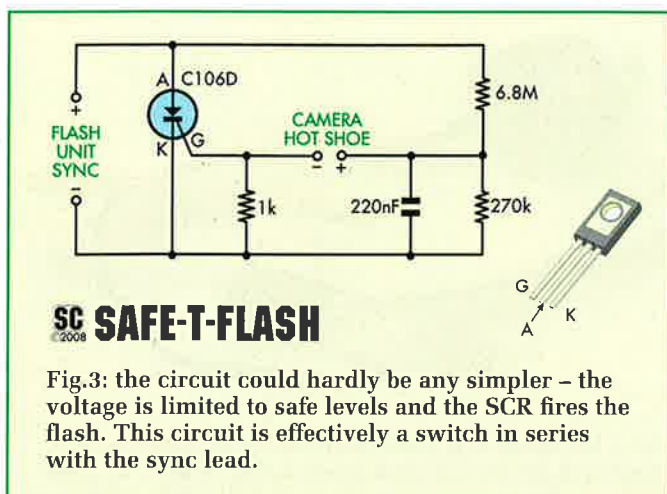
Our trigger circuit

Fig.3 shows the Safe-T-Flash, a circuit we developed to ensure that the strobe sync voltage presented to the Nikon was absolutely safe.

With a minor amendment, it can also be used on cameras with a much lower sync voltage (such as the 6V of Canons

Table 1: the various voltage readings with a range of analog multimeters. What this table proves is that you cannot rely on any meter reading in a high-impedance circuit. Many have been trapped by this "little" problem!

Impedance	Scale	Voltage
50M Ω	(scope)	310V
10M Ω	500V	210V
5M Ω	250V	160V
3M Ω	300V (10k Ω /V)	70V
2M Ω	100V (20k Ω /V)	54V



and Olympuses – or should that be Olympi?).

The circuit is simplicity itself. A voltage divider across the sync supply charges a 220nF capacitor to a much lower voltage than the original sync voltage. When the shutter is released, discharges instantly into the gate of an SCR connected across the sync supply. This then almost instantly turns on, shorting out the sync and firing the flash in the normal way.

We said almost instantly – we’re talking microseconds here, very much faster than the 1/250th second sync speed of a modern digital camera. So using this circuit will have no effect on exposure times or flash timing.

The voltage divider we used (6.8MΩ and 270kΩ) gives about 7.5V from a 320V sync supply. These two resistor values can be changed if (a) the strobe/flash you use has a lower sync voltage (most modern ones do) or (b) if your digital camera has a low maximum sync voltage.

For example, replacing the 270kΩ with 180kΩ will give about 5V with a 320V sync – ideal for Canon and Olympus. If your sync is lower than 300V, you’ll need to select the resistor to suit.

The SCR is a “garden variety” type, albeit with a high-enough rating to deal with 300V+ sync voltages. We used a C106D, a plastic-pack (TO126) type with a 400V rating. The 1kΩ resistor from gate to cathode keeps the gate tied low until it receives a “fair dinkum” trigger from the camera. Otherwise, induced voltages on the sometimes-relatively-long sync leads could lead to false triggering.

Speaking of sync leads, you’re going to need one – either a new one or perhaps (if you’re like me!) you’ll find a couple of pensioned-off ones in the bottom of your camera bag or drawer!

And with most DSLRs, you’ll also need a hot-shoe-to-PC-terminal adaptor. Both of these are relatively easy to obtain at camera stores.

But be careful – some stores (particularly “consumer” camera chain stores

Many DSLRs do not have an “X” (sync) connector but do have provision for a hot-shoe adaptor, such as this one shown with sync lead attached.



in shopping centres) tend to charge an arm and a leg for these relatively obscure items, especially if you buy “genuine” (eg, Nikon branded hot shoe adaptor ~\$60. Large camera store model? \$19.95!). Trust us, the cheaper variety work just as well!

Polarity

There are two voltage polarities to check. First is the sync voltage. From our Balcar flash, the tip of the 6.5mm plug is negative and the body positive – just the opposite of what might be expected (sync leads sold for Balcar flash units take this into account).

Make sure you construct the circuit with the polarity that suits your strobe/flash.

The second is the polarity of the camera flash trigger. It makes sense to connect the more positive side (even if you’re only measuring millivolts, which is quite possible) to the voltage divider/capacitor side and the negative to the 1kΩ resistor/SCR cathode side.

Before construction

It’s much easier to make any changes to the circuit (which you might have to do) before the components are packed into a small space. So the first thing to do is to “tack together” your SAFE-T-FLASH without trying to miniaturise it, to ensure it is going to work with your particular strobe/flash and camera.

When finished and checked, connect your strobe/flash (only) at this stage, turn it on and measure the voltage across the lower (in our case 270kΩ) resistor. Depending on the voltage divider you have chosen and the sync voltage of your flash, it should be quite low – certainly no more than 20V or so but it could be just a few volts if you have chosen a lower value resistor to suit your system or if your strobe has a lower voltage sync.

If all appears well, short out the sync terminals in your circuit. The flash should fire immediately. Repeat this several times just to make sure the flash doesn’t misfire.

Now connect the two wires in the sync lead from your camera to the two sync terminals – as we mentioned before, the more positive wire goes to the voltage divider/capacitor. Fire off a shot or two to ensure that the flash still works. If it does, you’re ready to build the final version.

If it doesn’t (or if the previous test didn’t work), you either have a mistake to correct or perhaps a resistor to change to achieve the required voltage.

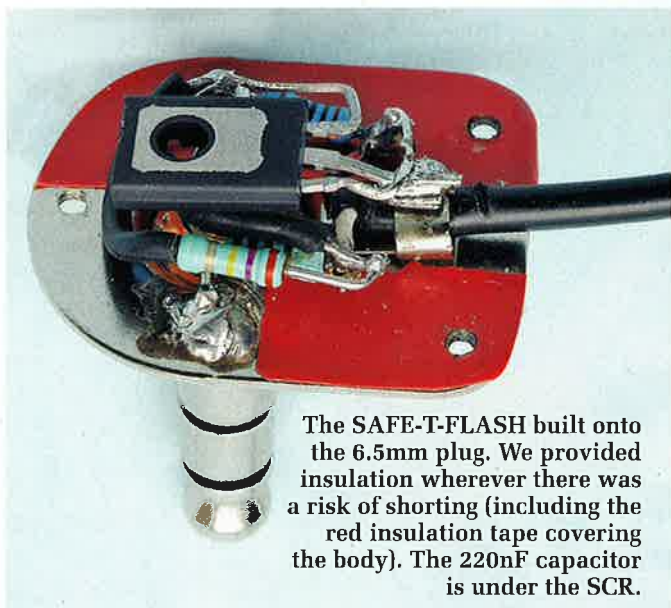
Parts List – SAFE-T-FLASH

- 1 connector to suit your flashgun or strobe (prototype used a Jaycar PP-0176 6.5mm stereo plug)
- 1 sync lead to suit your camera with appropriate PC male (sync) plug
- 1 hotshoe-to-female-PC converter, if required
- 1 C106D 400V SCR (or equivalent)
- 1 220nF 60V monolithic capacitor

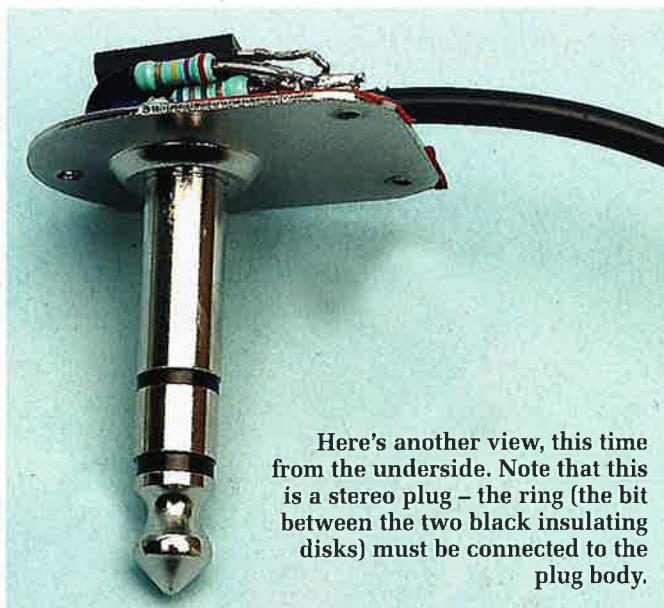
Resistors (0.25W or 0.5W metal film)

- 1 6.8MΩ
- 1 270kΩ
- 1 1kΩ

Spaghetti insulation, insulation tape, potting compound, etc, as required.



The SAFE-T-FLASH built onto the 6.5mm plug. We provided insulation wherever there was a risk of shorting (including the red insulation tape covering the body). The 220nF capacitor is under the SCR.



Here's another view, this time from the underside. Note that this is a stereo plug – the ring (the bit between the two black insulating disks) must be connected to the plug body.

Again, refer to camera and strobe/flash manufacturer's websites and/or distributors, agents, repair shops, etc for more detailed info. However, remember our warning earlier about misinformation on some websites!

Construction

We built our SAFE-T-FLASH inside a 6.5mm plug because these are the sync connectors used on our Balcarr studio flash. Each manufacturer has their own "standard" and it's quite possible (in fact, probable) that this option will not be available to you because we don't know of too many manufacturers who use the 6.5mm plug.

Other ideas are building it inside a "hot shoe" adaptor, or perhaps simply as a "lump in the sync cable" – eg, insulated with heatshrink tubing.

Another possibility is one that I used many years ago when making an optical slave flash trigger for a Metz flashgun, which (along with quite a few other flashguns and strobes) uses a 2-pin (US-style 110V) sync plug.

Mount the components on the back of the plug and "pot" them in epoxy adhesive – once you've confirmed it works properly, of course. 5-Minute Araldite makes a great potting compound if you make some type of container/mould to hold it while it is still runny.

But we'll leave that part up to you and your particular flash – our photos show how ours was constructed inside the 6.5mm plug.

We used a right-angle stereo plug (Jaycar PP-0176) not because we needed stereo – in fact, exactly the opposite – but because this style plug has plenty of room inside and the "lid" is plastic. The mono version doesn't have much room at all and is also all-metal construction, which could be a problem with shorts!

If using the 6.5mm stereo plug, you will need to connect the ring and body together to convert it back into a mono plug – and hope that the point of contact inside the socket doesn't line up exactly with the insulator between the two! Yes, it is unlikely (it didn't on ours) but you never know when Murphy is going to strike . . .

We simply soldered the appropriate tag down onto the plug body. The surface had to be scratched a little to remove

the plating to get the solder to take. This then became the main positive connection point.

As there are only three resistors, a capacitor and an SCR inside the plug (and also due to the fact that many constructors won't be using the 6.5mm plug anyway) we haven't shown any form of wiring diagram. The close-up photos should give you all the info you need.

Just take care that no leads can short to any others or the plug cover, remembering that when the cover is screwed on some compression is possible. We covered any leads which might short with insulation (actually removed from other wires and slid onto the leads). You will note that we also covered the inside of the metal plug body with insulation tape – just in case.

Also note that the back of the SCR has a metal face which is connected to the anode. Make sure that nothing can short to this (we used it upside-down so that the anode was on top, against the plastic lid of the 6.5mm plug).

As we have already tested the "large" version of the circuit and made any component adjustments needed, your miniature version should work perfectly if you haven't made any mistakes or allowed components to short. Remember that when you put the back of the plug on, it may compress the components so that they do short – again, use spaghetti insulation if there is any danger of this happening. SC



Finally, the finished SAFE-T-FLASH with the "case" screwed onto the 6.5mm plug. The opposite end of the cable goes to the PC (sync) connector.

Pt.2: By MAURO GRASSI



12V-24V High-Current Motor Speed Controller

Last month, we described the circuit and software features of our new High-Current DC Motor Speed Controller. This month, we show you how to build and test it.

THE DC MOTOR Speed Controller is built on two PC boards: a main board coded 09103081 (124 x 118mm) and a display board coded 09103082 (73 x 58mm). These are joined together via a 12-way flat ribbon cable which plugs into a pin header on the main board.

The main board can be assembled first – see Fig.9. Start by checking the PC board for hairline cracks and for any visible shorts, especially between the ground plane and any adjacent tracks. In addition, check the hole sizes for the larger hardware items by test fitting these parts into position.

That done, begin by installing the 17 wire links. These must go in first, since some of them run under components.

To straighten the link wire, first clamp one end in a vice, then stretch it slightly by pulling on the other end with a pair of pliers. It's then just a matter of cutting the links to length and bending their leads down through 90° to match the holes in the PC board.

The resistors are next on the list. Table 1 shows the resistor colour codes but you should also check each one using a digital multimeter before installing it on the board, as some colours

can be difficult to decipher.

Note that resistor R1 should be 1k Ω if the supply voltage will be higher than or equal to 16V. Alternatively, use a 100 Ω resistor if the supply voltage is going to be less than 16V. The 22 Ω 1W resistor (on the lefthand side of Fig.9) should be mounted 3-4mm proud of the PC board to aid heat dissipation.

Once the resistors are in, install the diodes and the zener diodes. Take care to ensure that these are all correctly oriented and note that diode D2 (near inductor L1) must be a 1N5819 Schottky type.

Take care also with the zener diodes. ZD1-ZD5 are all 16V 1W types, while ZD6 and ZD7 are 33V 5W types. The fast recovery diode (D3) can be left until later as there are two options for this.

The next thing to do is to solder in the four power Mosfets (Q5-Q8). These come in a TO-220 package and sit

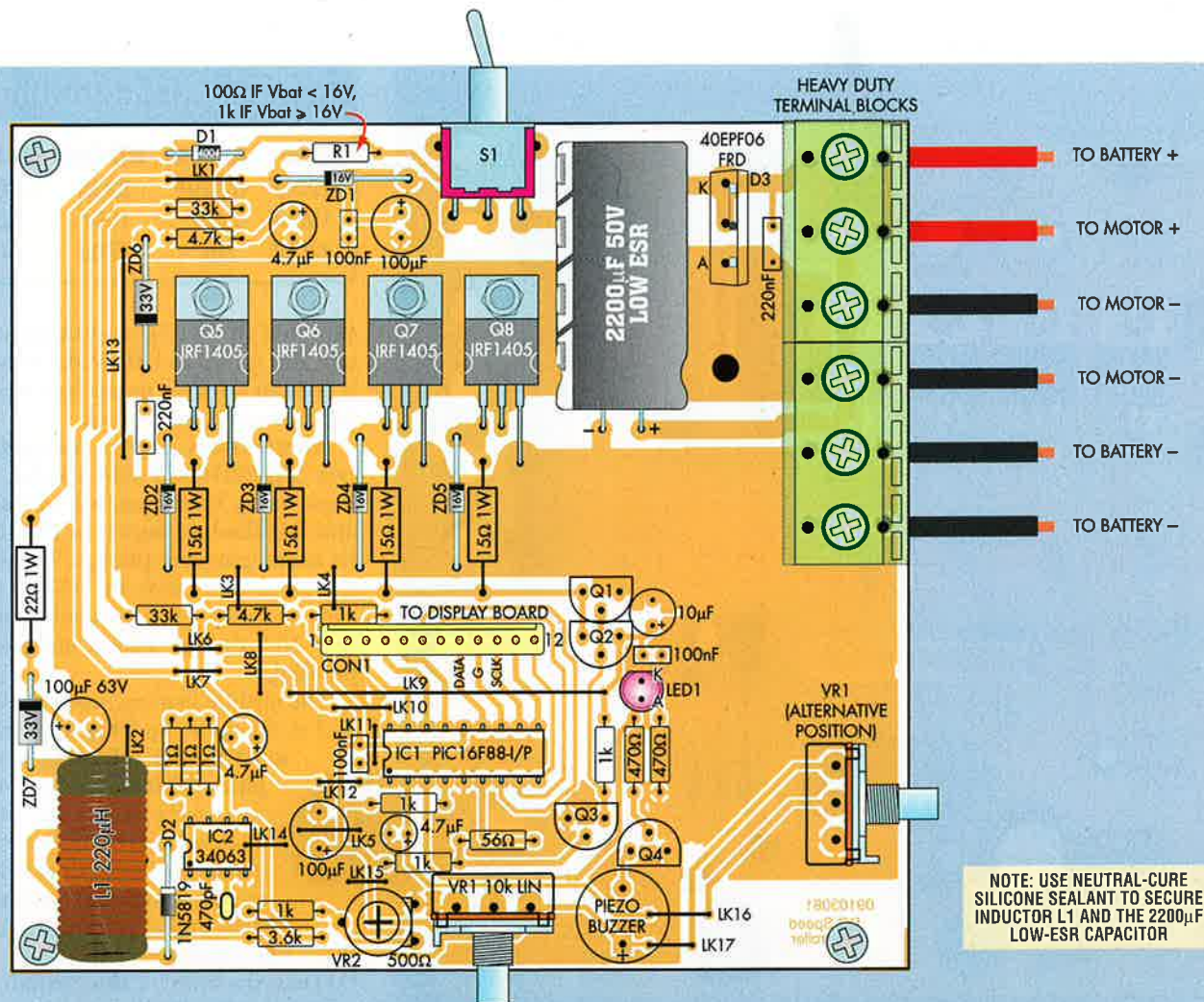


Fig.9: install the parts on the main PC board as shown on this layout diagram, starting with the 17 wire links. The 40EPF06PBF 40A fast recovery diode (D3) is shown in position here but you can also use two MBR20100CT 20A diodes connected in parallel (see Fig.10). Note the alternative positions for VR1.

horizontally on the PC board. Note that the source lead of each device extends further than the other two.

Before mounting each device, you will have to first position it on the PC board and bend its leads down through 90° so that they mate with the holes in the board. That done, fasten each device to the PC board using an M3 x 6mm screw and nut before soldering its leads.

Do not solder the leads before bolting the metal tab down. If you do, you risk stressing the soldered joints as the screw is tightened and this could crack the copper or lift the pads.

The next thing to do is to solder in the two IC sockets. Make sure these are oriented correctly as per the component overlay. It is important that you use IC sockets because calibration of the +5V rail is done with microcontroller IC1 out of circuit. This is described later during the setting-up stage.

Now the four bipolar transistors can be soldered in. There are three BC337 NPN types (Q2-Q4) and one BC327 PNP type (Q1) – don't get them mixed up. Their leads will only go in one way and it's just a matter of pushing them down onto the board as far as they will comfortably go before soldering the leads.

The single 3mm red LED can go in next, again taking care to orient it correctly. Its anode lead is the longer of the two.

Follow this with trimpot VR2 and the piezo buzzer. Note that the buzzer must be installed with its positive terminal towards the bottom edge of the board – see Fig.9.

