SILICON CHIP

ISSN 1030-2662 01
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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

Electrical energy will cost more in the future



So Australia has now ratified the Kyoto Protocol. This is a largely symbolic move but it is the start of many developments on the energy scene. The Federal Government has also promised to set up a carbon trading scheme by 2010 and following the Bali climate change conference, Australia will set greenhouse gas emissions targets, after a report by Professor Ross Garnaut. At this early stage, it looks as though the new Federal Government is taking a conservative approach but they could well turn around and set quite ambitious targets.

At the same time, the New South Wales government has just decided to sell its electricity generating assets to private enterprise and Queensland will probably follow within a few years.

All of these developments will inevitably mean that electricity and other forms of energy will be more expensive in the future. Regardless of how you view the prospect of rising energy prices, there will be some positive results. For a start, carbon emissions trading means all those carbon emissions will have a price. So private enterprise owners of power stations will look very carefully at their operations.

They are most unlikely to build any new coal-fired power stations; we at SILICON CHIP have been advocating this for years. They may well decide to shut down older less-efficient power stations too. In particular, Victoria's brown coal power stations could well get the chop and quite soon. Ultimately, all coal-fired power stations will be phased out although that will probably take 30 years or more.

All new thermal power stations will be gas-fired and are likely to be much more efficient, particularly if co-generation is used, ie, waste heat from the gas turbines is used to run steam-powered alternators. In the longer term, we may also have nuclear power stations. Interestingly, if most of the electricity generated in the future comes from gas-fired stations, that will probably mean the end of "off-peak" power rates as we now know them. This is because, unlike coal-fired power stations, gas-fired power stations can be brought on line quickly and so there is less need to provide "spinning reserve" – which is why we presently have such cheap "off-peak" rates.

With the likely end of "off-peak" rates and generally higher charges for electricity, there will probably be a major move into solar hot water for all homes and apartment blocks. And so it will go. You will be less likely to use electric radiators in the future. Instead, home heating will be by gas or reverse-cycle air conditioning. We will also insulate our homes much better in the future.

We will probably see a lot more wind farms and solar thermal power stations too. And what about geothermal energy? This shows enormous potential but at the moment, it is just that: potential. If we are going to get any geothermal energy within the next decade, the companies concerned will need to make huge investments. If they succeed, Australia's greenhouse gas emissions due to electricity generation could be greatly reduced.

That will leave transportation, industry, agriculture and mining as the big greenhouse gas emitters. And while much of Australia's industries may well be able to make big reductions in emissions in the future, obtaining major cuts for transportation, agriculture and mining is likely to be far more difficult. Electric cars are bound to become commonplace (in spite of the doubters!) but even widespread use will not make a great difference to the total emissions from the whole of transportation.

All up, we regard theses developments as positive. There will be enormous investment in energy resources and power generation and at the same time, we will inevitably become more conservation minded – that can only be good.

Leo Simpson

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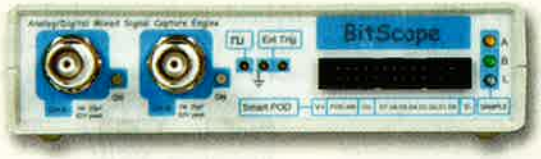


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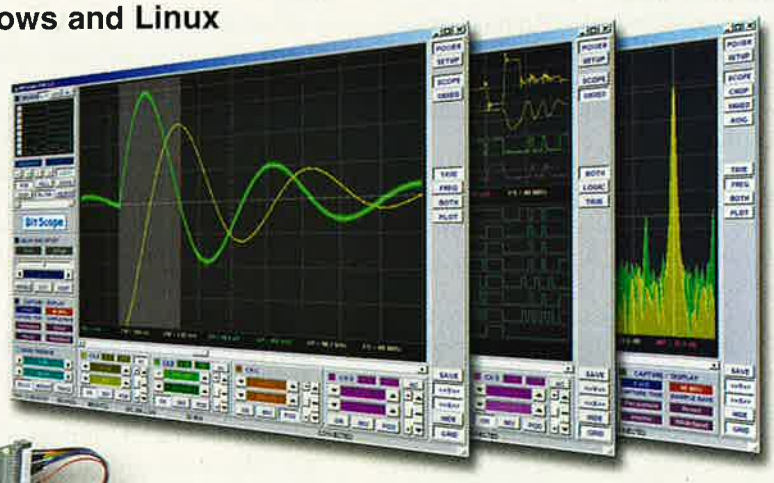
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Electric cars are not viable (1)

To comment on the Publisher's Letter in the December 2007 issue, an electric car will only do short-range commuting. If you own an electric car you have to own another car that'll do all the other things. And pay another lot of registration and insurance and depreciation.