Once these parts are in, you can solder the capacitors in place. The ceramic, monolithic and MKT types can go in either way around but be sure to orient the electrolytics correctly. The large low-ESR 2200μF capacitor sits

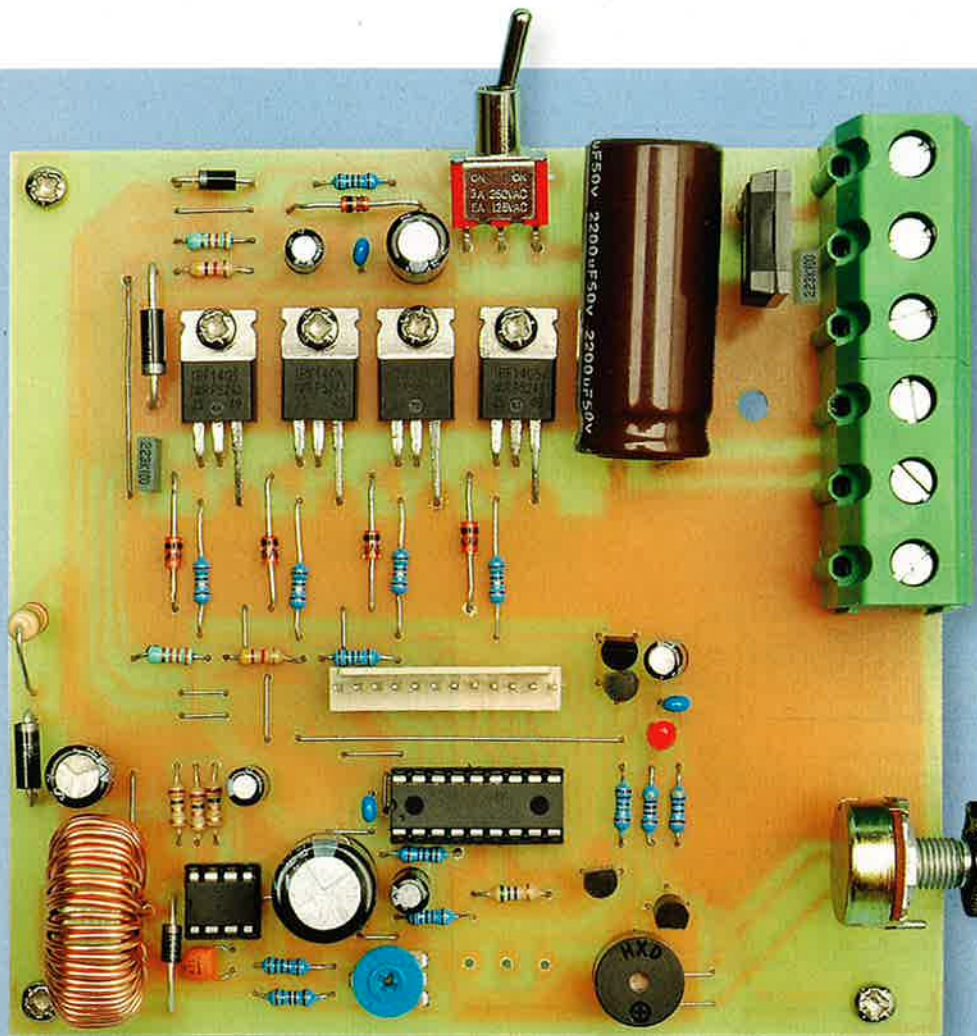
horizontally on the PC board with its leads bent at 90° to go through their holes in the board.

The SPDT horizontal toggle switch (S1) can be soldered in next. Alternatively, this part can be mounted on a panel and connected back to the PC board via flying leads – it all depends on how you intend mounting the board.

The 220μH toroid inductor (L1) sits vertically on the PC board – see photo. Be sure to strip the enamel from its leads and tin them with solder before attempting to solder it in position.

CON1, the 12-way header, is next on the list. This should be oriented as shown on Fig.9 and the photographs. That done, mount the two heavy-duty 3-way screw terminal blocks. Note that these are dovetailed together to make a 6-way block before mounting them on the board.

Potentiometer VR1 can now be



This view shows the fully assembled main board. Note that this prototype board differs slightly from the final version shown in Fig.9.

installed. There are two possible locations on the board for this part. Mount it in the position that's the most convenient for your application (but don't install a pot in both positions).

Alternatively, the pot can be mounted off the board and connected to its mounting pads via flying leads.

Leave the two ICs out of their sockets for now. We'll cover their installation later in the article.

Fast recovery diode

Now for the fast recovery diode (D3). If you are using the 40EPF06PBF diode (rated at 40A), then this can be

Table 2: Capacitor Codes

Value	μF Code	IEC Code	EIA Code
220nF	0.22 μF	220n	224
100nF	0.1 μF	100n	104
470pF	NA	470p	471

soldered straight in as shown in Fig.9 and the photo at left. Make sure that it goes in with its metal face towards the screw terminal block.

Alternatively, if you are using the two MBR20100CT 20A diodes, then these must be connected in parallel and installed as shown in Fig.10 and its accompanying photos. These particular diodes come in TO-220 packages and each package itself contains two 10A diodes which are used in parallel.

The middle lead connects to the tab and is the cathode. **This middle lead must be cut off using a small pair of sidecutters**, as the tabs are used to make the cathode connections to the board. The two outer leads of each device are the anode connections.

The procedure for mounting these two diodes is as follows:

- (1) Drill the hole for the cathode connection on the PC board to 3mm.
- (2) Lightly tin the copper around the two mounting holes (this is necessary to ensure good contact with the screw heads).
- (3) Secure the metal tab of the first device to the PC board using an M3 x 12mm screw and nut, with the screw passing up from the underside of the board. Tighten the nut down firmly.
- (3) Install an M3 x 12mm screw through the hole at the anode end of the diodes, secure it with a nut, then

Table 1: Resistor Colour Codes

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
□	2	33k Ω	orange orange orange brown	orange orange black red brown
□	2	4.7k Ω	yellow violet red brown	yellow violet black brown brown
□	1	3.6k Ω	orange blue red brown	orange blue black brown brown
□	6	1k Ω	brown black red brown	brown black black brown brown
□	6	470 Ω	yellow violet brown brown	yellow violet black black brown
□	1	100 Ω	brown black brown brown	brown black black black brown
□	1	56 Ω	green blue black brown	green blue black gold brown
□	8	39 Ω	orange white black brown	orange white black gold brown
□	1	22 Ω	red red black brown	red red black gold brown
□	4	15 Ω	brown green black brown	brown green black gold brown
□	3	1 Ω	brown black gold gold	brown black black silver brown

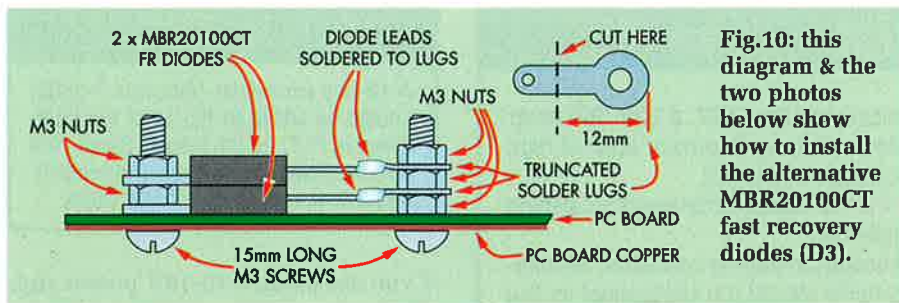
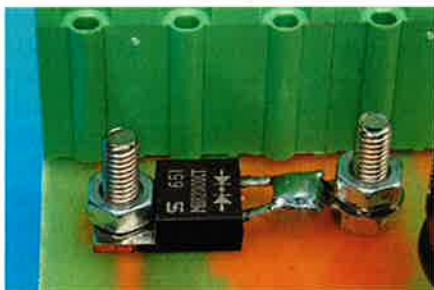
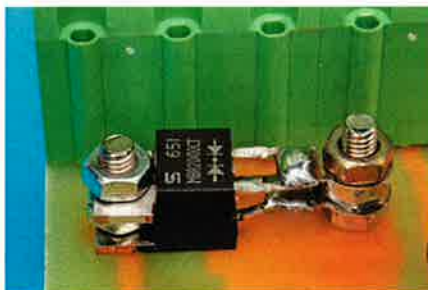


Fig.10: this diagram & the two photos below show how to install the alternative MBR20100CT fast recovery diodes (D3).



In this photo, the first diode has been fastened into position and its two outer leads soldered to the solder lug.



The second diode is then mounted in position and its outer leads soldered to the top solder lug.

fit a solder lug and secure it with a second nut. Again, make sure the nuts are done up tightly.

(4) Solder the two outer leads of this first device to the solder lug, then fit another solder lug and nut.

(5) Secure the tab of the second device in position and solder its outer leads to the top solder lug.

Building the display board

The display board is optional but will be useful in many applications. If you decide not to build it, you will not be able to change the settings and default values will have to be used. You will also have no way of knowing what percentage of full speed the motor is running at.

As before, check the board for defects. In particular, check for shorts between tracks or between the ground plane and any adjacent tracks.

That done, start the assembly by installing the 23 wire links. Some of these sit under the 7-segment LED displays, so make sure these links sit flat against the PC board. Don't forget the short links immediately to the left of CON1 and at bottom right.

The resistors can go in next, followed by the 100nF capacitor and the four transistors (Q9-Q12). If you are using an IC socket for IC3, then this can also now go in. Install it with its notched end positioned as indicated on the diagram, then install IC3 (74HC595).

Alternatively, IC3 can be directly soldered to the PC board. Be sure to install the IC with the correct orientation – ie, its notched end goes towards CON2.

Finally, complete the display board assembly by installing a 12-way pin header (this part is optional), the two pushbutton switches and the four 7-segment displays. Be sure to orient the displays with the decimal points at bottom right.

Similarly, make sure that the push-button switches are correctly oriented. As shown in Fig.11, they must each be installed with the flat side towards the displays.

Connecting the boards

Once the board assemblies are complete, make up a 12-way ribbon cable to connect the two boards together. This should be terminated at either end to a 12-way header plug. Be sure to arrange this cable so that pin 1 of the header of the main board connects to pin 1 of the header of the display board and so on.

Set-up

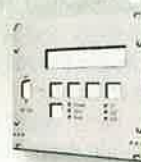
Once you have completed the construction, the next step is to go through the setting up procedure. You also need to adjust trimpot VR2 on the main board, so that the output from the MC30463 IC (IC2) sits at exactly +5V (this rail needs to be at exactly +5V to ensure that the voltage meas-

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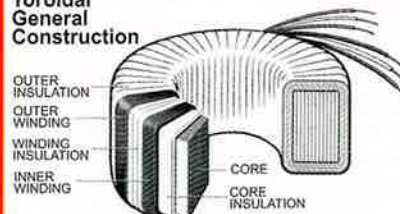
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Questions, Problems & Answers

Question: is the display board optional?

Answer: yes the display board is optional and the DC Motor Speed Controller will function without it. However, the display board is necessary if you want to change the settings of the battery alarm, the audible cues and the frequency of the PWM, as well as to view the current speed of the motor and the values of the settings.

We therefore recommend that you build the display board as well, even if you use it to change the settings only once. If this board is subsequently disconnected, the speed controller will still work and will use the last settings stored in the microcontroller's non-volatile memory.

Problem: when using the display board, not all digits light up. What should I do?

Answer: check the 12-way cable and the pin header connections. Check that all 12 connections are good.

Problem: the voltage at the cathode of ZD1 is nowhere near 12-16V (it should be 16V if the supply voltage is 16V or greater).

Answer: check the orientation of ZD1 and check for incorrect power supply connections.

Problem: the power supply voltage does not appear on the cathode of D1.

Answer: in normal operation, D1's cathode should sit about 0.6V below the supply voltage. This cathode should not exceed 40V at any time, or damage may occur to the switchmode IC and to the

microcontroller. ZD7, a 33V 5W zener diode, is there to protect against high voltages on this rail.

Problem: some components are getting quite hot.

Answer: in normal operation, all components should run cool except for the fast recovery diode (D3), the four power Mosfets Q5-Q8 (especially if high currents are being switched) and possibly zener diodes ZD6 & ZD7, although the latter should not get too hot. If they do, it could mean that the supply lead inductance is causing high transient voltages on the supply rail.

Normally the low-ESR 2200 μ F capacitor should filter these out but if you do strike problems, try minimising the length of the power supply connecting leads (as well as those to the motor, if possible). You should also twist the positive and negative power supply leads together in order to cancel any magnetic fields induced by high currents.

Problem: the speed controller does not respond to the pushbutton switches on the display board.

Answer: this could be caused by the pushbuttons being incorrectly oriented on the display board. Make sure the two pushbuttons are installed with their flat sides as indicated on the parts layout diagram (Fig.10).

Problem: LED1 (red) lights but there is no beep from the piezo buzzer. Alternatively, there is a beep from the piezo buzzer but the LED does not light.

Answer: either the LED is incorrectly oriented or the buzzer is.

Errata For Parts List

A 12-way pin header (Altronics P-5502) should be added to the parts list (published in Pt.1) for the Display Board. You also need two header plugs (Altronics P-5482) to terminate the 12-way cable.

if you are using a 12-16V power supply.

(6) If these voltages are OK, switch off and install the MC34063 switchmode IC (IC2) into its socket. Make sure that the notch on the IC matches the notch on the socket – ie, the notch must face towards inductor L1.

(7) Apply power and check the voltage at pin 1 of the 12-way header on the main board. This is the +5V rail but it may not yet be at exactly +5V (the exact voltage depends on the setting of trimpot VR2).

(8) Adjust VR2 until the voltage on pin 1 of the header is exactly +5V.

(9) Assuming that the above voltage is now correctly set, switch off and insert microcontroller IC1 into its socket. Make sure that its notched end goes towards link LK11.

(10) Plug the display board into the 12-way header and apply power. If everything is working correctly (and assuming a motor isn't connected), the 4-digit display should immediately read "P00.0", indicating the current speed.

(11) If it all works correctly, skip the following troubleshooting section and go straight to the software initialisation procedure.

Troubleshooting

If you strike problems, the first thing to do is go back and check the board for any missed or bad solder joints. Check also that there are no shorts between tracks or between the ground plane and any adjacent tracks.

If these checks don't reveal the problem, we suggest that you go through the following checklist:

(1) Check that all 17 links are installed on the PC board. A missing link could mean that parts of the ground plane are floating and this will lead to improper operation!

(2) Check that all polarised components, including the diodes, zener diodes, electrolytic capacitors and ICs are correctly oriented as per the component overlay.

(3) Check that you have used the cor-

urements made by the microcontroller are accurate).

The setting-up procedure is as follows:

(1) Check that the two ICs on the main board are out of their sockets and that toggle switch S1 is in the OFF position (ie, the switch should be in the opposite position to that shown Fig.9).

(2) Connect a 12V-24V DC supply to the screw terminal blocks (check the supply voltage before you do this). Note that if you are connecting the supply leads directly to a battery, there could be a spark when you first connect power due to the low-ESR 2200 μ F bypass capacitor across the supply. For this reason, connect the supply leads

to the battery first, then to the terminal blocks, as it's never a good idea to generate a spark near a battery.

As noted previously, resistor R1 should be 1k Ω if you are using a supply greater than or equal to 16V. Alternatively, R1 should be 100 Ω if you are using a supply of less than 16V.

(3) Apply power to the circuit by toggling S1 to ON.

(4) Check the voltage on D1's cathode. It should be about 0.6V less than the supply voltage.

(5) Check the voltage on ZD1's cathode. This should be very close to +16V if you are using a power supply that's greater than 16V. Alternatively, it should sit between +12V and +16V

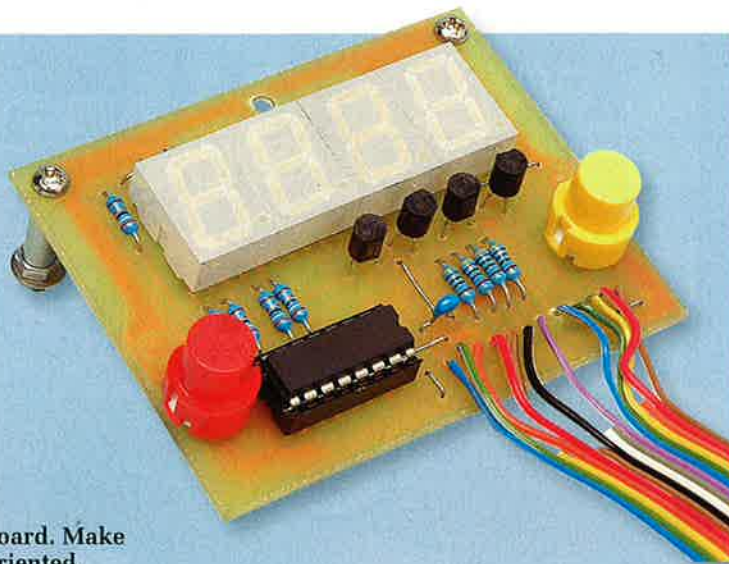
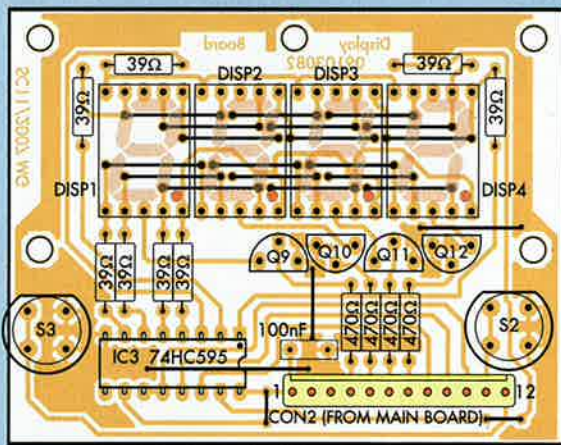


Fig.11: here's how to assemble the optional display board. Make sure all parts, including the switches, are correctly oriented.

rect value for R1, depending on your input supply voltage.

(4) Make sure that the four transistors on the main board are the correct types. Q2-Q4 are all BC337s but Q1 is a BC327 type.

(5) Make sure that the input voltage connections to the 6-way terminal block are correct.

We have also assembled a list of likely questions and answers that may help you troubleshoot the DC Motor Speed Controller if it is not operating as expected. These are set out in the accompanying panel.

Software initialisation

If your boards are working, it is now time to initialise the software settings before connecting a motor. To do this, you must have the display board connected.

Note that more detailed user instructions for the DC Motor Speed Controller appeared in Pt.1 last month (p37-39). This section simply explains how to change the battery level alarm and the frequency of the PWM before you use the unit for the first time. These settings will be retained in non-volatile memory.

When the microcontroller begins executing the firmware (from a power-on reset) you should be taken straight to the main menu. This will indicate the percentage of full speed that the motor is currently running at. Without a motor connected, it should read "P00.0".

From here, press "short R" twice (see Pt.1) to arrive at the battery level alarm menu. This menu shows an "A" followed by a 3-digit voltage value which indicates the low battery alarm will sound.

In this menu, press "long L" to set the level using potentiometer VR1. The "A" should start flashing and you should then be able to vary the pot to change the level. Once you are happy with the current level, press "short L" to update the setting and return to the main menu.

Next, press "short R" three times to arrive at the frequency menu. This will show an "F" followed by a 3-digit frequency in kilohertz.

Once you are in this menu, press "long L" and set the frequency of the PWM (pulse width modulation) using VR1. The "F" should flash while you

are setting the frequency. In practice, the frequency can be set to one of 256 values between 488Hz and 7812Hz.

Once you have set the desired frequency, press "short L" to store the setting and return to the main menu.

That's it! For more detailed instructions on the other software modes, refer back to the March issue.

Connecting the motor

Once you have verified that the DC Motor Speed Controller is working correctly, you can connect a motor. This should be connected with its positive terminal to the second terminal block from the top, while its negative terminal can go to either the third or fourth terminal from the top.

Note that all supply and motor connections to the terminal block should be run using heavy-duty 56A wire.

The top terminal block is used to terminate the positive supply lead from the battery. **This lead should connect via the 50A in-line fuse.** Either of the bottom two terminals can be used for the negative battery lead (ie, one is left unused).

Your DC Motor Speed Controller is now ready for action. **SC**




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2-Way Stereo Headphone Adaptor



By Mauro Grassi

Do you have a stereo amplifier without a headphone socket but want to listen to your music via headphones? If so, this versatile Stereo Headphone Adaptor will do the job. It connects between your amplifier and loudspeakers, has several operating modes and features two output sockets with individual volume controls.

IF YOU BUILT our 20W Class-A Stereo Amplifier described last year, you will be aware that it lacks a headphone socket. Similarly, many hifi valve amplifiers also lack a headphone socket, the assumption being that a true hifi enthusiast will want to listen via good-quality loudspeakers.

A headphone output was not included in the Class-A Stereo Amplifier because it would degrade its superb audio performance. Both the wiring paths and the general circuit layout are critical factors in the design and any changes, however slight, can cause big changes in the signal-to-noise ratio

and harmonic distortion figures of the amplifier.

If you do want to listen via headphones, a far better option is to build the simple Stereo Headphone Adaptor presented here. It connects directly to the amplifier's speaker terminals and switches the loudspeakers and stereo headphone sockets using two DPDT (double-pole, double-throw) relays, so there's no chance of it degrading the audio performance.

As mentioned in the introduction, you can connect up to two sets of stereo headphones. These can be switched on or off at the touch of a button and the volume of each can be individually controlled. In addition, the loudspeakers can be switched on or off and there's also a Mute switch which turns everything off.

This means that you can operate

the system in one of four modes: (1) loudspeakers only; (2) headphones only; (3) headphones and loudspeakers operating together; and (4) mute (all off). It's also possible to mute the system by individually turning the headphones and the speakers off.

Perhaps we should clarify the operation of the Mute switch, as it doesn't function quite like a traditional mute switch. Pressing it once certainly mutes the headphones and/or loudspeakers but pressing it a second time doesn't "unmute" the system. Instead, you have to press either the "Phones" button or the "Headphone" button (or both) to restore the sound.

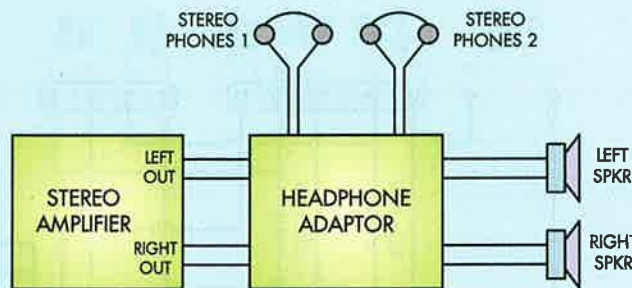
DPDT relays

Because it uses two DPDT relays to do the switching, the Stereo Headphone Adaptor can be used with amplifiers with quite high power outputs. In fact, it's good for use with amplifiers with outputs up to about 100W RMS or more, provided you're sensible with the volume control setting on the amplifier.

We've also designed the unit to not only work with solid-state amplifiers but with valve amplifiers as well. The latter must be taken into account separately because unlike solid-state amplifiers, operating a valve amplifier without a load (ie, a loudspeaker) can cause problems.

The reason why most valve amplifiers should not be operated without a load is that they can sometimes oscillate supersonically. Worse still, they can then produce very high AC

Fig.1: the Stereo Headphone Adaptor connects between your stereo amplifier and the loudspeakers and can drive two pairs of headphones.



voltages in the primary windings of the output transformers. These voltages can be so high that they can cause flashover across the valves sockets or even within the valves themselves. This can not only damage the valves but other components as well.

As shown in the photos, the unit is housed in a low-profile instrument case with the volume controls, headphone sockets and pushbutton switches neatly laid out on the front panel. The miniature pushbutton switches incorporate integral LEDs which indicate the settings – red for "power on", green for "phones on" and blue for "speakers on".

On the rear panel is a DC power socket and nine gold-plated binding post terminals. Eight of these terminals are used to connect the amplifier input and loudspeaker output leads, while the ninth terminal connects to the amplifier's chassis and is the earth return for the headphone sockets.

Default setting

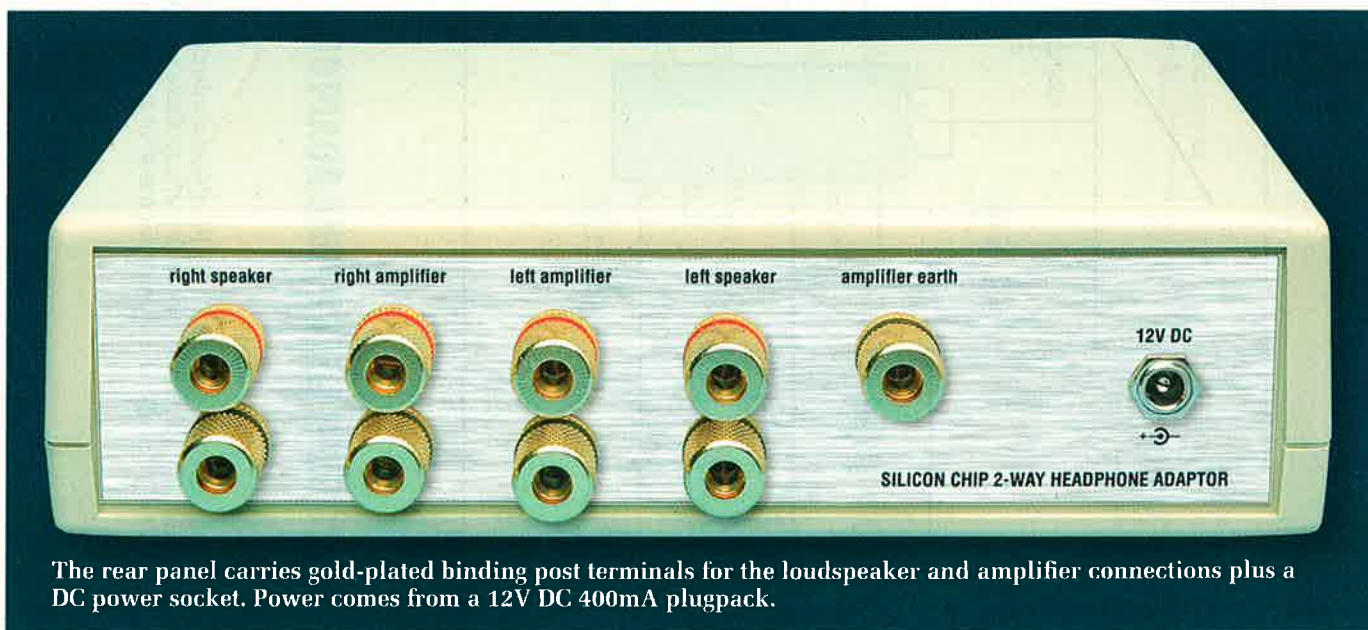
The default mode setting was an

important consideration in designing this circuit. We opted to have both the loudspeakers and the headphones on when the circuit is unpowered and this is done using the normally-closed (NC) contacts of the relays. The advantage of this scheme is that the loudspeakers (and the headphone outlets for that matter) will operate normally when the unit is switched off (ie, zero power consumption).

This is also the default setting when power is first applied to the unit. After that, it's just a matter of using the pushbutton switches to toggle the loudspeakers and the headphones off and on.

The leftmost switch is the Mute switch and, as mentioned, this turns both the loudspeakers and the headphones off (but not on again). This switch carries a red LED which is permanently lit while ever power is applied – ie, this LED simply serves as a power indicator.

The next switch controls the two headphone sockets and its green LED lights when the headphones are on.



The rear panel carries gold-plated binding post terminals for the loudspeaker and amplifier connections plus a DC power socket. Power comes from a 12V DC 400mA plugpack.

Finally, the third switch controls the speakers and its blue LED lights when the speakers are on. These latter two switches toggle their respective outputs on or off each time they are pressed.

Note that when the loudspeaker switch is toggled to the off position, it places dummy 22Ω loads across the amplifier's left and right channel outputs – ie, these loads appear in place of the speakers. This is done to accommodate valve amplifiers, as these should be loaded at all times as explained previously.

Circuit details

Refer now to Fig.2 for the circuit details. It's based on two ICs (IC1 & IC2), a couple of transistors (Q1 & Q2) and the aforementioned DPDT relays (RLY1 & RLY2).

IC2, a 74HC74 dual D-type flipflop, forms the heart of the circuit. This is wired in toggle mode, with its D1 & D2 inputs directly connected to their corresponding Q1-bar and Q2-bar outputs. The two set inputs (S1-bar & S2-bar) are connected to a power-on reset circuit consisting of a 470Ω resistor and a 1μF capacitor, while the two resets (R1-bar & R2-bar) are connected to ground via the Mute (reset) switch.

In operation, the D-type flipflop toggles its outputs on the rising edges of the clock signal pulses. When that happens the state of the D input (either a logic high or low) is transferred to the Q output and Q-bar toggles to the opposite state.

For example, let's assume that IC2's Q1 output (pin 5) is low. This means that Q1-bar (pin 6) and D1 (pin 2) will both be high. When the next clock pulse arrives, the high on D1 is transferred to Q1 and Q1-bar and D1 toggle low.

Similarly, on the next clock pulse, the low on D1 is transferred to the Q1 output and Q1-bar and D1 then toggle high again.

When power is first applied, the two set inputs (pins 4 & 10) are pulled low via the 1μF capacitor. This sets IC2's Q outputs high and so Q1-bar and Q2-bar are both low and transistors Q1 & Q2 are off.

As a result, the relays also remain off and the loudspeakers and headphone outputs are switched on via the NC contacts. In addition, LEDs 2 & 3 both light (since the two Q outputs are high)

to indicate that the speakers and the headphones are on.

Dual timer

IC1 is a 556 dual timer and is basically two independent 555s timers in one package. Both sections are configured as one-shot monostables with pulse widths of just under 0.5s. They are used to debounce switches S2 (Phones On/Off) and S3 (Speakers On/Off), to provide clean clock pulses for the D inputs of IC2.

This debouncing circuitry is necessary because the metal contacts in the switches tend to "bounce" as they close. As a result, we get a series of short pulses from the switches instead of just one pulse. If these pulses were fed directly to the clock (CK) inputs of IC2, there's no guarantee that the flipflops would toggle as the switches are just as likely to produce an even number of pulses as an odd number.

The monostables in IC1 eliminate

this problem. As shown, S2 & S3 are connected to the trigger inputs (Tr1 & Tr2) of the monostables via 10nF capacitors. When a switch is pressed, its corresponding trigger input is briefly pulled low (via one of the 10nF capacitors) and this triggers the monostable.

As a result, the monostable's output (pin 5 or pin 9) goes high and applies a positive-going clock pulse to the relevant clock input of IC2. This causes the corresponding D-type flipflop to toggle.

For example, let's assume that the circuit is powered up and is in the default state. If S3 is now pressed, pin 5 of IC1 goes high for about 0.5s and applies a clock pulse to pin 3 (CK1) of IC2. As a result, the relevant flipflop toggles and sends its Q1-bar output high.

This turns on transistor Q1 and relay RLY1 and so the NC (normally closed) contacts open and disconnect

Parts List

- 1 PC board, code 01104081, 172 x 104mm
- 1 ABS instrument case, 190 x 140 x 50mm (Altronics H-0374 or equivalent)
- 1 12V 400mA DC plugpack
- 2 1kΩ dual 16mm log pots
- 2 knobs to suit
- 2 12V DPDT relays with 10A 240VAC contacts (Jaycar SY-4065, Altronics S-4310)
- 2 6.35mm PC-mount stereo jack sockets (Jaycar PS-0195, Altronics P-0073)
- 1 SPST horizontal PC-mount tactile switch with green LED (Jaycar SP-0616)
- 1 SPST horizontal PC-mount tactile switch with red LED (Jaycar SP-0615)
- 1 SPST horizontal PC-mount tactile switch with blue LED (Jaycar SP-0617)
- 3 3-way heavy-duty PC-mount screw terminal blocks (Altronics P-2053)
- 1 PC-mount 2.5mm DC socket, OR
- 1 panel-mount 2.5mm DC socket
- 4 self-adhesive rubber feet
- 2 M3 x 12mm machine screws
- 1 M3 x 6mm machine screw
- 3 M3 nuts

- 2 M3 x 6mm tapped spacers
- 4 panel-mount gold-plated binding posts, red
- 5 panel-mount gold-plated binding posts, black
- 1 1m-length of heavy-duty speaker cable
- 1 300mm-length tinned copper wire for links

Semiconductors

- 1 NE556 dual timer IC (IC1)
- 1 74HC74 dual D-type flipflop (IC2)
- 2 BC337 NPN transistors (Q1-Q2)
- 1 7805 +5V regulator (REG1)
- 3 1N4004 diodes (D1-D3)
- 2 1N4148 diodes (D4-D5)

Capacitors

- 2 220μF 25V electrolytic
- 3 10μF 16V electrolytic
- 1 1μF 16V electrolytic
- 3 100nF monolithic (code 104 or 100n)
- 4 10nF ceramic (code 103 or 10n)

Resistors (0.25W, 1%)

- 2 39kΩ 3 470Ω
- 4 10kΩ 4 270Ω 1W
- 2 2.2kΩ 2 100Ω
- 2 22Ω (10W wirewound)

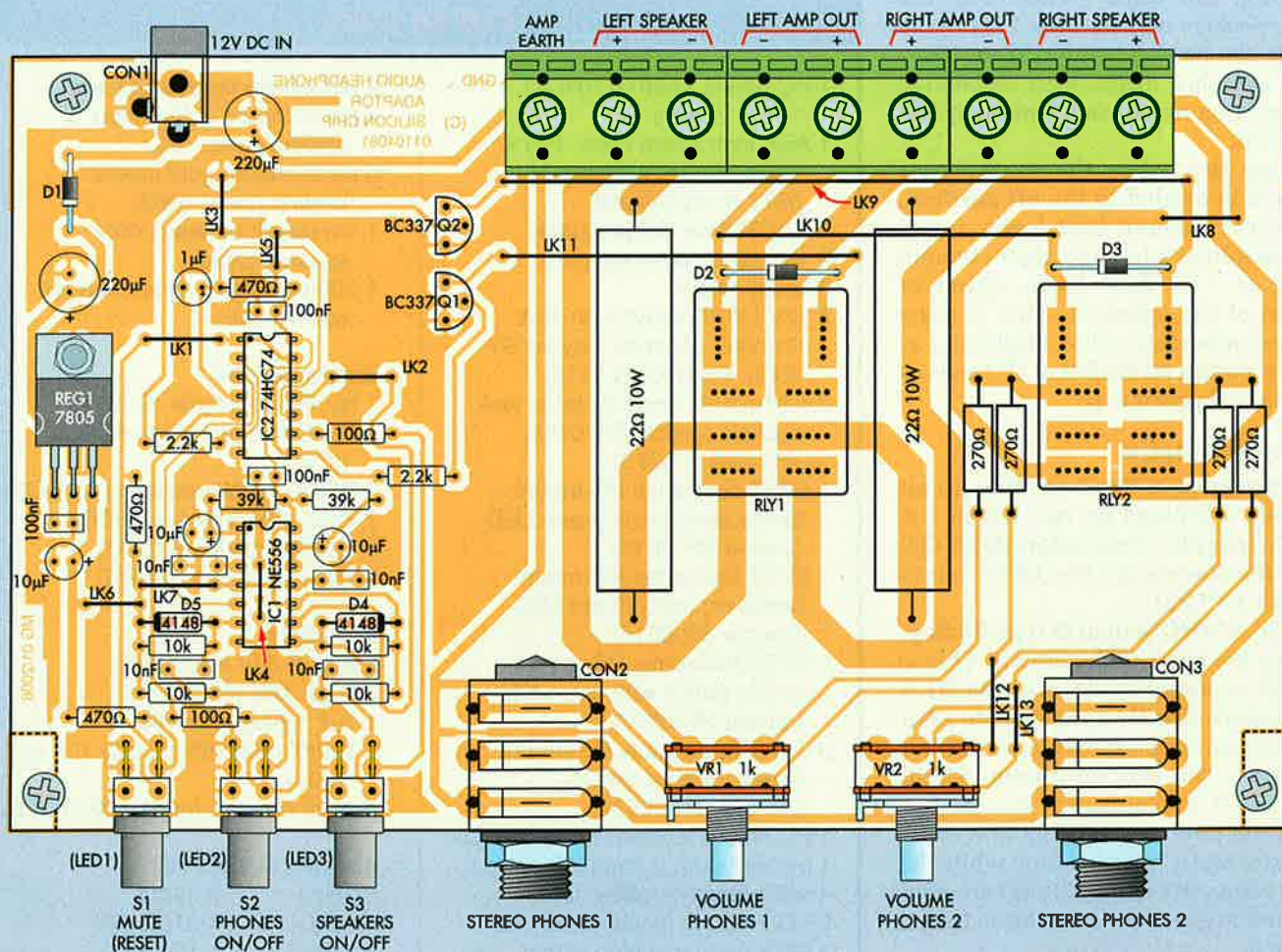


Fig.3: install the parts on the PC board as shown here. Leave the DC socket out if you intend mounting the board in a case and note that the two 22Ω 10W resistors must be mounted 3-4mm proud of the board to allow the air to circulate beneath them for cooling.

the loudspeakers. At the same time, the relay's NO contacts switch two 22Ω 10W resistors across the amplifier outputs to provide the dummy loads. In addition, LED 3 turns off since IC2's Q1 output is now low.

Pressing switch S3 again retriggers the monostable and toggles the flipflop to its opposite state, so that Q1-bar is low again. This turns off transistor Q1 and RLY1 and reconnects the loudspeakers via the relay's NC contacts. In addition, LED 3 turns on (to indicate that the speakers are on) since IC2's Q1 output is now high.

Switch S3 and its following circuitry work in exactly the same fashion to control transistor Q2 and relay RLY2. This relay, in turn, switches the signals from the left and right channel amplifier outputs to the two headphone sockets (via the volume controls).

Both the ring (right channel) and tip (left channel) terminals of the

headphone sockets are driven via 270Ω 1W resistors and dual 1kΩ log potentiometers VR1 & VR2, the latter functioning as volume controls. Even with the volume wound right up, the 270Ω resistors should provide sufficient attenuation to protect the headphones from damage.

Note, however, that you should increase these resistors to 680Ω or more if you have high-impedance (say 600Ω) headphones.

The sleeve (ie, earth) terminal of each headphone socket is connected to the amplifier chassis to provide the ground return.