It's simpler and a lot cheaper to do a dual-fuel conversion on the car you've got. LPG has long range and is becoming readily available everywhere. Natural gas only has short range and isn't available generally but is delivered to most homes at cents per petrol-litre-equivalent and all it takes is a compressor at home to refill your car each night.

In a country where only a limited amount of electric power comes from anything but coal and natural gas, it's just as climate-friendly to buy a cheap second-hand car and convert it to natural gas and just use it around town than to convert it to electric power and have to cart around heavy expensive batteries and replace them every few years.

Gordon Drennan,
Burton, SA.

Electric cars are not viable (2)

Straight electric cars for most Australian people are just fairy floss! The standard petrol engine does not just generate power for motion but also generates power for air-conditioning and electric power for all manner of devices such as ABS (and other computing/servo systems), wipers, pumps, fans, stereo systems and lighting. Headlights alone can consume many tens of amps of current!

Hybrids of some sort may be a viable alternative for city travel but come on, let's get serious; a family trip between Sydney and Brisbane in an all-electric car is just a pipe dream with current technology.

I am not sure about the efficiency of using electricity to create motive power and any assessment should include losses from generating power at the power stations and transmission right through to efficiency of the electric motors and any regenerative braking, etc. A comparison with petrol, diesel and hybrid vehicles would be interesting but would also have to include complete end-of-life and recycling comparisons for equivalent mileage/time.

A similar study by a consortium of US manufacturers found that a diesel 4WD is both environmentally and economically less damaging than hybrids, mainly because the average 4WD stays registered for approximately 20 years and travels around 700,000km which is an equivalent lifespan to about 3.5 hybrids!

If you really want to feel good about the environment, then instead of spending $50,000 on a fancy new hybrid status symbol, buy a small diesel instead and donate the difference to your nearest university doing research into solar cells.

Prof. Jon Jenkins,
Bogangar, NSW.

Comment: we believe that electric cars will be viable. They may not ever be capable of making a non-stop journey from Sydney to Brisbane but a good many petrol vehicles cannot do the trip on a single tank either.

Electric cars are here now

I enjoyed Peter Seligman's articles on reducing greenhouse emissions. There were, however, a couple of points I feel were not up-to-date in the third article.

The first point is regarding the range, convenience and performance of electric cars, compared to conventional cars, being way off in the future. This is clearly not true. One prominent example is the Tesla Roadster which can be seen at **http://www.teslamotors.com/**

The roadster has acceleration from zero to 100km/h in less than four seconds and a top speed of over 200km/h. It has a range of 390km per charge and is able to put more than 80% of the energy it consumes to use in moving the car down the road.

At a cost of $US98,000 it is not cheap. But although not within the price range of an everyday car, the point is that the technology has come a long way in recent years. Obviously with mass production, the cost would be far lower.

Other examples of DIY electric cars which beat petrol cars in both performance and economy can be seen at:
http://www.evconvert.com/eve/electric-car-motors and **http://www.evconvert.com**

Most consist of converted petrol cars. There are quite a large number of people in the USA doing this.

Greg Macmillan,
Christmas Hills, Vic.

Not enough lithium for electric cars

I like the idea of electric cars, however there is a fundamental problem that you did not mention in your Publisher's Letter. There are simply not enough metals such as lithium for a world-scale roll-out of electric cars.

There have been a number of studies on this, including I think, one by the University of WA. If it was possible to make rechargeable batteries as good as lithium from more common metals, such as zinc, then this may be feasible but this seems to be a long way off.

DVD players need the digital connection

I am an audio design engineer specialising in low noise electrophysiology amplifiers used to monitor picoamp currents in human cells, so I am aware of hum and RF emission problems.

I was amazed at the poor hum and RF radiation you saw in Tevion DVD players, so I decided to check my own $50 Onix brand. I purchased this about a year ago because my "high quality" Philips player would not play home-recorded DVD or MP3 disks.

I have the Onix optically connected to a Yamaha RXV640 6.1 channel amplifier with Jamo speakers and subwoofer so if hum was a problem I would easily detect it. Optical connection is great as ground loops are eliminated.

With an MP3 disk inserted into the player and paused, I turned the volume up to maximum. I could not hear any hum out of the speakers or sub woofer. A small amount of hiss could be heard but was considered acceptable.