Diodes D4 & D5 are there to ensure that IC1's trigger inputs (pins 6 & 8) can not go more than 0.6V above the +5V supply rail. What happens is that when a switch is pressed, the relevant 10nF capacitor quickly charges to +5V via a 10kΩ resistor (ie, one side of the capacitor is pulled to ground and the

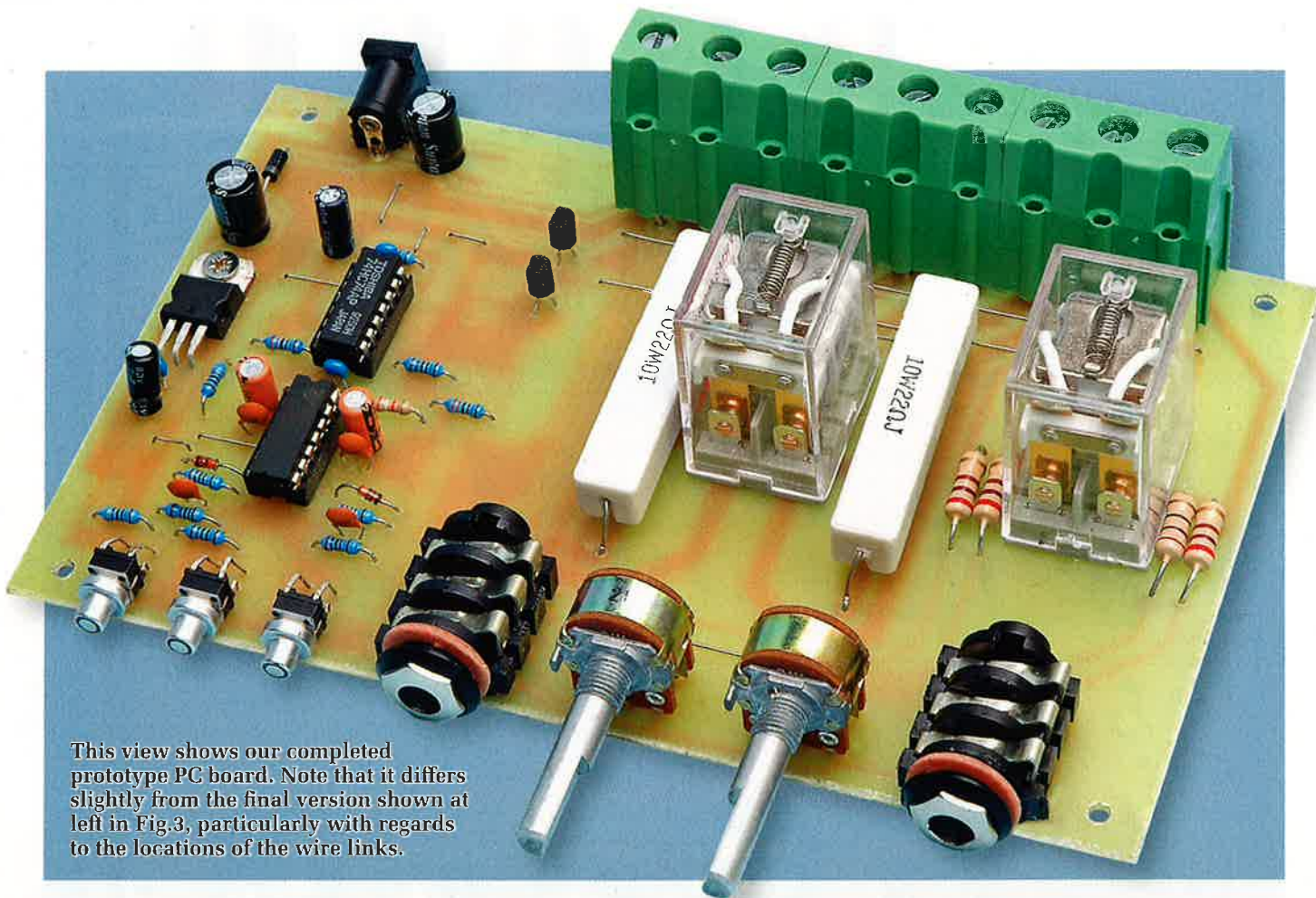
other side goes to +5V). When the switch is subsequently released, the side that was at ground is immediately pulled to the +5V rail by another 10kΩ resistor and so the other side of the capacitor would go to +10V if not for the diode – ie, we would get a brief 10V spike.

D4 & D5 clip these voltage spikes to +5.6V and thus prevent damage to IC1.

Muting

Switch S1 is the Mute (or reset) switch and is connected directly to the reset inputs (pins 1 & 13) of both flipflops in IC2. When this switch is pressed, the reset inputs are pulled to ground and the flipflops are both set with their Q outputs low and their Q-bar outputs high.

As a result, transistors Q1 & Q2 and the relays are on and so the headphones and loudspeakers are off. They



This view shows our completed prototype PC board. Note that it differs slightly from the final version shown at left in Fig.3, particularly with regards to the locations of the wire links.

can then only be turned back on again by pressing S2 and S3.

Diodes D2 & D3 are used to quench the high back-EMF spikes that are generated when the relays switch off. This is necessary to protect the relay driver transistors from damage.

Power supply

Power is derived from a 12V DC plugpack. This supply is filtered using a 220 μ F electrolytic capacitor and used to directly power the relay driver transistors and the relays.

The rest of the circuit is powered from a +5V rail which is derived via 3-terminal regulator REG1. Diode D1 provides reverse polarity protec-

tion and its output is filtered using a second 220 μ F electrolytic capacitor before being applied to the input of the regulator. A 10 μ F capacitor decouples the regulator's output, with additional 100nF capacitors placed close to the supply pins of IC1 & IC2.

Finally, the power LED (inside S1) is powered via a 470 Ω current-limiting resistor. This LED is on while ever power is applied.

Construction

Construction is straightforward with all the parts mounted on a PC board coded 01104081. Our prototype was housed in a plastic case measuring 190 x 140 x 50mm. **Note that if you intend**

using this case, it will be necessary to cut out the front corner pieces from the PC board in order to clear the front case pillars.

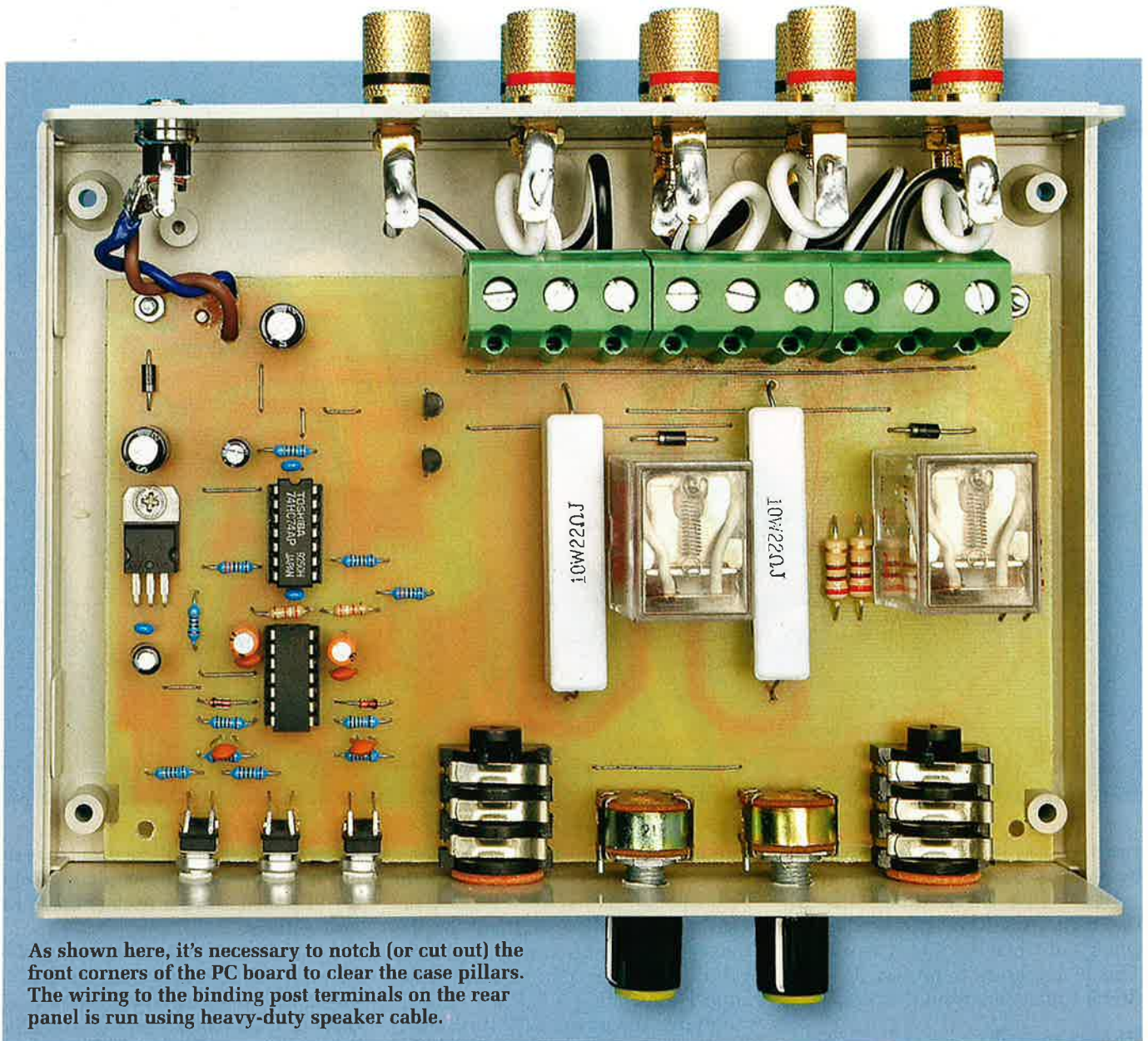
Fig.3 shows the parts layout on the PC board. Before mounting any parts, check the board carefully for etching defects, then check the hole sizes for the headphone sockets, screw terminal blocks and relays by test fitting these parts into position. Enlarge any holes if necessary.

Begin the assembly by installing the 12 wire links in the positions indicated. These links should all be run using tinned copper wire and must be straight.

To straighten the link wire, simply

Resistor Colour Codes

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
□	2	39k Ω	orange white orange brown	orange white black red brown
□	4	10k Ω	brown black orange brown	brown black black red brown
□	2	2.2k Ω	red red red brown	red red black brown brown
□	3	470 Ω	yellow violet brown brown	yellow violet black black brown
□	4	270 Ω	red violet brown brown	red violet black black brown
□	2	100 Ω	brown black brown brown	brown black black black brown
□	2	22 Ω	NA	NA



clamp one end in a vice and then stretch the wire slightly by pulling on the other end with a pair of pliers. Each link can then be cut to length and its end bent down at right angles before installing it on the PC board.

Note particularly that LK4 goes under IC1, while LK9 runs directly behind the screw terminal blocks.

That done, install the resistors and diodes D1-D5 but leave the 22Ω 10W resistors out for the time being. Table 1 shows the resistor colour codes but you should also check each one using a digital multimeter. Take care with the orientation of the diodes and note that D1-D3 are 1N4004s while D4 & D5 are 1N4148s.

Note also that D4 and D5 face in opposite directions.

The 7805 3-terminal regulator is

next on the list. As shown, it's installed with its metal tab flat against the PC board and its leads bent down through 90° to go through their respective holes.

To do this, first position the device on the board, then use a pair of needle-nose pliers to grip the leads at the appropriate point and bend the leads down by 90° . The device's metal tab can then be fastened to the board using an M3 x 6mm screw, nut and lock-washer and the leads soldered.

Do not solder the leads before bolting down the metal tab. If you do this, you could crack the soldered joints as the tab is bolted down.

The capacitors are next on the list. Start with the monolithic and ceramic types, then install the six electrolytics. Make sure that the latter are all

installed with the correct polarity.

Next, install the two 22Ω 10W resistors. These should be mounted 3-4mm proud of the PC board to allow the air to circulate beneath them for cooling. A couple of thick pieces of cardboard can be used to achieve an even spacing.

Now for the ICs and transistors. Push the transistors down onto the board as far as they will comfortably go before soldering their leads and be sure to use the correct IC at each location. Make sure also that each IC is correctly oriented and be careful not to create unwanted solder bridges when soldering their pins.

Finally, the board assembly can be completed by mounting the larger hardware items. These include the two pots, the headphone sockets,

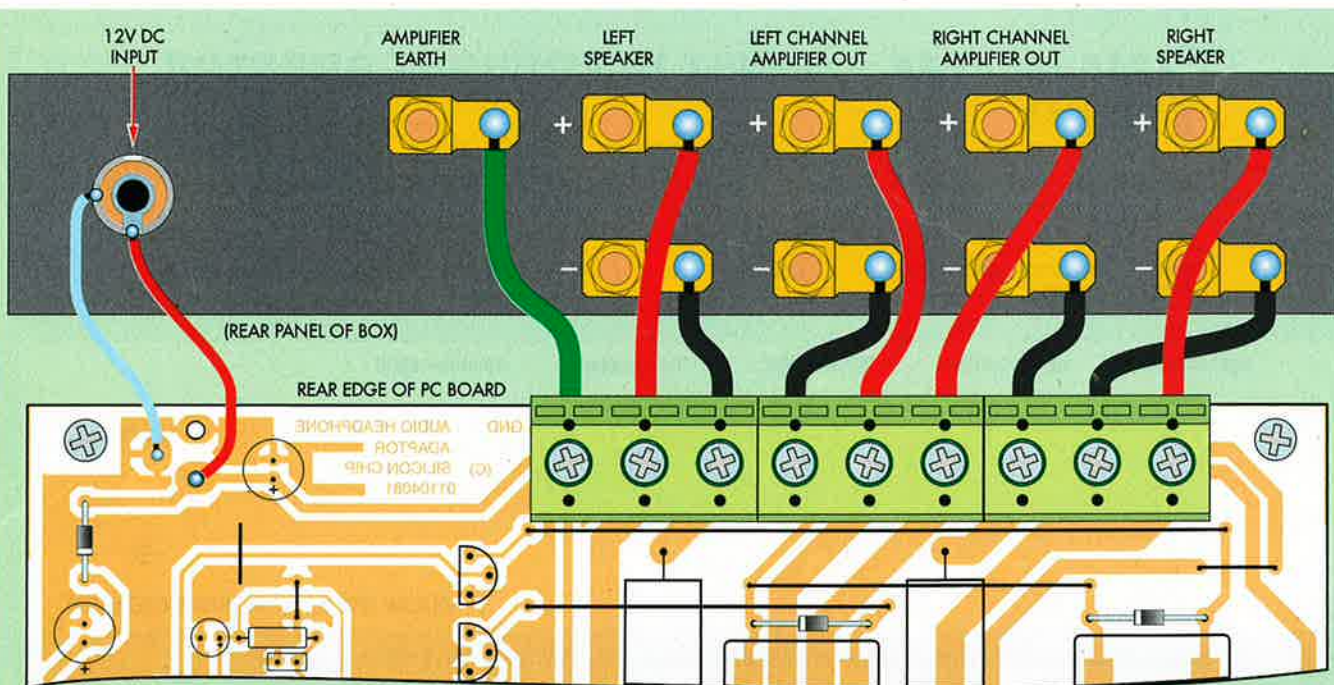


Fig.4: follow this diagram to complete the wiring between the PC board and the rear panel hardware. Note that the leads to the loudspeaker and amplifier terminals should be run using heavy-duty speaker cable.

the relays and the three 3-way screw terminals blocks. **Cut the pot shafts to about 15mm long before fitting them and make sure that each part is seated correctly against the PC board before soldering its leads.**

The DC socket should also be installed unless you are mounting the board in a case and intend using a panel-mount DC socket instead.

Testing

Before applying power, go over the board and carefully check your work. In particular, check that the correct part has been used at each location, that all polarised parts are correctly oriented and that there are no missed solder joints or solder bridges.

Once you are satisfied that all is correct, connect a 12V DC plugpack, switch on and check that all three LEDs in switches S1-S3 light. Check also that the relays remain off at switch-on.

Now press the Phones switch (S2) and check that relay RLY2 toggles. At the same time, the green LED in S2 should go out. Pressing this switch again should toggle RLY2 off again and turn the green LED back on.

Finally, check that RLY1 and the blue LED alternately toggle on and off each time the Speakers switch (S3) is pressed.

If the module passes all these tests,

then it is working correctly. If not, then you're in for a spot of trouble-shooting. Here's what to look for if it doesn't work:

(1) Symptom: no LEDs light when power is applied.

Do this: check the supply polarity. If that's correct, check the orientation of diode D1 and check for +5V at the output of regulator REG1.

(2) Symptom: all LEDs initially light but one relay refuses to toggle when its switch is pressed

Do this: check that the corresponding Q output from IC2 toggles correctly (ie, between 0V and about +4.8V) each time the switch is pressed. If it does, then check the relevant transistor – its collector should toggle high or low each time the switch is pressed.

If the transistor is switching correctly but the relay doesn't operate, check that the diode across the relay coil is correctly oriented.

(3) Symptom: a Q output from IC2 does not toggle when the relevant switch is pressed.

Do this: check IC2 & IC3 for correct placement and orientation and check that their pins are all soldered correctly. Check also that diodes D4 and D5 are the right way around (note: these two diodes face in opposite directions).

If you have a scope, check the rel-

evant output (pin 5 or 9) from IC1 – you should see a 0.5s positive-going pulse each time the switch is pressed. Check that this pulse is being applied to the corresponding clock input of IC2.

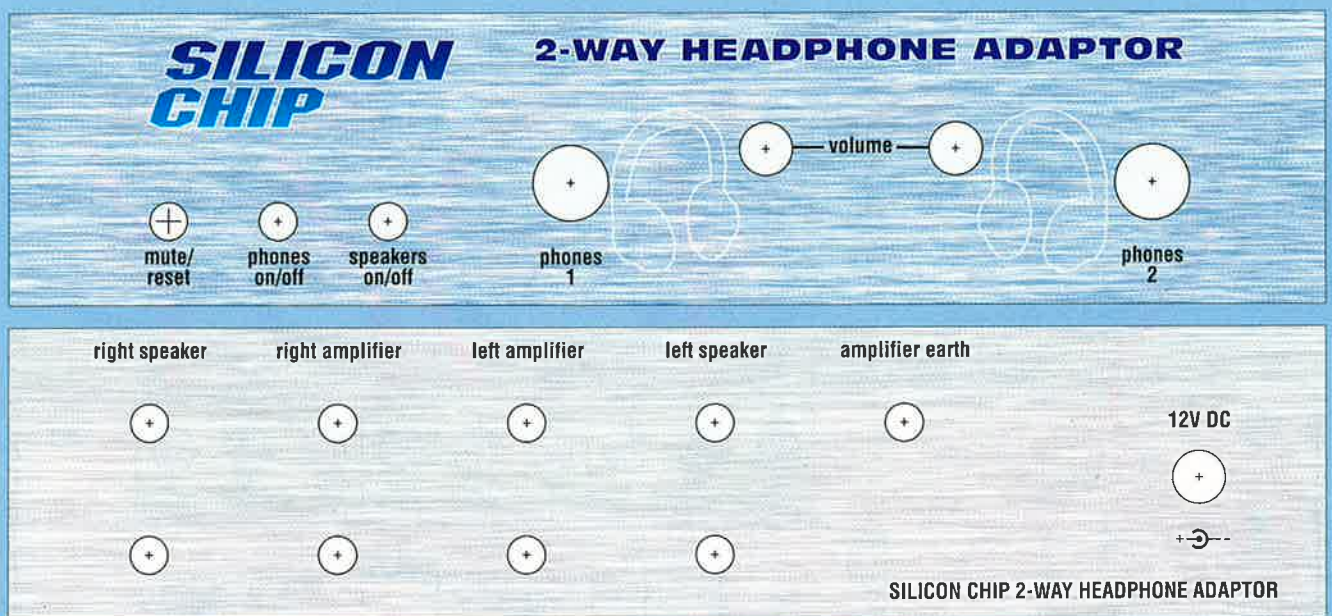
If there are no pulses from IC1, check the parts associated with the switches at the trigger inputs to this IC. The IC itself may also be faulty (unlikely).

Final assembly

Now for the final assembly. If you are building the unit from a kit, the case will probably be supplied pre-drilled with screen-printed front and rear panels. If not, then you will have to drill the panels yourself using the front and rear panel artworks (Figs.5 & 6) as templates.

The best approach is to first centre-punch the hole locations, then drill each one using a small pilot drill before enlarging it to the correct size. The larger holes (ie, for the headphone sockets, the pots and the DC socket) should be initially drilled to about 5mm, then carefully enlarged to size using a tapered reamer.

That done, the panel artworks can be downloaded from the SILICON CHIP website and printed onto photographic paper. They are then attached to the panels using an even smear of silicon sealant and the holes cut out using a very sharp hobby knife.