A radio in close vicinity to either amplifier or DVD player revealed minimal interference on AM or FM. I then turned on my LG 50-inch Plasma TV and all hell broke loose with RF emissions from the TV. It was really bad on AM but reasonable on FM. I had to move the radio about 10 metres away from the TV before noise in the radio was acceptable. Personally I would have considered this level of radiation excessive.

I cannot find any reference to CE compliance on the LG's rear panel or in the manual but I assume it has a CE compliance certificate so RF radiation is within spec.

I also made some measurements on my system to compare optical digital and analog outputs on DVD using the headphone to monitor signals with a scope. I connected the analog audio to the CD input of the amplifier and the digital input to the DVD input, so it was easy to switch between the two sources.

The volume control was advanced so that the playing peaks of typical music were just clipped (18V p-p). I then put the DVD into pause and measured the noise from both sources. The difference was staggering!

For the digital link, the scope measured 3mV p-p of noise. I could not see any hum in the plot. Listening to the noise revealed only a quiet background hiss. For the analog input, the noise was four times higher than the optical noise at 12mV p-p and had some mains harmonics. There also appears to be a high 250Hz component.

Listening to the analog sound was definitely noisier. I could not hear any fundamental 50Hz hum but the 250Hz component can definitely be heard.

I think this is a graphic demonstration for using digital against analog signals. The DVD also has a coax digital output but I did not try that. I suspect it will be OK.

I am surprised that the Tevion was radiating so much RF as all equipment sold in Australia should have a CE compliance certificate which restricts RF radiation to low levels. Maybe you should try optical connection to remove hum and possibly ground the case of the DVD to remove any RF.

Peter Kay,
Dromana, Vic.

Comment: optical is certainly the way to go if your amplifier has the right connection.

On another subject, your advice to T.U. on potting compound (December 2007, page 107) is possibly one of the worst pieces of advice you have ever given. Given the sticky viscous nature of neutral-cure sealant it would be very difficult to get a good result.

Specialist fibreglass shops have available a wide range of potting compounds, including silicone ones, and should be able to advise T.U. on the most suitable one for his particular application.

Graham Shepherd,
via email.

Comment: thanks for the comment about potting compound. However, your remarks about lithium and rechargeable batteries are wrong. We expect electric cars to become com-

Atmel's AVR, from JED in Australia

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



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

See JED's www site for a datasheet.

AVR573 Single Board Computer



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

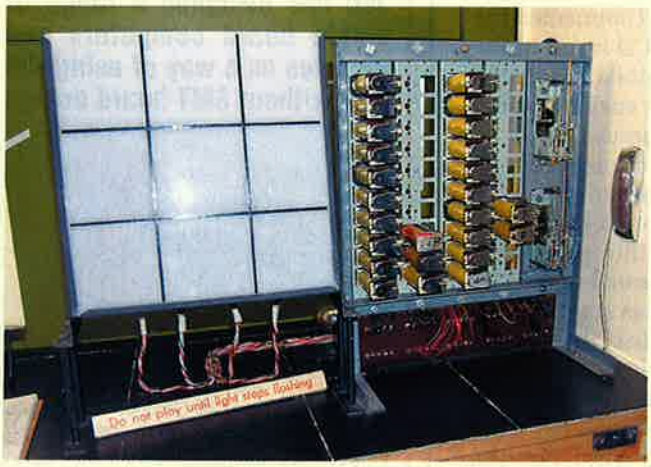
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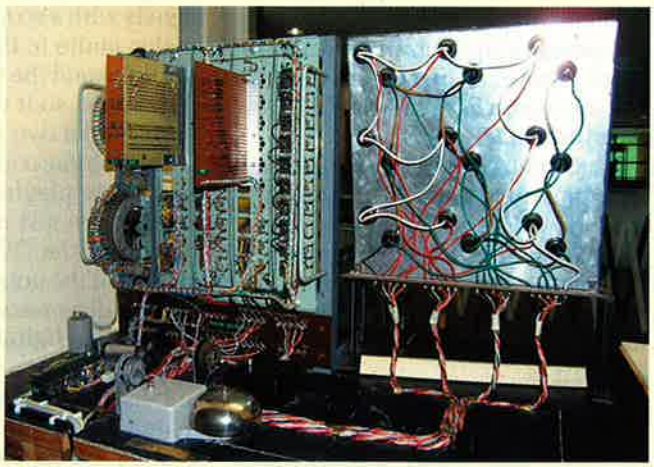
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Oscar déjà vu

It was with some particular interest and a feeling of déjà vu that I read your article on the Noughts & Crosses machine project in the October issue of the magazine. Some years ago I was involved with the restoration of a similar machine in Melbourne.