Figs.5 & 6: these full-size artworks can be used as drilling templates for the front and rear panels

Next, fit the front panel to the module and secure it by doing up the nuts for the two headphone sockets. Similarly, fit the panel-mount DC socket and the nine gold-plated binding post terminals to the rear panel.

Now drop the PC board and front panel assembly into the case and mark out the locations in the base for the rear corner mounting holes. Remove the board and drill these two holes to 3mm, then mount two tapped 6mm spacers in these positions, securing them using M3 x 12mm machine

screws which pass up through the bottom of the case.

That done, solder a couple of 50mm-long medium-duty hook-up leads to the power supply pads on the PC board. The board assembly can then be secured in place and the wiring to the rear panel completed as shown on Fig.4.

Be sure to use extra heavy-duty speaker cable (eg, 32/0.20) for all connections between the speaker binding posts and the screw terminal blocks. The lead to the amplifier earth terminal

can be run using medium-duty hook-up wire. You can then complete the assembly by fitting the knobs to the pot shafts and attaching the case lid.

Trying it out

As already mentioned, this unit connects in series between the amplifier outputs and the loudspeakers, so disconnect the loudspeaker leads from the amplifier and connect them to the Stereo Headphone Adaptor instead.

The outputs from the amplifier then connect to the left and right channel input terminals on the adaptor.

Finally, connect a lead from the terminal marked "Amp Earth" to the amplifier's chassis.

If your amplifier doesn't have a ground terminal, then it may be possible to attach a solder lug under one of the case screws. Alternatively, the earth lead can go to the "negative" terminal of one of the amplifier output channels (but not to both, otherwise you'll get an earth loop and lots of hum). This can be done by connecting an insulated wire link between the "Amp

Earth" terminal and the "Left Amp -" terminal on the back of the Stereo Headphone Adaptor.

After that, it's just a matter of switching everything on, plugging in your headphones and trying it out. **SC**



The completed 2-Way Stereo Headphone Adaptor can be used with both valve and solid-state amplifiers.

PRODUCT SHOWCASE

Hakko 808 Desoldering Gun

The Hakko 808 Desoldering Gun will quickly, efficiently and safely heat and remove solder from circuit boards and components. This is an essential tool for anyone who has to repeatedly repair or rework through-hole circuitry.



The Hakko 808 Desoldering Gun features a thin, comfortable pistol grip that places the pump and motor above, not inside, the grip. This keeps the vibration to a minimum and insures that the grip is comfortable for extended use. Thanks to the balance of the grip, delicate tasks are performed with greater ease as the tool can be precisely handled and doesn't move around while the vacuum operates.

The new miniature high-performance diaphragm pump is housed in the chamber at the rear of the 808. Pump maintenance is quick and easy – simply remove the cover. If repairs are ever needed, replacement parts are available and inexpensive.

The Hakko 808 features a tip-to-ground potential difference no greater than 2mV and a tip-to-ground resistance no greater than 2Ω. Temperature is adjustable from 380°-480°C and it comes with a 1mm nozzle installed.

Contact:
RS Components
25 Pavesi St, Smithfield, NSW. 2164
Tel: (02) 9681 8500 Fax: (02) 9681 8600
Website: www.rsaustralia.com

Test Instrument catalog from Emona

Emona Instruments have just released their 2008 Test Instruments Catalog. Its 72 pages covers instrumentation and equipment for electronics design, manufacturing, service and education, as well as general electrical testing and specialist electrical compliance testing. The 2008 catalog features a "Digital Oscilloscope Selection Guide" with scopes from Tektronix, GW, Rigol and Pico. The catalogue also includes two completely new sections for 2008.

A "Thermal Imaging and Reporting" section highlights the Electrophysics Inc range of thermal imagers with on-board data logging and the "Electrical Safety & Biomedical Testing" section launches the new Rigol Medical Model 288 AS/NZS3551 Biomedical Appliance Tester. The Rigol 288 is Australia's first handheld medical appliance tester to fully comply with the requirements of AS/NZS3551 and also features Bluetooth connectivity to the Optima printer and scanner.

You can browse the catalog on-line at www.emona.com.au, or to obtain a copy free of charge, phone Emona on 1 800 632 953 or email testinst@emona.com.au

siliconchip.com.au

Neat camera fits in door peep hole

This low cost colour video camera system with a 2-inch colour TFT display is designed to replace the optical door viewer or for a new installation in any timber door.

The camera has a 90° viewing angle and is encased in metal with an extendable stem and front and rear flange for clamping the camera assembly.

Powered by two AA cells, it has a pushbutton on-switch with a timed-off function to save power. The system can select an on-time of 15 or 30 seconds.

It provides a much better viewing for security when answering the door, for home use or hotel rooms.



Contact:
Tenrod Australia Pty Ltd
18/2/24 Vore St, Silverwater NSW 2128
Tel: (02) 9748 0655 Fax: (02) 9748 0258
Website: www.tenrod.com.au

Tool sharpening made easy

Correct tool grinding and honing is an art. Without training and experience, costly mistakes can be made and expensive tooling ruined.

This TiGer 2000 Wet stone sharpening system offers professional results and a razor sharp finish every time and is easy to use even for a beginner.

Intended for the home and small workshop and available with a comprehensive range of accessories, it is ideal for producing sharp cutting edges to knives, scissors and tools.

The Tiger 2000 includes a jig for straight edges, plane irons, ripping chisels, an angle-setting jig for measuring exact angles & settings and removable leather honing wheel to remove burrs after sharpening.



Contact:
Hare & Forbes Machinery House
1/2 Windsor Rd, Northmead NSW 2152
Tel: (02) 9890 9111 Fax: (02) 9890 4888
Website: www.machineryhouse.com.au

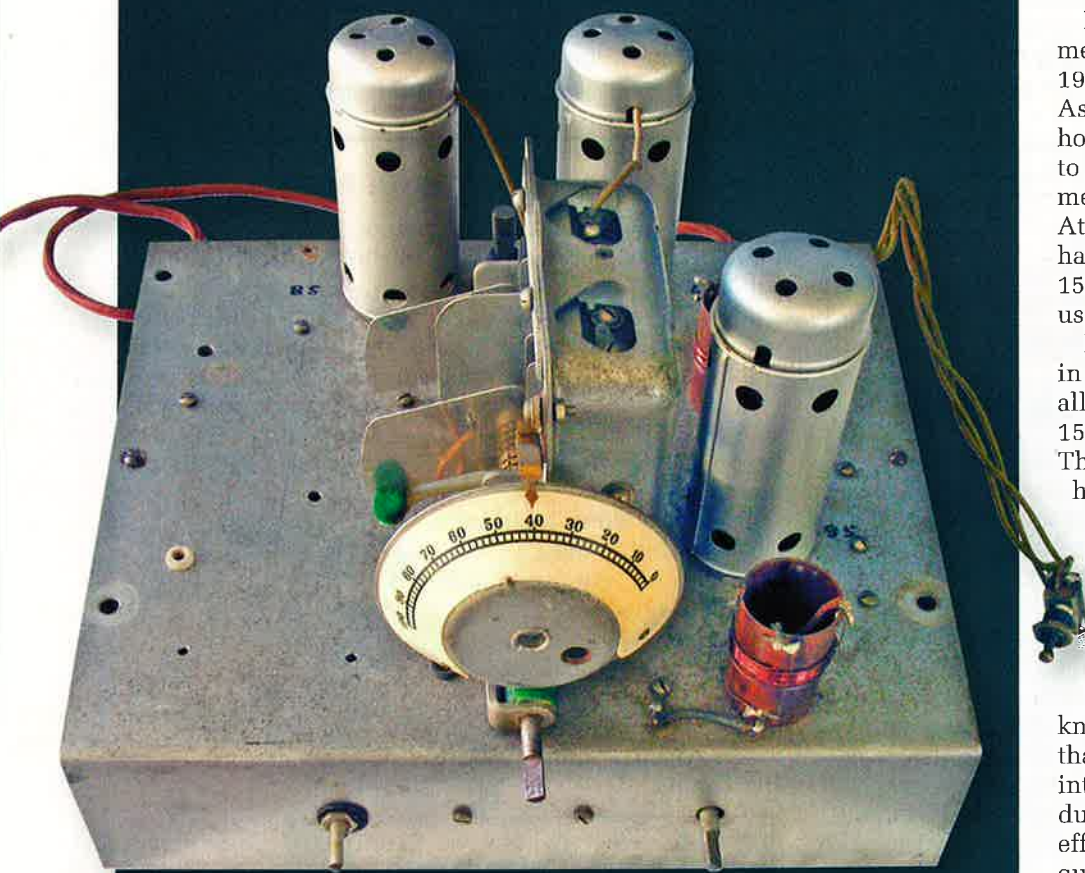
Vintage Radio

By RODNEY CHAMPNESS, VK3UG



Shortwave converters from the 1930s

Shortwave converters were popular for a brief period in the 1930s and 1950s. In an era when money was tight, they provided a low-cost means of converting a standard broadcast-band receiver to shortwave reception.



This view of the AWA C103/43 converter shows the layout on the top of the chassis. All parts are readily accessible, making it easy to service.

INITIALLY, radio transmissions were broadcast on frequencies ranging from 100kHz to 1500kHz (ie, on wavelengths from 3000 metres to 200 metres, respectively). However, there were some high-power transmissions below 100kHz.

Basically, all "important" transmissions were licensed or permitted to operate in this general frequency range. By contrast, those "pesky" experimenters and amateurs were permitted to use any of the so-called "useless" frequencies above 1500kHz. Because of this frequency allocation, they were not expected to be able to contact each other over long distances but they quickly proved the authorities wrong!

Radio transmissions for entertainment commenced during the early 1920s and quickly became popular. As a result, radio manufacturers and home constructors developed receivers to operate on both the long-wave and medium-wave bands (100-1500kHz). At the time, there was no reason to have radios capable of tuning above 1500kHz, since those frequencies were used only by the experimenters.

In any case, the components used in radios at the time were generally unsuitable for frequencies above 1500kHz, as was the layout of the sets. That didn't deter the experimenters, however. They immediately set about making the most of the frequencies that they were permitted to use and began by experimenting with ways to improve both the stability and the performance of their receivers and transmitters.

In some cases, they were even known to remove the valve bases so that the valves could be wired directly into the circuit. This was done to reduce the inductance and capacitance effects that limited a valve's high-frequency response.

By the end of the 1920s, experimenters had convincingly proved that the frequencies above 1500kHz were not

useless. In fact, they permitted world-wide communications under the right circumstances.

The governments of the day soon realised that these shortwave transmissions could be used for inter-continental communications to suit their own needs. They could also be used to broadcast "propaganda" thinly disguised as entertainment to people overseas. As a result, shortwave stations were set up and because components, circuit design and layout had greatly improved over the decade, both the receivers and the transmitters worked quite effectively on the shortwave bands.

Shortwave converters

The introduction of shortwave transmissions was naturally accompanied by a corresponding demand for new receivers capable of receiving the new frequencies. However, not everyone had the money for this and instead wanted to "modify" their existing receiver.

The answer was to fit what was called a "shortwave converter" ahead of a conventional broadcast-band (medium-wave) receiver. A converter stage was, in fact, nothing more than the front-end of a superheterodyne receiver and effectively converted stations on shortwave to the broadcast band (ie, the IF output of the converter was in the broadcast band).

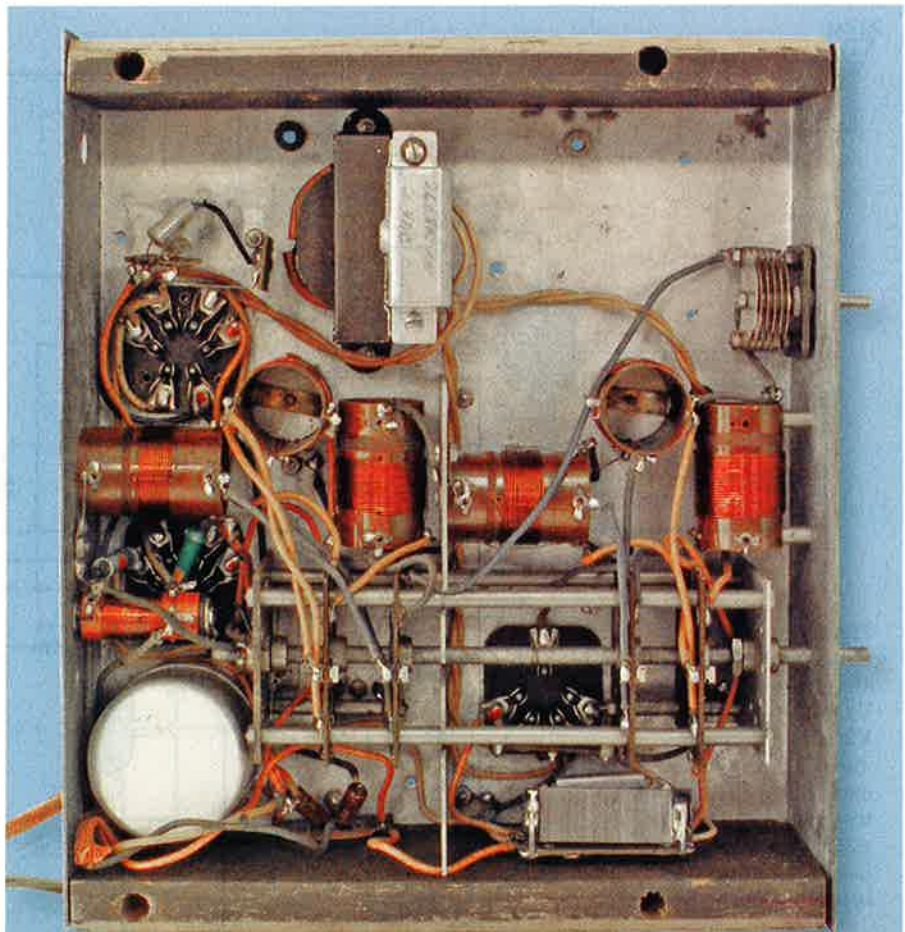
In practice, this meant that a tuned radio frequency (TRF) receiver became a superhet receiver when a converter was connected to it, while a normal superhet receiver became a double-conversion superhet.

AWA C103/43 converter

I recently had a chance to examine two such shortwave converters, one an Australian design and the other an American design. Both are circa 1930/3 and neither has been restored at this stage.

The AWA C103/43 converter is set up in the following manner. First, the antenna lead is removed from the broadcast receiver and attached instead to the antenna terminal of the converter. The yellow wire coming out of the converter is then connected to the antenna terminal of the broadcast receiver – this is the converter's RF (radio frequency) output lead.

Next, the earth wire to the receiver remains in place and the black wire



This is the under-chassis view of the AWA C103/43 shortwave converter. Despite its age, it is still in remarkably good condition and requires little in the way of restoration.



The AWA C103/43 shortwave converter is housed in a wooden cabinet. This is also in good condition and will be easy to restore.

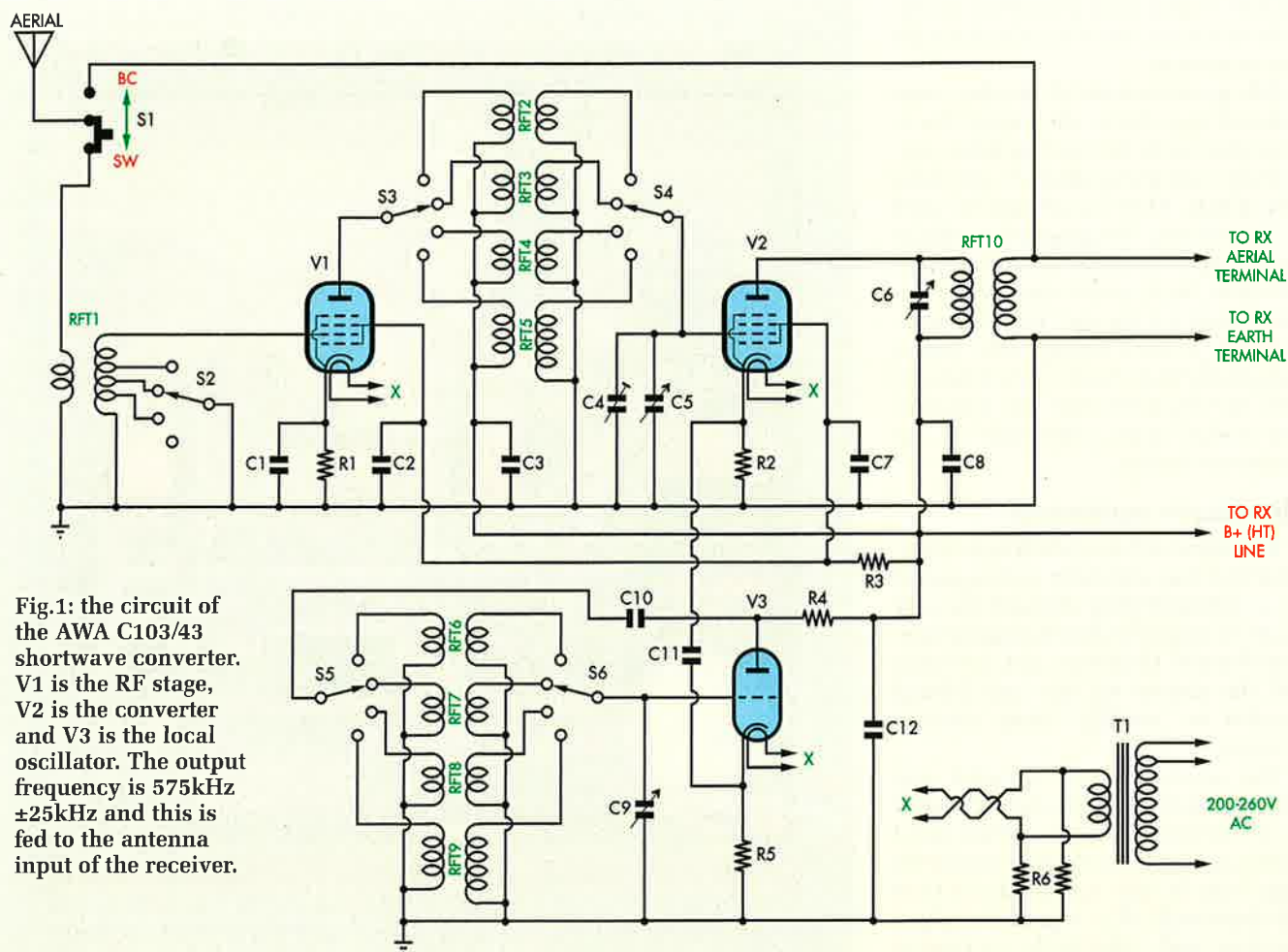
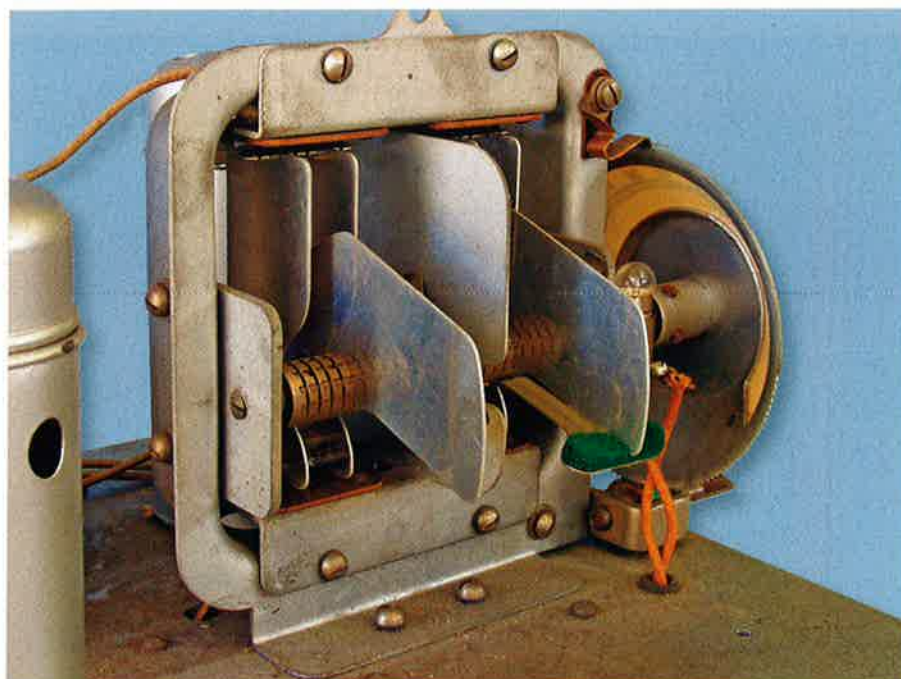


Fig.1: the circuit of the AWA C103/43 shortwave converter. V1 is the RF stage, V2 is the converter and V3 is the local oscillator. The output frequency is 575kHz $\pm$ 25kHz and this is fed to the antenna input of the receiver.