I am a member of the Victorian Telecommunications Museum and in the process of becoming established, we formed a rapport with Museum Victoria. Since many of our members are former Telstra/Telecom/PMG technicians, it was suggested that we might be able to assist the museum with the restoration of some of their old displays. Significant in the list was their Noughts & Crosses machine.

This machine had been built in the early 1960s for the then Museum of Applied Sciences by a Mr Roy Hartkopf, an engineer in the then PMG's Department. Many Melbournians would have remembered pitting their wits against the machine in the Science Museum until it fell into disrepair in the 1980s. It then went into storage until the prospect of its restoration was raised.

An inspection revealed that it was based on uniselectors and relays, as used in the older telephone exchanges that I had cut my teeth on. Its condition was not too good. However, with such a significant heritage, it was a challenge too good to miss and in due course it was delivered to the workshop of our museum in Hawthorn.

Countless hours were put into replacing uniselector banks, relay contacts and wiring, re-adjusting relays and generally upgrading the electrical safety and operation of the machine. Paramount in the criteria of the undertaking was that the original appearance of the machine had to be retained, both externally and the mechanics as visible through its glass front panel.

After 11 months and about 300 hours work, the machine was ready to go again. In late 2003 it was placed into service in its own little alcove at Scienceworks Museum in Spotswood. Since that time, it has played over 100,000 games and is still going strong.

Its logical sequence of operation is similar to the one that Brian Healy built back in the 1960s, except that this one does allow the player to win – occasionally.

Bob Muir, Vice President,
Victorian Telecommunications Museum.

monplace, whatever type of rechargeable battery becomes the norm.

Sputnik lasted six months

With reference to the letter by Graham Harvey in the November 2007 issue, regarding the 50th anniversary of Sputnik I, the satellite actually spent six months in orbit, not three weeks. Because the batteries which powered the on-board radio transmitter were not recharged by solar cells (as they would be now), the batteries went flat after 22 days.

Taking just 96 minutes to circle the earth, Sputnik I travelled some 60 million kilometres before burning up in the atmosphere upon re-entry. The only artefact which remains from that project is a tab which was pulled out of a receptacle on Sputnik just prior to launch, to power up the radio transmitter.

Peter van Schaik,
Tenterfield, NSW.

Low-tech water tank level meter

I have followed your articles on water tank level devices with great interest. My own system uses a weighted marine float, two pulleys, a length of fishing line and a 100g fishing sinker. Total cost: about $10.00.

Wow! No electronics and a carbon-neutral footprint.

Peter Lord,
Camberwell, Vic.

Comment: Ah, but can you read the tank level from inside your house?

Caustic soda is available in supermarkets

I was reading your article on the UV Light Box (SILICON CHIP, November

Current limiting desirable for Oscar

When I saw the "Oscar" project in the October 2007 issue, my first reaction was "Oh no, too late!" as I had intended to develop a PIC-based noughts and crosses project for submission to SILICON CHIP, quite soon. Oh well, these things happen!

But when I looked at the design, I wondered, "where are the current limiting resistors?" Clearly, the approach taken in the Oscar design, of connecting LEDs directly across the PIC's pins, does work. You can get away with it but it's not recommended.

What's happening is that at least 4.5V is being applied directly across each lit LED. That would normally fry most LEDs but the current is being limited by the output drivers on the PIC's pins. That would be OK if the outputs were designed to be current limited but they are not.

According to the PIC16F84 data sheet, under "Absolute Maximum Ratings", each pin is rated to source up to 20mA (with further restrictions on port totals), with the following warning:

"Notice: stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability".

In other words, using the device this way – relying on the output drivers to limit current to a maximum – is "at your own risk". Adding a 100Ω resistor in series with each output pin would be a lot kinder to the poor old PIC.

David Meiklejohn,
Macquarie Fields, NSW.

Comment: you are correct – the maximum current sourced by an output pin should be 20mA and the LEDs are not current limited by a resistor.

Looking at the specifications of current versus output, at 20mA a high output is typically 3.25V and a low output is 0.7V when running from a 5V supply. So the available voltage for the LED when driven by a high output for the anode and a low output for the cathode is 3.25V - 0.7V, or 2.55V.

We measured a red/green LED at 20mA and found that the forward voltage for the green LED was 2.25V and 2.2V for the red. So the current is therefore more likely to be about 22mA instead of 20mA.