The ganged tuning capacitor in the AWA C103/43 has only one variable plate in each section. This means that the converter tunes over a fairly limited range on each of its four bands, rather than tuning across the entire shortwave band (ie, it was designed to tune the four international shortwave bands only).

from the converter is attached to the same terminal. Also in this batch of cables is another wire coloured red. This red lead has a 4-pin plug attached to its end. The 80 rectifier in the receiver is removed and this 4-pin adaptor is then plugged into the rectifier's socket. The 80 rectifier is then plugged back into the receiver via the 4-pin adaptor.

Why is this done? Simple – the red wire is connected to the HT high-tension output of the 80 and thus supplies the necessary HT to the converter. How's that for cutting costs in the converter unit?

By contrast, the heater supply for the converter's valves is obtained from an internal 240V to 2.5V filament/heater transformer.

The final connection simply involves plugging the 240V lead into the mains. There is no on-off power switch on the converter and in most cases there was no on-off switch on the radios of the era either. So to turn the system off completely, it was necessary to turn two power points off (one for

the converter and one for the receiver), unless a double adaptor was in use.

The controls

The cabinet of the AWA C103/43 was rather tall and chunky for the time and has quite a dark colour. The unit I have is in quite good condition and requires little in the way of restoration.

The front panel carries three controls and a "peephole" type dial. The lefthand knob controls a trimmer capacitor to peak up the performance on the selected band and this trimmer is C4 in the circuit diagram (Fig.1). The centre knob is the tuning control, while the righthand control is the 4-position wave-change switch. A broadcast/shortwave toggle switch is also located on the side of the cabinet.

In practice, the front-panel controls are well spaced and easy to use. However, it's a mystery why the broadcast/shortwave switch was not placed on the front panel as well.

In summary, the unit is quite neatly made both above and below the chassis and would not be difficult to work on if required.

Circuit details

Fig.1 shows the circuit of the AWA C103/43. The ganged tuning capacitor is interesting in that each gang has only one variable plate in each section. This means that the converter was designed to tune over a fairly limited range on each band selected.

The RF stage is broadly resonant on the shortwave band selected and has no variable tuning capacitor. This stage uses a 58 valve (V1), the output of which is coupled via band-switching to converter stage V2 (a 57 valve). The LC circuits between these two stages are tuned by one section of the tuning gang.

To enhance frequency stability and general performance, a separate oscillator valve (V3) is employed. This uses a 56 valve and its cathode output is fed to the cathode of the converter stage (V2) via capacitor C11.

The output from the converter stage is applied to a single IF (intermediate frequency) transformer, tuned to $575\text{kHz} \pm 25\text{kHz}$. Its output is in turn fed to the antenna terminal of the receiver via an unshielded yellow wire.

It's open to conjecture as to just how stable this would be and whether sta-



tions close to 575kHz would be picked up by this unshielded antenna wire. It was undoubtedly necessary to tune the IF transformer away from any radio stations in the $550\text{--}600\text{kHz}$ range to alleviate this problem.

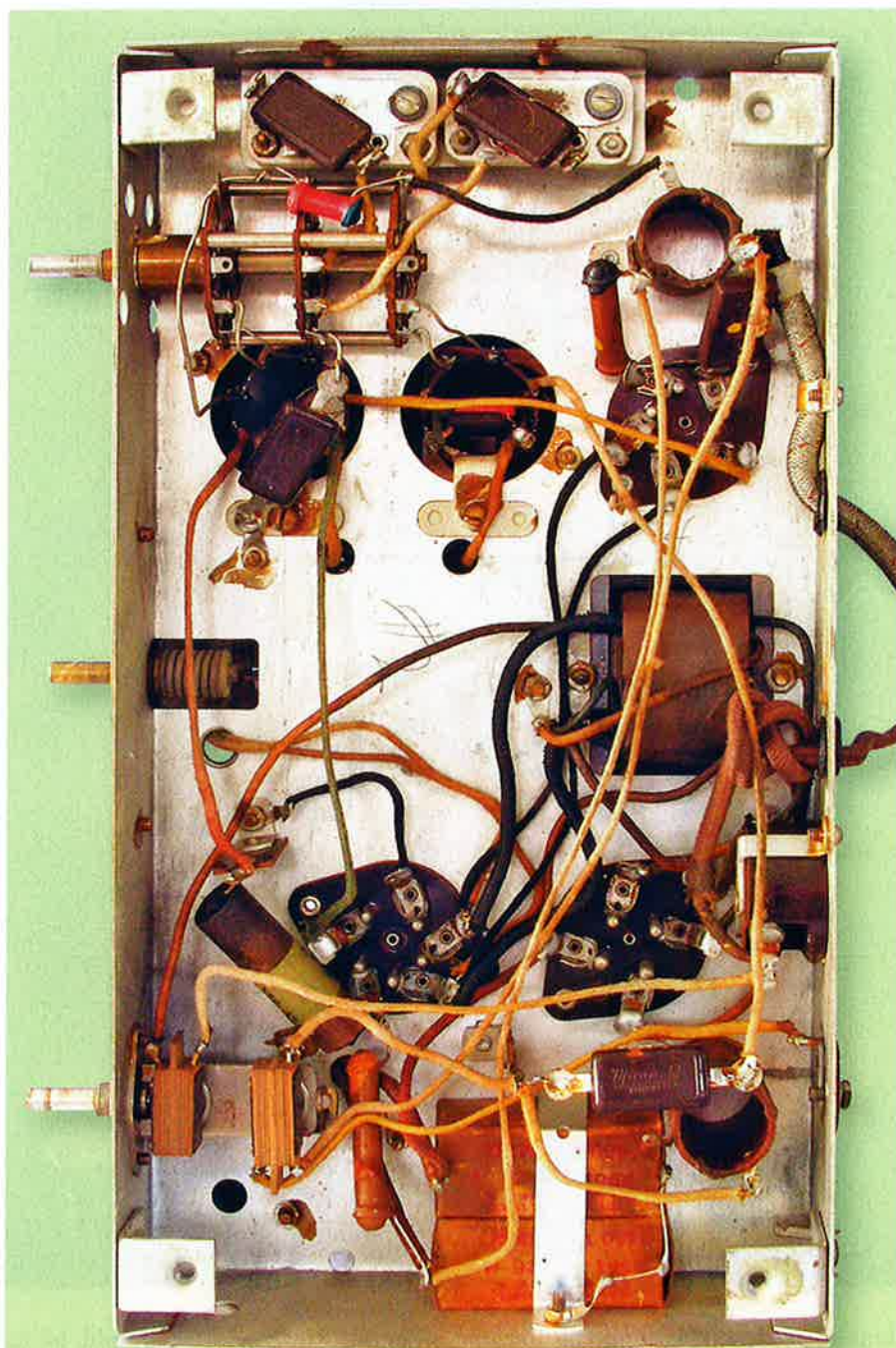
By the way, there is some doubt as to which valves were actually used in the converter, as the diagrams, the circuit and the manual don't match in several areas. There was obviously not much care taken when it came to proof-reading and checking the manual.

The bands tuned by the converter are the 49, 31, 25 & 19-metre international broadcasting bands, which equate roughly to 6, 9, 12 & 15MHz. Providing the RF and oscillator coils are correctly

aligned, the converter should be as easy to tune as the broadcast receiver to which it is connected. Mechanical band-spreading is achieved by the single plate gang sections with their restricted tuning range.

Apex converter (USA 110V)

The American Apex converter dates from around 1930 and is different in several ways to the Australian unit. It's attached to the receiver by first removing the antenna lead from the set and attaching it to the antenna terminal of the Apex. The output from the Apex is fed out via a shielded cable and this goes to the antenna and earth terminals of the receiver.



The Apex converter is a snack to service, with all parts under the chassis easy to access. At top right is the above-chassis view.



larger and easier to read than the dial on the AWA converter.

Finally, the righthand control is a 3-position wave-change switch and the knob is labelled "H", "M" & "L". I am unsure of the tuning range on this converter, but suspect that it tunes from about 2-22MHz as it has three bands and a full-size 2-section tuning gang.

This converter also has three valves: a 24 converter stage, a 27 (or 56) which is used as a local oscillator and an 80 rectifier in the power supply. The valve types are marked on the sockets themselves, so only a very careless person would get the valves mixed up.

The Apex converter has no RF stage, so it will not be as sensitive as the AWA unit. Its image ratio may not be as good as the AWA unit either. However, if the output frequency of the converter is close to 1500kHz, instead of 575kHz as in the AWA unit, the image ratio will be quite satisfactory.

Another difference between the two units is that the output frequency of the Apex converter isn't directly adjustable. However, if break-through from a strong local broadcast station did occur, the output frequency could easily be altered by changing the value of the fixed capacitor on the output coil.

Unlike the AWA converter, this unit tunes over quite a wide frequency range on each band selected. This in turn means that the tuning would be quite critical. However, fine tuning of any station can be achieved by

Unlike the AWA unit, the Apex converter relies solely on its own power supply and is designed to plug into a 110V AC mains outlet. That means that it is a little easier to connect than the AWA unit.

The controls

The Apex converter is housed in an attractive wooden cabinet. As shown in the photo, the controls and tuning escutcheon are arranged in an easy-

to-use layout on the front panel. The knobs are somewhat unusual, being made of wood with a metal insert.

The lefthand control is used to switch the unit from the broadcast band to shortwave. It does this using a pair of toggle switches which are ganged together. In the broadcast position, all power is removed from the converter.

The central control is the tuning control and the dial in this unit is



altering the tuning of the broadcast receiver that it is connected to by a few kilohertz.

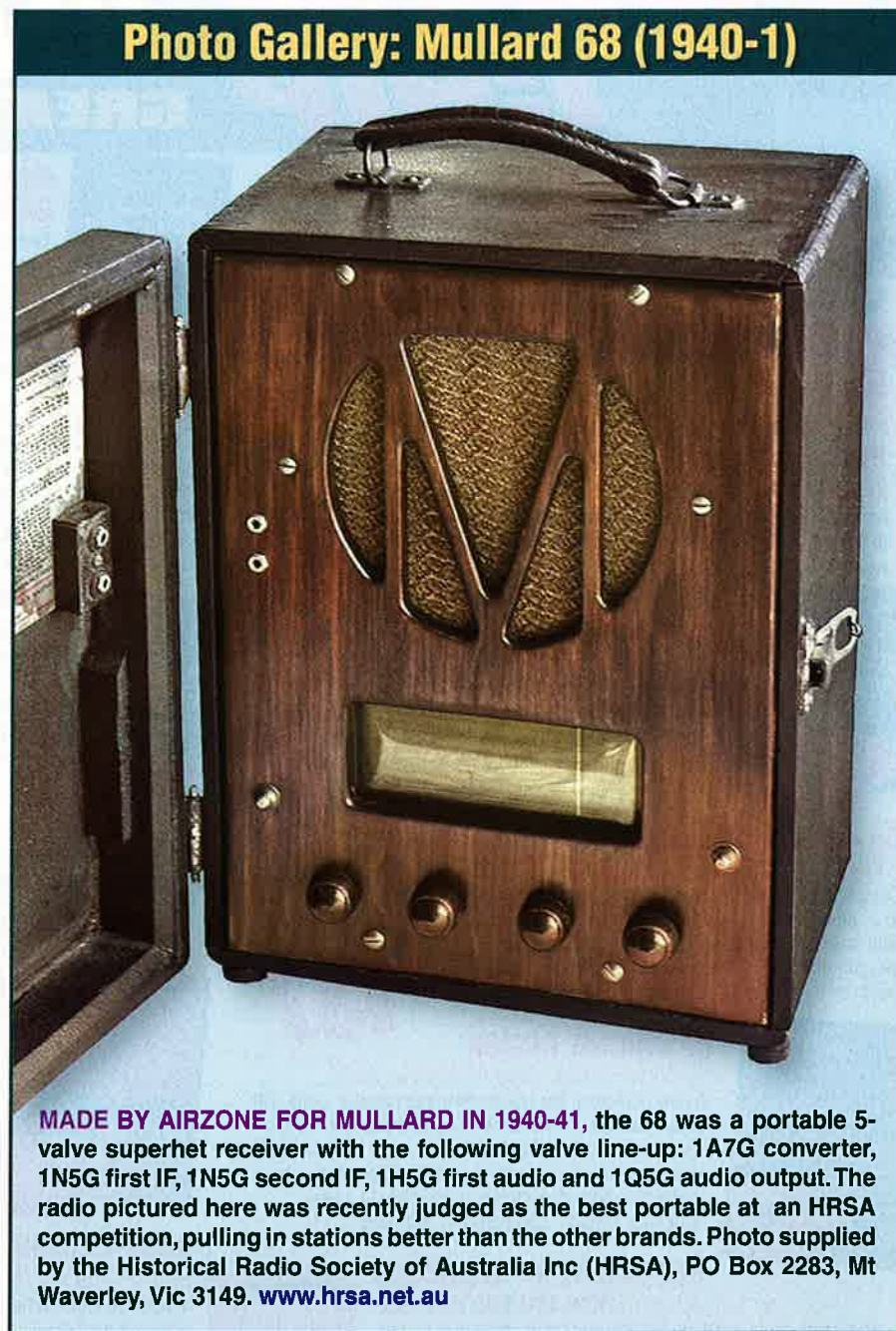
Performance

Although I haven't used the AWA converter (as it has not yet been restored), I believe that it would acquit itself quite well. The bandspread tuning (over four bands) is certainly a plus for the unit, as it makes tuning so much easier compared to sets that tune over one sweep of the dial.

By contrast, the Apex converter covers three bands and as previously stated, is probably a general-coverage unit that tunes up to around 22MHz. This means that the two units are designed for slightly different markets. The AWA unit was designed specifically for tuning four international broadcast bands whilst the Apex converter would have been more suited to the amateurs and experimenters of the day who wanted to tune as much of the shortwave spectrum as possible.

Both units would be relatively stable, as each uses a separate oscillator to feed the converter valve. However, I am not convinced that the unshielded output lead on the AWA unit was a good idea. That said, there weren't as many broadcast stations around in 1933 as there are now, so break-through may not really have been a significant problem.

One problem that was not alluded to in the manual was the possibility of supplying excessive HT voltage to the



MADE BY AIRZONE FOR MULLARD IN 1940-41, the 68 was a portable 5-valve superhet receiver with the following valve line-up: 1A7G converter, 1N5G first IF, 1N5G second IF, 1H5G first audio and 1Q5G audio output. The radio pictured here was recently judged as the best portable at an HRSA competition, pulling in stations better than the other brands. Photo supplied by the Historical Radio Society of Australia Inc (HRSA), PO Box 2283, Mt Waverley, Vic 3149. www.hrsa.net.au

AWA converter. The unit is designed for a HT voltage ranging from 200-220V and this is derived from the 80 rectifier output of the host receiver. As a result, the voltage applied to the converter could be as high as 400-500V but no mention is made in the manual as to how this voltage should be adjusted, a rather serious oversight in my opinion.

The Apex converter would have worked well in the USA where stations are either closer together geographically or are stronger than in Australia. Its shielded output lead would have largely eliminated any break-through

of signals from nearby stations in the broadcast band. However, an ability to readily adjust the output frequency would have been a good idea to completely eliminate this possible problem.

In summary, converters from the early 30s are rarely seen and are from an interesting phase of the development of radio. They are well worth having in a collection of vintage radios.

Finally, my thanks to Brian Lackie for the opportunity to look at these two units. It will be interesting to hear them in action once they have been restored.

SC

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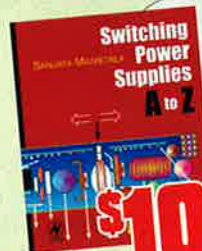
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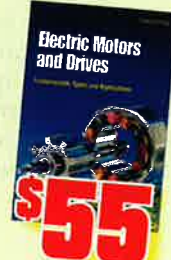


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Measuring the local oscillator in a superhet

Is it possible to use a frequency counter to check the local oscillator frequency of a transistor radio, ie 455kHz? If so, is it possible to achieve this without physically connecting the counter to the local oscillator circuit? (V. K., Newcastle, NSW).

- This is certainly possible. The way to do it is to use a sniffer coil connected to the frequency meter. This is simply several turns of wire connected to the frequency meter probe and positioned close to the oscillator coil.

The local oscillator in a superhet is always above the incoming station, so the local oscillator frequency will be 455kHz above the tuning frequency. So for example, when the radio is tuned to 1269kHz the oscillator will be at 1724kHz.

Fridge controller is not working

I have a question to ask regarding the Fridge Temperature Controller in the June 2005 issue. I built the kit and

find that the unit is permanently on. I've double-checked the construction (I bet everyone says that) and can't find anything wrong.

What I am getting is 8.9V at pin 3 of the comparator chip and if I measure the resistance of the LM335 over a temperature range of 2°C to 20°C, it only varies from 35.7kΩ to around 36.5kΩ. I'm guessing that this small change isn't enough to give a 2V to 3V drop across pin 3; in fact, the voltage stays at 8.9V. If I remove the LM335 and replace it with a 2.2kΩ resistor, the LED goes out.

My question is where could my circuit be wrong or is there some instruction missing and should I be adding some extra resistance to the LM335 part of the circuit to help with the voltage drop? (J. P., via email).

- If you are getting a voltage of 8.9V more or less permanently on pin 3 of IC1, this suggests that the connections to your temperature sensor are either open-circuit or perhaps reversed. That's about the only reason why the voltage at pin 3 would remain very close to the 9V supply line.

Measuring the resistance of the

LM335 is not very meaningful, because it's very non-linear. In fact it behaves very much like a zenier diode, whose reverse breakdown voltage varies in direct proportion to the absolute temperature in Kelvins. And at any particular temperature the dynamic resistance is very low, so that the voltage drop hardly changes over a fairly wide range in current (100μA to say 5mA). This is why a resistance measurement is not very meaningful.

Using a line level source with the Voice Recorder

The Voice Recorder project (SILICON CHIP, December 2007) was the kind of versatile project we love to see. How can the recorder be adapted to accept a line level input instead of via the mic? This would allow me to record something like a sound track off of a computer. I feel this would be a very useful addition to the project. (P. N., Byron Bay, NSW).