Probably the PIC will survive this extra current. However as you say, 100Ω limiting resistors at pin 1 and pin 18 would be better.

2007) where it says you can use sodium hydroxide for etching positive-resist PC boards. That is correct. I think I used one heaped teaspoon per litre of water last time I tried. Warming it up to 25-35°C will make it work faster.

The best part is it can be bought from just about any supermarket, in the washing powder section, for around $2 a 500g tub.

Michael Jeffery,
Eurobin, Vic.

Where to obtain caustic soda

I read with interest the article on the UV Light Box in the November 2007 issue of SILICON CHIP. It is nice to see a down-to-earth article such as this that explains "all" of the process.

Having produced PC boards commercially for many years, a couple of points may be of interest. First, the author says he is unable to find sodium hydroxide in Tasmania – it is readily available in most supermarkets around Australia, as drain cleaner. There are several in dry/powder form and they are 99.9% NaOH. Usually, one teaspoon to a litre of water is sufficient to strip PC boards, so to develop them would require somewhat less.

Another developer is potassium carbonate, commonly used to dry fruit. That may be a bit harder to find but I think most chemical supply companies should be able to get it.

For printing the transparency, there

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Mailbag: continued

is a product specifically for this purpose, used in the printing industry. It is an Agfa product called "Laserlink", available from graphics supply companies. It is translucent, dimensionally stable and specifically for use in laser printers.

As for coated board material, there is another option. With pre-coated board, if you make a mistake in the exposure and/or developing stage or find a design error at the developing stage, the board is then useless. With the product below, if you make a mistake (found before etching the board), you simply strip and recoat the board and start again (no wasted board material).

Again, used in the printing industry, is a UV-imageable ink, Taiyo PER20, easily applied by the hobbyist with just a rubber roller found in art shops. It does require baking at 90°C to dry it but that is easily accomplished with an old electric frying pan.

It is expensive at around $100 a litre but get a few friends together and share it; one litre will go a very long way – many tens of square meters if applied thinly (as recommended).

Terry Mowles, Force Electronics, Holden Hill, SA.

How to dispose of used etchant

I would like to make a couple of notes on the article entitled "A UV Light Box For Making PC Boards" in the November 2007 issue.

First, the etching needs to be done in a well-ventilated area or in a fume cupboard for safety reasons. Second, given relevant State requirements, in sufficiently dilute concentrations the used etchant may be poured down the sink. However, the outlet pipes must not be made of copper.

Unfortunately, one educational institution learnt that too late. Otherwise there are organisations that collect dangerous chemicals for disposal.

Joe Zanatta, Werribee, Vic.

Good results with PC board transparencies

I have been using Kinsten PC boards for some years now, with great results. Up until recently, the transparencies were laser-copied by one of the commercial copy shops. The last couple of prints were less than fully opaque and it was necessary to double up a pair of copies to obtain full opacity.

In desperation, I tried using some inkjet transparencies I had on hand. These had formerly yielded similar semi-transparent prints. Finally I ran the print through the printer (HP 2355) four times. The registration was perfect and opacity almost 100%. The resulting PC board finished spot on.

The image was originally scanned from a SILICON CHIP speaker protector design and cleaned up using Adobe Photo Deluxe.

Robert Field, Croydon Vic.

Window glass is not desirable for UV transmission

With reference to the Light Box article in the November 2007 issue, many years ago when I built my first light box it was pointed out to me that ordinary window glass is poor at transmitting UV light and that quartz glass should be used.

To quote from Wikipedia: "ordinary glass is partially transparent to UVA but is opaque to shorter wavelengths while silica or quartz glass, depending on quality, can be transparent even to vacuum UV wavelengths. Ordinary window glass passes about 90% of the light above 350nm but blocks over 90% of the light below 300nm".

Because the operating lifetime of the UV tubes is very short (less than one year for normal UV output), it could be cost-effective to replace the normal window glass mentioned in the project with UV-transmissive glass, thereby reducing the exposure times by a significant amount and thus extending the useful life of the tubes.

Tony King, Lilydale, Vic.

Comment: your remarks about window glass are correct and are in fact, covered in the article. Since actinic tubes radiate mainly at around 965nm, we don't see a real problem as far as transmission losses are concerned, particularly as the tube operating times are quite short. SC





Review by LEO SIMPSON

Denon DCD-700AE compact disk player

Now that DVD players are being made in the squillions and are very cheap, there are few hifi manufacturers actually making CD players. Denon is one of the few makers and their products are highly prized. The Denon DCD-700AE CD player is a high quality machine which provides the bonus of pitch control and being able to play MP3 disks.