- It's easy to modify the Voice Recorder to accept a line level input instead of the mic-plus-preamp. All you need to do is remove the 100nF capacitor linking pins 21 & 20 of IC1 on the board and use it to couple in the line level audio from your PC, CD or MP3 player to pin 20 (A_{in}) of the IC. The ground side of the line level input connects to the board's ground, of course.

If you want to also use the on-board mic from time to time as an alternative to the line level input, you can use an SPDT switch off the board to switch the input side of the 100nF coupling capacitor between the line level input and pin 21 (A_{out}) of the IC.

Change of display for Big-Digit Clock

I have built the Big-Digit 12/24 Hour Clock from the March 2001 issue of SILICON CHIP, using six common cathode 0.5-inch 7-segment displays. Now I want to connect it to 2-inch displays as shown in the article but

Speedo Corrector Affects Odometer Readings

I built and installed the Speedo Corrector Mk2 from the December 2006 issue in a rebuilt 1977 Porsche 911 which had the wheels changed from 15-inch to 16-inch. I have calibrated the speed against a GPS unit and it is accurate at 100km/h and a little under at 50km/h (48). The odometer reads under by about 300 metres on a measured 5km stretch.

Is this normal when the speed is corrected? If it is to be expected, how can I correct the problem? (D. B., via email).

- This whole issue was thoroughly canvassed in the Mailbag pages during 2007. The problem is that most cars have an odometer which is highly accurate but a speedometer

which is optimistic. This means that a typical car's speedo will read high at any speed and may read as much as 108km/h at 100km/h.

Since the speedometer and odometer use the same pulse stream from the wheel sensor, there is nothing you can do about it. If you want the odometer to be accurate, you will have to live with the speedo reading being high.

In practice, we think it would be better to have the speedo reading slightly high at 100km/h (eg, 103km/h) so that if you have the speedo sitting on a particular speed limit, you know that you have a safe margin and cannot be pinged by a speed camera.

have common anode displays, not common cathode types. So do you have a solution for me please? (P. R., Columbo, Sri Lanka).

● There is no easy way to convert the circuit to drive common anode displays. The 2.3-inch common cathode displays are available from Jaycar (Cat. ZD-1850).

No spark at low revs

I built the Universal High-Energy Electronic Ignition System (SILICON CHIP, December 2005 & January 2006) for reluctor pickup but have found that I get no spark at cranking speed. If I spin the dizzy by hand at a faster speed, the spark is good and strong.

When adjusting trimpot VR2, I can only attain a voltage of 4.9V. This probably has no significant bearing on the result but can you suggest a remedy to produce a stronger input signal? (M. K., Horsham, Vic.)

● The voltage is at 4.9V because of regulator tolerances. When setting up for your reluctor, wire it in-circuit and find the setting of VR2 where the voltage changes from 0V to 4.9V. This is the most sensitive setting for the reluctor signal.

However, you need to adjust about one turn clockwise or anticlockwise from this setting to prevent the coil firing with small changes in voltage before the engine is running.

Multimedia headset for Telephone Adaptor

I am interested in building the Telephone Headset Adaptor described in the July 2002 edition of SILICON CHIP.

Could you please advise me if I can use a multimedia headset with microphone which has individual plugs for both the microphone and headphone? What modifications would I need to make? (R. B., via email).

● The use of separate connections for the headphones and microphone does mean that the existing stereo socket on the adaptor is unsuitable. You would need to wire up two sockets, one for the headphone and another for the microphone.

How you wire the headphone depends on whether you connect both the left and right headphones or use just one. With two in parallel, the

NiMH Fast Charger Is Over-charging

I recently completed the NiMH Fast Charger published in the September 2007 issue and the unit I've built is not performing as specified. It has been built to charge 700mAh Nicad batteries wired in series to give 8.4V. I have two sets of batteries with the same symptoms. The charger has been built as a fast charger with top-up and trickle charge for my kid's remote control cars.

If the unit worked, I was going to connect seven 2500mAh NiMH cells, adjust the charger to suit and replace the Nicads. The unit is supplied from a transformerless 12VDC regulated supply capable of delivering 2.5A. Dt/t was set to 1.25 but reducing this value makes no difference to the performance of the unit.

Time-out was set to 1.5 hours (Link 1 was in). I later removed Link 1 and re-adjusted VR1 to give a time-out equal to 1.5 hours. The trickle current (VR3) was set to give 35mA and VR4 was set to 1V.

The result is that the charger is overcharging the batteries. They take between 12-15 minutes to reach 55°C and the charge temperature keeps rising. I made sure the battery

thermistor was touching the battery case, not the webs in between. The charge voltage is consistently 11.5V (MOSFET is not regulating the charge). RB3 is constantly low.

LED2 only illuminates if the thermistor is disconnected (charge light extinguishes); it doesn't illuminate when the battery temperature is greater than 55°C. Occasionally the charge light flashes or extinguishes while charging (thermistor light does not illuminate) but unit continues to charge (battery gets hotter). When the thermistor is disconnected, the battery continues to over charge.

I've made sure there are no shorts on the PC board and the Mosfet is insulated from the case. It looks like the microcontroller is cactus. (M. L., via email).

● It seems that there is a path between the drain and source of Q1 which is causing the battery to charge, with the charger having no control. Check the resistance between drain and source of Q1.

Since the LEDs are not operating as they should, it does suggest the PIC needs reprogramming and should be returned to the kit supplier.

impedance will be 16Ω and so the windings for transformer T1 will have to be changed as detailed in the "Catering For Different Headset Speaker Impedances" section.

On the PC board, the 3.5mm socket has the ring connection on the left and the tip on the right. The sleeve is the front metal section.

Horn speaker project

I have been approached by three different people over the past year or so, all with the same basic problem. All are involved with providing circus and performance-related activities in places where there is no accessible grid power and for environmental, safety and other reasons do not wish to or cannot use generator power.

The essential problem they have is how to power a typical 800W PA system. Many investigate pedal power

but a few sums (assuming the known 80W max/person) show you would need a minimum of 15-20 pedallers. It occurred to me that a far better approach is to generate the desired sound levels without needing 800W.

I suggested investigating horn-loaded loudspeakers – which as you would be aware – can be 95-98% efficient, a far cry from the average PA unit which is 2-4%.

My guess is that one needs a maximum of about 110dBA at seven metres on axis from about 100Hz to about 4kHz. Having recently heard a horn-loaded speaker driven directly from an iPod at less than 1mW yet audible many metres away, it seems feasible to get the desired levels from a little over 50 watts. A basic crossover network would suffice as one is not seeking hifi quality nor rock concert levels.

I recall an article in an early ETI where Roger Harrison checked out a house with a living area which was the

Queries On Power Supply Filter Capacitors

In reference to your answer about capacitors on page 104 of the December 2007 issue, I was curious to know how critical is the voltage rating on a given ripple capacitor? This issue has nagged me for many years.

As a tech of some 15 years, I have come across a couple of technical opinions that suggest that the "working voltage" of a ripple capacitor (normally an electrolytic) needs to be relatively close to that of the DC rail/voltage which it helps to produce.

I even remember coming across a service bulletin for a well-known brand where they were upgrading from 16V to 25V electros on 15V rails. Obviously, they were being a bit too optimistic originally using 16V caps on a 15V rail but when I asked the question why they wouldn't take them to 63V versions, I was told that the capacitors would lose too much efficiency if the working voltage was too high and therefore leave too much ripple on the rail.

On the other hand, it is not uncommon to hear of techs replacing

supply capacitors with higher voltage units, probably with the notion that they are "upgrading" the unit's reliability. For example, using a 63V instead of a 25V replacement because that's all they had and/or they wanted to ensure the capacitor wouldn't fail again etc.

So how critical is the voltage? I notice that most electros that are suited to supply filtering usually have a ripple current rating and a "working voltage". Does the efficiency of a capacitor's ability to remove ripple diminish as you move away from the given rail/voltage rating?

I would really appreciate your comments on this subject as until now I have never been able to determine how critical the voltage rating is in terms of ripple and have been unable to substantiate the claims of some technicians/engineers. Possibly in the case of the Class-A amplifier this doesn't matter or is maybe not critical at all but I would like to put this debate to rest once and for all. (B. H., via email).

● As a general rule, you can always use a higher voltage rated electro-

lytic capacitor in any application, provided its physical size will allow it to be fitted into the PC board etc. As far as the comment about "losing too much efficiency" is concerned, it is just wrong.

If you need to judge the filtering efficiency of a given electrolytic capacitor, you can do so by reference to its ESR (equivalent series resistance), its power factor and its ripple current rating. What you are looking for is capacitors with very low ESR and a high ripple current rating.

While power factor figures may not be readily available, all of these parameters improve as the size of the capacitor increases. By capacitor size, we mean size of the winding element, not can size. However, because of can standardisation by the manufacturers, some cans are not entirely "filled" by the element, so the size of the can is not necessarily a guide.

You can judge for yourself by having a look at ESR and ripple ratings for a large range of electrolytic capacitors listed in the Altronics or Jaycar catalogs.

end of the horn. Roger measured about 120dBA from the stereo 5W valve amplifier. The driving source was about 75mm diameter. He said the sound was excellent, even down low.

What is needed is a DIY project – it would have worldwide interest in this field and also perform an invaluable service. It is also of wider environmental interest in that it emphasises the need to concentrate on possibly achievable energy saving ends without being constrained by preconceived approaches.

● First, it is not necessarily true that horn drivers are 95% efficient although they are far more efficient than typical domestic hifi speakers. Typical compression drivers can output as much as 115dB/1W/1m but their sound quality is not particularly good. If you designed a horn-loaded cabinet around a conventional cone driver it would sound better but it would not be as efficient as a compression horn.

We think that designing a portable PA system with a decent horn speaker

would be a major task – and it might not be very portable. Why not consider a portable PA system along the lines of our 50W Portapal project described in the February & March 2003 issues? Altronics have a kit (K5360).

Altronics also have a commercial equivalent of this kit and one of our staff members recently tested it at a local surf carnival where it worked very well. These units are also commonly used by schools and sports associations for outdoor meetings. It should do equally well in your application.

Guitar amplifier wanted

Have you ever published a circuit for a guitar amplifier? My friend has an old valve guitar amplifier which is unserviceable. I could take the valve chassis out and build a solid-state amplifier, leaving the pots and controls from his unit in place.

Also, have you ever thought about constructing a "Kappelmeister"

speaker box. I made a pair a few years ago, 1600mm high, 500mm deep, with a solid timber cavity 6m long and lined with ceramic tiles. The weight is 120kg each and the sound is better than speakers costing well over \$10,000. (A. H., via email).

● We have not produced a guitar amplifier although we did describe a 2-channel guitar preamplifier in the November & December 2000 issues. This can be teamed with our 100W SC480 amplifier module described in the January & February 2003 issues.

We have not described any guitar loudspeakers.

How to adjust the Theremin

I've put together a Theremin (SILICON CHIP, August 2000) and I am having some trouble calibrating it. When I probe the gates of the FETs, instead of a 300-400mV RMS sinewave it's more like 10V. Also, the volume plate adjusts the pitch and the pitch antenna

does nothing except when touched, whereby it increases the volume significantly.

I know as far as diagnostic info goes, this is quite vague. I was hoping that this was a common enough symptom of something simple, which you might recognise, like a misplaced resistor or "you've gotta stand with one foot in the air, clap twice, face east, then adjust". (T. O., via email).

- With regard to "you've gotta stand with one foot in the air, clap twice, face east, then adjust", for northern hemisphere constructors such as yourself, you would need to face west, then do the adjustments.

The waveforms at Fig.3 show 510mV p-p (180mV RMS) for the reference and pitch oscillators measured at the pin 1 & pin 10 inputs of IC1. You can expect to get 10V at the gates due to the transformers!

The likely problem with your Therman is that the current tuning for T2 is set at a harmonic rather than the fundamental frequency. You may need to adjust the reference oscillator using T1 so that the T2 oscillator can be set correctly.

Try to find the range that T1 travels from fully anticlockwise to fully clockwise and set this in the middle of its tuning range. Then retune T2 for the low frequency as detailed in the alignment.

Search for Marantz special capacitor

I would like to ask your readers if they could point me in the right direction to find a very special electrolytic capacitor which is used in the power of my trusty old Marantz "1250". The

Valve RIAA Preamp Modification Not Possible

I was wondering whether the Valve Preamp described in your November 2003 issue could be modified to become an RIAA preamp?

In your February 2004 edition you described a modification to the feedback network which the changed plate load and cathode bias resistors. I'm assuming that an RIAA feedback network will also require such changes?

I realise that the extra components for the equalisation time constants may require some "imaginative" fitting to the existing PC board. Could you advise as to what component values to use? (A. C., via email).

- It is just not possible to modify the Valve Preamp to function as

an RIAA preamp. There is simply nowhere near enough gain.

Consider that just to provide the full RIAA characteristic, you need to provide 20dB more gain at 20Hz than at 1kHz. You also need to provide a lot more gain to bring the signal up from around 4mV to 400mV or more – that's a total of at least 60dB. On top of that you need to provide a reasonable margin of open-loop gain so that feedback can be applied to keep distortion reasonably low.

Even if you cascaded two 12AX7 valves to give the required gain, the signal-to-noise ratio is likely to be quite poor. These are some of the reasons why transistors rapidly took over from valves.

capacitor is actually a "double", ie, two capacitors in the one case. There is just not enough room to fit two separate capacitors in its place.

The specs are 14,000µF x 2 @ 70V. The case measures 65mm in diameter and 110mm in length. Any help would be greatly appreciated. (David Williams, tori.williams@bigpond.com).

LED query on amplifier power supply

I built the new Class-A Stereo Amplifier and it is performing perfectly.

I don't know if it is a problem but when I switch off the amplifier, the two LEDs on the power supply do not switch off together; one goes off instantly while the other fades off

slowly. Is this a problem? (F. B., via email).

- There is more current drain from the positive rail (preamp, speaker protector etc), therefore the positive rail LED will go out earlier. **SC**

Notes & Errata

Cordless Power Tool Charger Controller, December 2006: by way of clarification, the controller can be used with an NiMH or Nicad battery pack of up to 15 cells (18V). This should have been included in the specification panel.

The minimum rated voltage battery pack that the charger can control is 6V (five cells).

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.

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January 2002: Touch And/Or Remote-Controlled Light Dimmer, Pt.1; A Cheap 'Easy Motorbike Alarm; 100W/Channel Stereo Amplifier, Pt.3; Build A Raucous Alarm; FAQs On The MP3 Jukebox.

February 2002: 10-Channel IR Remote Control Receiver; 2.4GHz High-Power Audio-Video Link; Touch And/Or Remote-Controlled Light Dimmer, Pt.2; Booting A PC Without A Keyboard; 4-Way Event Timer.

March 2002: Mighty Midget Audio Amplifier Module; 6-Channel IR Remote Volume Control, Pt.1; RIAA Pre-Amplifier For Magnetic Cartridges; 12/24V Intelligent Solar Power Battery Charger.

April 2002: Automatic Single-Channel Light Dimmer, Pt.1; Water Level Indicator; Multiple-Output Bench Power Supply; Versatile Multi-Mode Timer; 6-Channel IR Remote Volume Control, Pt.2.

May 2002: 32-LED Knight Rider; The Battery Guardian (Cuts Power When the Battery Voltage Drops); Stereo Headphone Amplifier; Automatic Single-Channel Light Dimmer, Pt.2; Stepper Motor Controller.

August 2002: Digital Instrumentation Software For PCs; Digital Storage Logic Probe; Digital Therm/Thermostat; Sound Card Interface For PC Test Instruments; Direct Conversion Receiver For Radio Amateurs.

September 2002: 12V Fluorescent Lamp Inverter; 8-Channel Infrared Remote Control; 50-Watt DC Electronic Load; Spyware – An Update.

October 2002: Speed Controller For Universal Motors; PC Parallel Port Wizard; Cable Tracer; AVR ISP Serial Programmer; 3D TV.

November 2002: SuperCharger For NiCd/NiMH Batteries, Pt.1; Windows-Based EPROM Programmer, Pt.1; 4-Digit Crystal-Controlled Timing Module.

December 2002: Receiving TV From Satellites, Pt.1; The Micromitter Stereo FM Transmitter; Windows-Based EPROM Programmer, Pt.2; SuperCharger For NiCd/NiMH Batteries, Pt.2; Simple VHF FM/AM Radio.

January 2003: Receiving TV From Satellites, Pt.2; SC480 50W RMS Amplifier Module, Pt.1; Gear Indicator For Cars; Active 3-Way Crossover For Speakers.

February 2003: PortaPal PA System, Pt.1; SC480 50W RMS Amplifier Module, Pt.2; Windows-Based EPROM Programmer, Pt.3; Fun With The PICAXE, Pt.1.

March 2003: LED Lighting For Your Car; Peltier-Effect Tinnie Cooler; PortaPal PA System, Pt.2; 12V SLA Battery Float Charger; Little Dynamite Subwoofer; Fun With The PICAXE, Pt.2 (Shop Door Minder).

April 2003: Video-Audio Booster For Home Theatre Systems; Telephone Dialler For Burglar Alarms; Three PIC Programmer Kits; PICAXE, Pt.3 (Heartbeat Simulator); Electric Shutter Release For Cameras.

May 2003: Widybox Guitar Distortion Effects Unit; 10MHz Direct Digital Synthesis Generator; Big Blaster Subwoofer; Printer Port Simulator; PICAXE, Pt.4 (Motor Controller).

June 2003: PICAXE, Pt.5; PICAXE-Controlled Telephone Intercom; PICAXE-08 Port Expansion; Sunset Switch For Security & Garden Lighting; Digital Reaction Timer; Adjustable DC-DC Converter For Cars; Long-Range 4-Channel UHF Remote Control.

July 2003: Smart Card Reader & Programmer; Power-Up Auto Mains Switch; A "Smart" Slave Flash Trigger; Programmable Continuity Tester; PICAXE Pt.6 – Data Communications; Updating The PIC Programmer & Checkerboard; RFID Tags – How They Work.

August 2003: PC Infrared Remote Receiver (Play DVDs & MP3s On Your PC Via Remote Control); Digital Instrument Display For Cars, Pt.1; Home-Brew Weatherproof 2.4GHz WiFi Antennas; PICAXE Pt.7.

September 2003: Robot Wars; Krypton Bike Light; PIC Programmer; Current Clamp Meter Adapter For DMMs; PICAXE Pt.8 – A Data Logger; Digital Instrument Display For Cars, Pt.2.

October 2003: PC Board Design, Pt.1; JV80 Loudspeaker System; A Dirt Cheap, High-Current Power Supply; Low-Cost 50MHz Frequency Meter; Long-Range 16-Channel Remote Control System.

November 2003: PC Board Design, Pt.2; 12AX7 Valve Audio Preamp; Our Best Ever LED Torch; Smart Radio Modem For Microcontrollers; PICAXE Pt.9; Programmable PIC-Powered Timer.

December 2003: PC Board Design, Pt.3; VHF Receiver For Weather Satellites; Linear Supply For Luxeon 1W Star LEDs; 5V Meter Calibration Standard; PIC-Based Car Battery Monitor; PICAXE Pt.10.

January 2004: Studio 350W Power Amplifier Module, Pt.1; High-Efficiency Power Supply For 1W Star LEDs; Antenna & RF Preamp For Weather Satellites; Lapel Microphone Adaptor For PA Systems; PICAXE-18X 4-Channel Datalogger, Pt.1; 2.4GHz Audio/Video Link.

February 2004: PC Board Design, Pt.1; Supply Rail Monitor For PCs; Studio 350W Power Amplifier Module, Pt.2; Shorted Turns Tester For Line Output Transformers; PICAXE-18X 4-Channel Datalogger, Pt.2.