OUR FEATURE STORY on the hum problems introduced into hifi systems by DVD players with switch-mode supplies and double-insulation (SILICON CHIP, October 2007) prompted the question: are CD players likely to produce the same signal-to-noise degradation in high-fidelity amplifiers? After all, what is the point in paying top dollar for premium hifi components which you expect to be utterly quiet, only to have them produce low level hum and buzz?

The answer is that, unless the CD player in question has a conventional transformer driven supply, the hum and buzz problems will be exactly the same as for DVD players.

There are two ways around this problem. The first is to use the digital optical output of your DVD or CD player in conjunction with the optical decoder in your home theatre receiver. If you take that approach, you would want to be sure that the digital decoder in your home-theatre receiver is at least as good as the decoder in the player. If not, the sound quality will not be as good as it potentially should be. In our experience, unless the home-theatre receiver is a top-end unit, with a price to match, its decoder and general performance are likely to be fairly ordinary.

The second approach is to purchase a high-quality CD player with a conventional linear power supplier, such as this Denon CD player. Which is how we came to be reviewing this particular machine.

Considering how compact most DVD players are, this Denon player is a fairly bulky machine, with dimensions of 434mm wide, 107mm high and 279mm deep, including rubber feet and front and rear projecting parts. It is also fairly heavy at 4.2kg, no doubt partly due to the internal mains transformer and partly due to the fact that the case is strongly built and has an extruded aluminium front panel. This is a refreshing change from the often flimsy construction of cheaper DVD players.

The styling of the DCD-700AE is relatively simple and austere, in keeping with other audio products in the Denon range. The front panel is finished in brushed aluminium and is dominated by the dark plastic display window and the disk drawer. On the lefthand side are the pushbutton Power switch, 6.5mm headphone

socket and the associated volume control. On the righthand side is an array of nine pushbuttons which control the Play functions.

Pitch control

Two small buttons are provided for pitch control, giving a range of ±12% in steps of 0.1%.

Just as an aside, pitch control is very useful if you are a musician or a keen dancer. If you are musician, you may want to adjust the pitch of the music on the disk to match the instrument you are playing or to make it easier to use as an accompaniment to singing.

If you are dancer, you may want to adjust the timing of the music (ie, beats per minute) to suit the dance, eg, Viennese waltz, quickstep, samba, etc. By the way, the pitch control on the Denon does not alter pitch independently of timing – the two are inversely locked together so that if you increase the pitch, the timing of the music will be proportionally reduced.

Either way, pitch control can be very useful and is seldom found on CD players. By the way, if you are using pitch control, you cannot use the optical digital output. By definition, the pitch control is a function of the digital decoder and Denon have decided that if you are using the pitch control, you need the internal decoder and therefore no digital data will be delivered via the optical link.

Remote control

As is the case with DVD players, virtually all playback functions are accessed via the infrared remote control. The Denon's control is quite a long slimline unit with the buttons laid out in a logical array. Surprisingly though, it does not provide remote control of volume, which may be a drawback if your amplifier does not have remote control of volume.

In other respects, the remote control is fine although it will not let you directly access tracks above 19. So if you have a 30-track disk (say) and you want to directly access track 25, you can go direct to track 19 and then repeatedly hit the "next track" button.

Inside the chassis is also quite different from typical DVD players which often apparently have very little in the way of circuitry. Usually DVD players just have a small multi-layer main PC board which is densely packed with surface-mount devices (SMDs), together with another board which provides the switchmode power supply.

In the case of the Denon, the main board is also a multi-layer board with lots of SMDs and there is an equally large single-sided PC board which appears to carry the audio output filtering and the digital optical output. An even larger single-sided PC board is devoted to the power supply which is fully linear. It uses a conventional laminated steel power transformer – not a switchmode component in sight. Denon have evidently made the judgment that if you want a CD player that is utterly quiet, then the way to do it is to use a conventional linear power supply.