March 2004: PC Board Design, Pt.2; Build The QuickBrake For Increased Driving Safety; 3V-9V (or more) DC-DC Converter; ESR Meter Mk.2, Pt.1; PICAXE-18X 4-Channel Datalogger, Pt.3.

April 2004: PC Board Design, Pt.3; Loudspeaker Level Meter For Home Theatre Systems; Dog Silencer; Mixture Display For Cars; ESR Meter Mk.2, Pt.2; PC/PICAXE Interface For UHF Remote Control.

May 2004: Amplifier Testing Without High-Tech Gear; Component Video To RGB Converter; Starpower Switching Supply For Luxeon Star LEDs; Wireless Parallel Port; Poor Man's Metal Locator.

June 2004: Dr Video Mk.2 Video Stabiliser; Build An RFID Security Module; Fridge-Door Alarm; Courtesy Light Delay For Cars; Automating PC Power-Up; Upgraded Software For The EPROM Programmer.

July 2004: Silencing A Noisy PC; Versatile Battery Protector; Appliance Energy Meter, Pt.1; A Poor Man's Q Meter; Regulated High-Voltage Supply For Valve Amplifiers; Remote Control For A Model Train Layout.

August 2004: Video Formats: Why Bother?; VAF's New DC-X Generation IV Loudspeakers; Video Enhancer & Y/C Separator; Balanced Microphone Preamp; Appliance Energy Meter, Pt.2; 3-State Logic Probe.

September 2004: Voice Over IP (VoIP) For Beginners; WiFry – Cooking Up 2.4GHz Antennas; Bed Wetting Alert; Build A Programmable Robot; Another CFL Inverter.

October 2004: The Humble "Trannie" Turns 50; SMS Controller, Pt.1; RGB To Component Video Converter; USB Power Injector; Remote Controller For Garage Doors & Gates.

November 2004: 42V Car Electrical Systems; USB-Controlled Power Switch (Errata Dec. 2004); Charger For Deep-Cycle 12V Batteries, Pt.1; Driveway Sentry; SMS Controller, Pt.2; PICAXE IR Remote Control.

December 2004: Build A Windmill Generator, Pt.1; 20W Amplifier Module; Charger For Deep-Cycle 12V Batteries, Pt.2; Solar-Powered Wireless Weather Station; Bidirectional Motor Speed Controller.

January 2005: Windmill Generator, Pt.2; Build A V8 Doorbell; IR Remote Control Checker; 4-Minute Shower Timer; The Prawnite; Sinom Says Game; VAF DC-7 Generation 4 Kit Speakers.

February 2005: Windmill Generator, Pt.3; USB-Controlled Electrocardiograph; TwinTenn Stereo Amplifier; Inductance & Q-Factor Meter, Pt.1; A Yagi Antenna For UHF CB; S2 Battery Charger.

March 2005: Windmill Generator, Pt.4; Sports Scoreboard, Pt.1; Swimming Pool Lap Counter; Inductance & Q-Factor Meter, Pt.2; Shielded Loop Antenna For UHF CB; Cheap UV EPROM Eraser; Sending Picaxe Data Over 477MHz UHF CB; S10 Lathe & Drill Press Tachometer.

April 2005: Install Your Own In-Car Video (Reversing Monitor); Build A MIDI Theremin, Pt.1; Bass Extender For Hi-Fi Systems; Sports Scoreboard, Pt.2; SMS Controller Add-Ons; A \$5 Variable Power Supply.

May 2005: Getting Into Wi-Fi, Pt.1; Build A 45-Second Voice Recorder; Wireless Microphone/Audio Link; MIDI Theremin, Pt.2; Sports Scoreboard, Pt.3; Automatic Stopwatch Timer.

June 2005: Wi-Fi, Pt.2; The Mesmeriser LED Clock; Coolmaster Fridge/Freezer Temperature Controller; Alternative Power Regular; PICAXE Colour Recognition System; AVR200 Single Board Computer, Pt.1.

July 2005: Wi-Fi, Pt.3; Remote-Controlled Automatic Lamp Dimmer; Lead-Acid Battery Zapper; Stepper Motor Controller; Salvaging & Using Thermostats; Unwired Modems & External Antennas.

August 2005: Mudlark A205 Valve Stereo Amplifier, Pt.1; Programmable Flexitimer; Carbon Monoxide Alert; Serial LCD Driver; Enhanced Sports Scoreboard; Salvaging Washing Machine Pressure Switches.

September 2005: Build Your Own Seismograph; Bilge Sniffer For Boats; VoIP Analog Phone Adaptor; Mudlark A205 Valve Stereo Amplifier, Pt.2; PICAXE In Schools, Pt.4.

October 2005: A Look At Google Earth; Dead Simple USB Breakout Box; Studio Series Stereo Preamp; Pt.1; Video Reading Aid For Vision Impaired People; Simple Alcohol Level Meter; Ceiling Fan Timer.

November 2005: Good Quality Car Sound On The Cheap; Pt.1; MicroBric – Robotics For Everyone; PICAXE In Schools, Pt.5; Studio Series Stereo Headphone Amplifier; Build A MIDI Drum Kit, Pt.1; Serial I/O Controller & Analog Sampler; Delta XL02 Tower Loudspeaker System.

December 2005: Good Quality Car Sound On The Cheap; Pt.2; Building The Ultimate Jukebox, Pt.1; Universal High-Energy Ignition System, Pt.1; Remote LED Annunciator For Queue Control; Build A MIDI Drum Kit, Pt.2; 433MHz Wireless Data Communication.

January 2006: Pocket TENS Unit For Pain Relief; "Little Jim" AM Radio Transmitter; Universal High-Energy Ignition System, Pt.2; Building The Ultimate Jukebox, Pt.2; MIDI Drum Kit, Pt.3; Picaxe-Based 433MHz Wireless Thermometer; A Human-Powered LED Torch.

February 2006: Electric-Powered Model Aircraft, Pt.1; PC-Controlled Burglar Alarm System, Pt.1; Build A Charger For iPods & MP3 Players; Picaxe-Powered Thermostat & Temperature Display; Build A MIDI Drum Kit, Pt.4; Building The Ultimate Jukebox, Pt.3.

March 2006: The Electronic Camera, Pt.1; PC-Controlled Burglar Alarm System, Pt.2; Low-Cost Intercooler Water Spray Controller; AVR ISP SocketBoard; Build A Low-Cost Large Display Anemometer.

April 2006: The Electronic Camera, Pt.2; Studio Series Remote Control Module (For A Stereo Preamp); 4-Channel Audio/Video Selector; Universal High-Energy LED Lighting System, Pt.1; Picaxe Goes Wireless, Pt.1 (Using the 2.4GHz Xbee Modules).

May 2006: Lead-Acid Battery Zapper & Condition Checker; Universal High-Energy LED Lighting System, Pt.2; Passive Direct Injection (DI) Box For Musicians; Remote Mains Relay Box; Vehicle Voltage Monitor; Picaxe Goes Wireless, Pt.2; Boost Your Xbee's Range Using Simple

Antennas; Improving The Sound Of Salvaged Loudspeaker Systems.

June 2006: Television – The Elusive Goal, Pt.1; Electric-Powered Model Aircraft, Pt.2; Pocket A/V Test Pattern Generator; Two-Way SPDIF-to-Toslink Digital Audio Converter; Build A 2.4GHz Wireless A/V Link; A High-Current Battery Charger For Almost Nothing.

July 2006: Television – The Elusive Goal, Pt.2; Mini Theremin Mk.2, Pt.1; Programmable Analog On-Off Controller; Studio Series Stereo Preamp; Pt.3; Stop Those Zaps From Double-Insulated Equipment.

August 2006: Video Projector Survey; Television – The Elusive Goal, Pt.3; Novel Picaxe-Based LED Chaser Clock; Build A Magnetic Cartridge Preamp; An Ultrasonic Eavesdropper; Multi-Throttle Control For PC Flight Simulators; Mini Theremin Mk.2, Pt.2.

September 2006: Thomas Alva Edison – Genius, Pt.1; Transferring Your LPs To CDs & MP3s; Turn an Old Xbox Into A \$200 Multimedia Player; Picaxe Net Server, Pt.1; Build The Galactic Voice; Aquarium Temperature Alarm; S-Video To Composite Video Converter.

October 2006: Thomas Alva Edison – Genius, Pt.2; LED Tachometer With Dual Displays, Pt.1; UHF Prescaler For Frequency Counters; Infrared Remote Control Extender; Picaxe Net Server, Pt.2; Easy-To-Build 12V Digital Timer Module; Build A Super Bicycle Light Alternator.

November 2006: Sony Alpha A100 Digital SLR Camera (Review); Build A Radar Speed Gun, Pt.1; Build Your Own Compact Bass Reflex Loudspeakers; Programmable Christmas Star; DC Relay Switch; LED Tachometer With Dual Displays, Pt.2; Picaxe Net Server, Pt.3.

December 2006: Bringing A Dead Cordless Drill Back To Life; Cordless Power Tool Charger Controller; Build A Radar Speed Gun, Pt.2; Heartbeat CPR Training Beeper; Super Speedo Corrector; 12/24V Auxiliary Battery Controller; Picaxe Net Server, Pt.3.

January 2007: Versatile Temperature Switch; Intelligent Car Air-Conditioning Controller; Remote Telltale For Garage Doors; Intelligent 12V Charger For SLA & Lead-Acid Batteries.

February 2007: Remote Volume Control & Preamp; Pt.1; Simple Variable Boost Control For Turbo Cars; Fuel Cut Defeater For The Boost Control; Low-Cost 50MHz Frequency Meter, Mk.2; Bike Computer To Digital Ammeter Conversion.

March 2007: Programmable Ignition System For Cars, Pt.1; Remote Volume Control & Preamp; Pt.2; GPS-Based Frequency Reference, Pt.1; Simple Ammeter & Voltmeter.

April 2007: The Proposed Ban On Incandescent Lamps; High-Power Reversible DC Motor Speed Controller; Build A Jacob's Ladder; GPS-Based Frequency Reference, Pt.2; Programmable Ignition System For Cars, Pt.2; Dual PICAXE Infrared Data Communication.

May 2007: 20W Class-A Amplifier Module, Pt.1; Adjustable 1.3-22V Regulated Power Supply; VU/Peak Meter With LCD Bargraphs; Programmable Ignition System For Cars, Pt.3; GPS-Based Frequency Reference Modifications; Throttle Interface For The DC Motor Speed Controller.

June 2007: 20W Class-A Amplifier Module, Pt.2; Knock Detector For The Programmable Ignition; Versatile 4-Input Mixer With Tone Controls; Fun With The New PICAXE 14-M; Frequency-Activated Switch For Cars; Simple Panel Meters Revisited.

July 2007: How To Cut Your Greenhouse Emissions, Pt.1; 6-Digit Nixie Clock, Pt.1; Tank Water Level Indicator; A PID Temperature Controller; 20W Class-A Stereo Amplifier, Pt.3; Making Panels For Projects.

August 2007: How To Cut Your Greenhouse Emissions, Pt.2; 20W Class-A Stereo Amplifier, Pt.4; Adaptive Turbo Timer; Subwoofer Controller; 6-Digit Nixie Clock, Pt.2.

September 2007: The Art Of Long-Distance WiFi; Fast Charger For NiMH & Nicad Batteries; Simple Data-Logging Weather Station, Pt.1; 20W Class-A Stereo Amplifier, Pt.5.

October 2007: DVD Players – How Good Are They For HiFi Audio?; Electronic Noughts & Crosses Game; PICProbe Logic Probe; Rolling Code Security System, Pt.1; Simple Data-Logging Weather Station, Pt.2; AM Loop Antenna & Amplifier.

November 2007: Your Own Home Recording Studio; PIC-Based Water Tank Level Meter, Pt.1; Playback Adaptor For CD-ROM Drives, Pt.1; Rolling Code Security System, Pt.2; Build A UV Light Box For Making PC Boards.

December 2007: Signature Series Kit Loudspeaker System; Infrared Audio Headphone Link For TV; An Enhanced 45-Second Voice Recorder Module; PIC-Based Water-Tank Level Meter, Pt.2; Playback Adaptor For CD-ROM Drives; Pt.2.

January 2008: Review – Denon DCD-700AE Compact Disk Player; PIC-Controlled Swimming Pool Alarm; Emergency 12V Lighting Controller; Build The "Aussie-3" Valve AM Radio; The Minispot 455kHz Modulated Oscillator; Water Tank Level Meter, Pt.3 – The Base Station; Improving The Water Tank Level Pressure Sensor.

February 2008: UHF Remote-Controlled Mains Switch; UHF Remote Mains Switch Transmitter; A PIR-Triggered Mains Switch; Shift Indicator & Rev Limiter For Cars; Mini Solar Battery Charger.

March 2008: How To Get Into Digital TV: The iC Bus – A Quick Primer; 12V-24V High-Current DC Motor Speed Controller, Pt.1; A Digital VFO with LCD Graphics Display; A Low-Cost PC-to-iC Interface For Debugging; One-Pulse-Per-Second Driver For Quartz Clocks.

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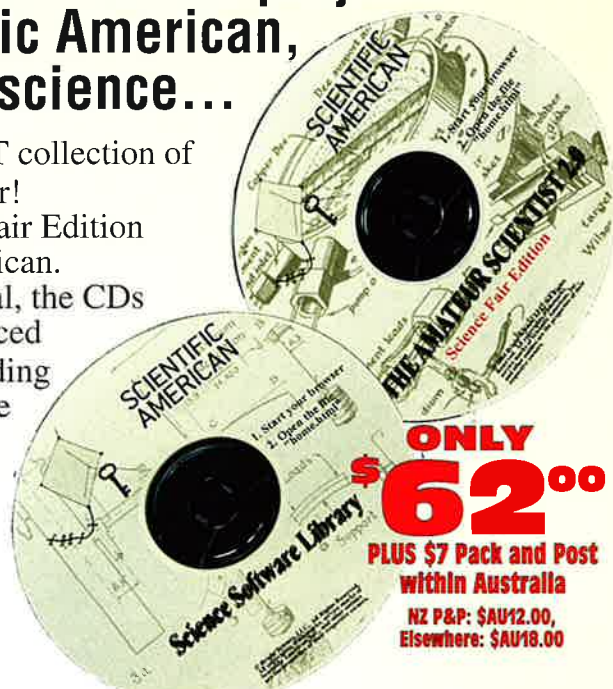
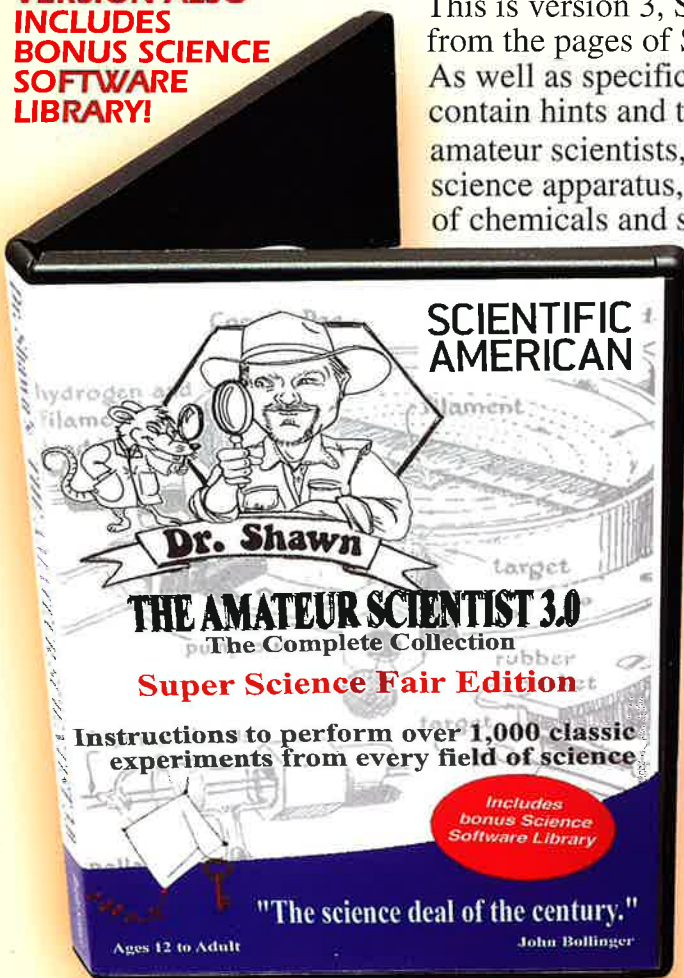
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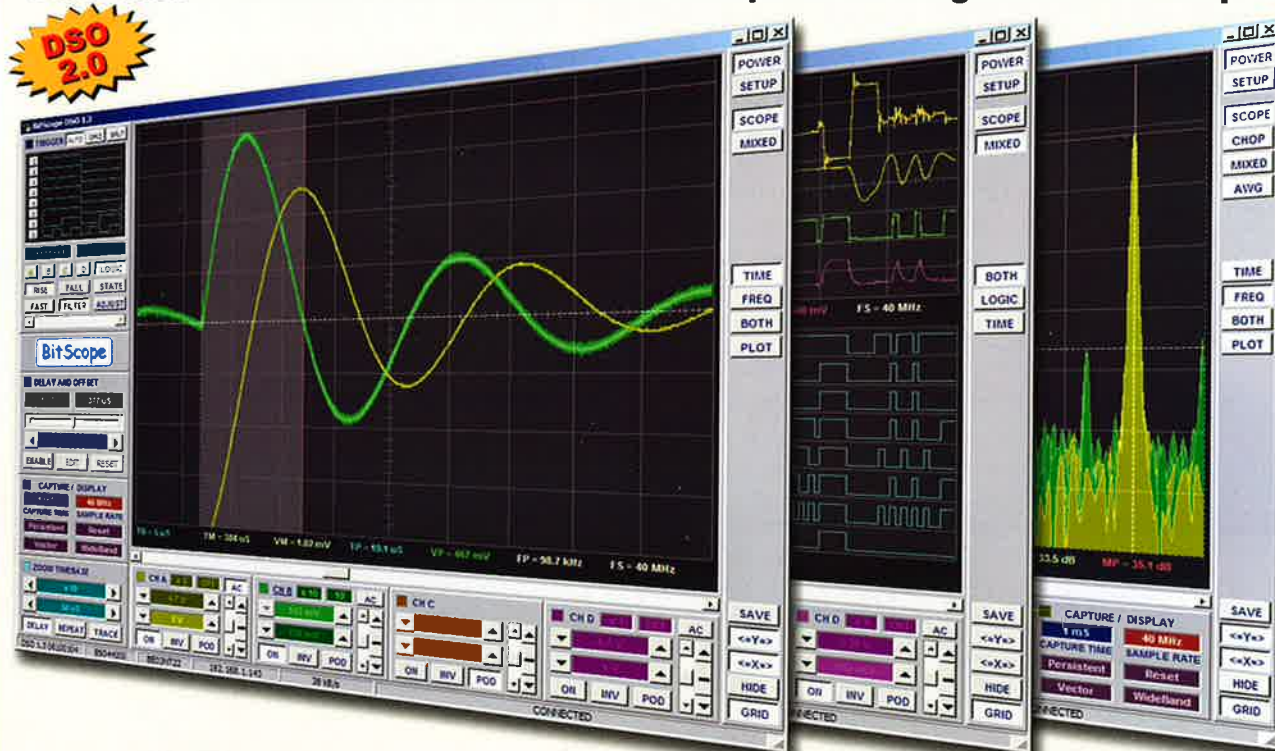
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