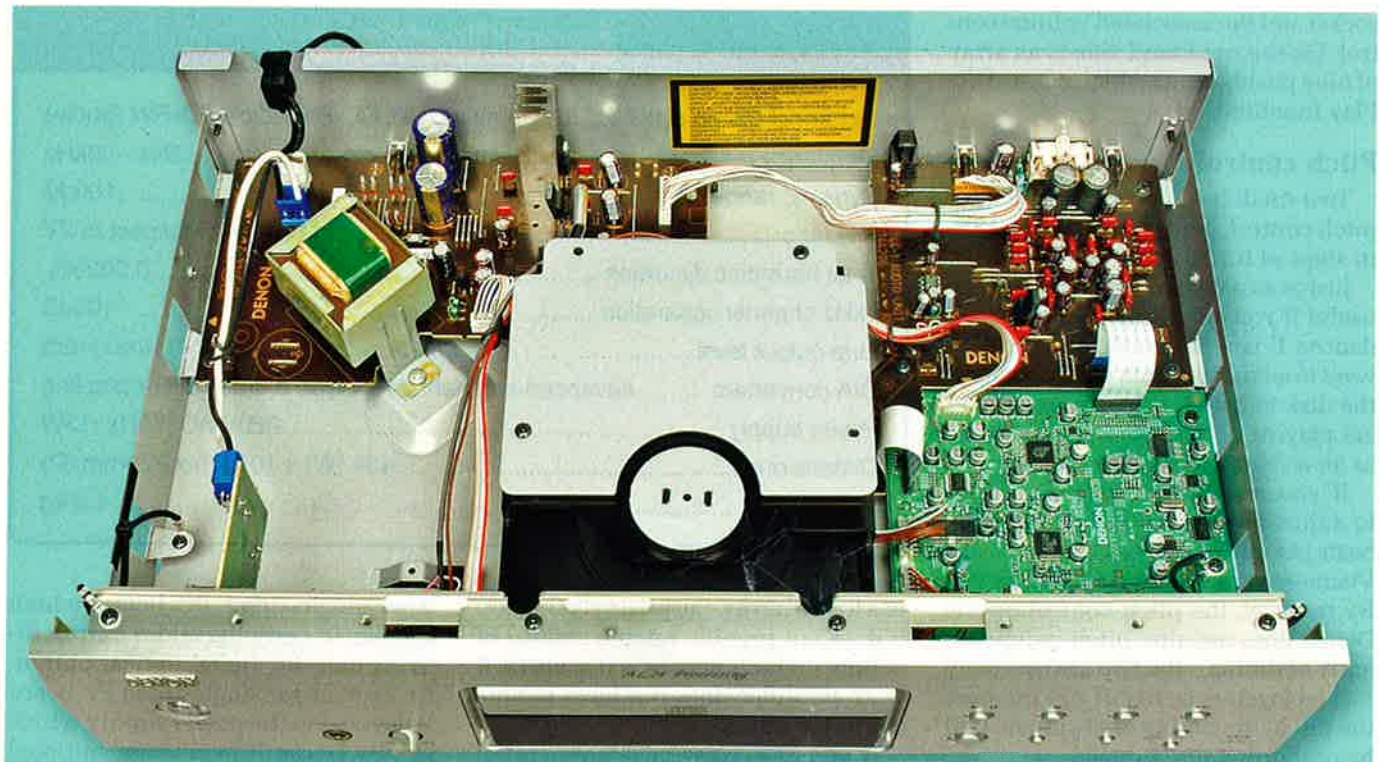
Denon have also evidently gone to some trouble with the orientation and mounting of the mains transformer, to ensure minimum hum induction. To further ensure a minimum of any digital artefacts, most of the control microprocessor's functions are shut down during playback and the display itself can also be turned off.

Another feature of the Denon DCD-700AE is its use of 24-bit processing

Specifications

2-channel stereo disks	music CD, CD-R (audio), CD-RW (audio)
Frequency response	2Hz - 20kHz
Dynamic range	100dB
S/N ratio	-110dB with respect to 2V
Total harmonic distortion	0.0025%,
1kHz channel separation	-105dB
Line output level	2V (10kΩ load)
D/A converters	advanced-segment 24-bit type 8-times over-sampling
Power supply	230V AC, 50Hz, 13W
Dimensions	434 (W) x 107 (H) x 279mm (D)
Weight	4.2 kg





The Denon DCD-700AE CD player is well made and uses a conventional linear power supply. The PC board at rear right carries the audio output filter which completely eliminates sampling artefacts.

and 8-times over-sampling. Denon is rather vague about what this means apart from stating that it delivers superior quality in the DCD-700AE's audio playback performance. Hmm. Yep, that would be right.

The player transport is centrally mounted and is a fast and quiet unit. It appears to be reasonably immune to external shock, as when you might inadvertently bump the case while it is playing.

Using it

When you start using the Denon, you rapidly become aware of the differences between it and typical DVD players. For a start, it does not wait for what seems like an interminable period before it determines that you have, in fact, loaded an audio disk and then take a further time to display the tracks. With the Denon, you put the disk in the drawer, load it and almost immediately it displays the number of tracks and the total duration. Press play and it does so immediately – no dithering about! And when you select another track, it goes to it almost immediately, within less than a second. Nor is there is any suggestion of high frequency "frizzle" or any other extraneous noises that are sometimes evident with the cheaper DVD players.

All of which is as it should be, of course, but it bears stating because by comparison, DVD players are often so hopeless at playing compact disks.

As noted above, the Denon deck will also play disks recorded in MP3 or WMA format and it has comprehensive features to display track titles, folders and so on. That is a convenient feature but we think that anyone who is truly committed to sound quality will not be doing most of their listening to MP3 or WMA files, whether they are recorded at the maximum sampling rate or not.

Performance

As with most CD and DVD players, the specified performance levels are fairly brief and it is not really possible to judge potential sound quality by reference to them. For example, the Denon lists frequency response as being between 2Hz and 20kHz but with no decibel limits. Ideally, it should be within ±0.3dB or better. After all, such performance limits were being routinely achieved with CD players being produced 20 years ago.

Similarly, total harmonic distortion is quoted at .0025% at 1kHz which again is not very demanding. How about distortion at 10kHz and at low levels, at say -40dB below the maximum (ie, at a level of 20mV instead

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of 2V)? This is never stated but really, if the manufacturer wanted to give a real indication of quality, that is what they would do. They would also give an indication of the efficacy of error correction which would tell you how good the player was at coping with badly scratched disks.

OK, so we put the player through a battery of tests, starting with test disks by Philips and Technics.

Test results

Frequency response was the first parameter to be tested and we achieved a response from 20Hz to 20kHz within +0.04dB and -0.02dB or you could just state it as flat within ±0.03dB. Just read that again: ±.03dB! This is truly "ruler-straight". So why is Denon so coy about its frequency response?

Separation between channels came in at -106dB between 100Hz and 10kHz, compared with the claimed figure of -105dB at 1kHz. At 20kHz, separation was -103dB.

Signal-to-noise ratio also came in at -106dB with respect to 2V and with a noise bandwidth from 10Hz to 22kHz.

These figures are not just very good; they are truly excellent because what they don't indicate is what we didn't measure. Er, what? In the past, whenever we have measured a CD player, we have always had to go to special lengths to remove the over-sampling artefacts at 44kHz, 88kHz (2-times oversampling), 352.8kHz (8-times over-sampling) or whatever. In fact, that is the sole reason we have a "brick-wall" passive 20Hz to 20kHz filter to match our Audio Precision test gear – to remove the digital sampling artefacts! But the Denon DCD-700AE has no measurable artefacts or any digital noise whatsoever, regardless of the noise bandwidth used to make the measurement. The only noise is very low-level hiss.

And while the player can have its display turned off, to remove any noise due to that source, we measured the same result whether the display was on or off.

Linearity tests always separate the ordinary CD players from the good ones and here the Denon excelled. The test involves reducing a 1kHz sine-wave by precise 10dB steps (from a test disk) and reading off the results. This is a measurement of the linearity of the Digital-to-Analog converter. Most players are OK down to -70B but below that they are in trouble. At -80dB, the Denon was -80.2dB. At -90dB (as far down as we can go), the result was -90.11dB. Excellent.

Finally, we did a range of harmonic distortion tests, starting at the maximum level of 2V (or 1.95V in the case of the Denon). Over the frequency range up to 5kHz, we got readings of .008%, increasing to .029% at 20kHz. This is very good.

Then we went further and took more measurements at reduced levels, including the suggested test above at -40dB. Under these conditions you always expect increased distortion because the overall signal range for the sampling process is much reduced. Even so, the Denon came in with good performance, giving a measurement of 0.13% at 1kHz and -40dB (2mV) level. We could go on but you should have the overall picture by now: this is the best CD player we have ever measured, although to be frank it is quite a few years since we last put a good quality CD player through its paces.

Suffice to say, Denon could trumpet their very good performance figures but for reasons known only to themselves, they don't.

Ultimately, sound quality is every bit as good as you would expect. Interestingly, I think that this player has more definition of low level bass signals than I have heard with my existing CD players. That could be a direct result of the very good low level linearity of this player.

The Denon DCD-700AE CD player is also utterly quiet and does not inject any hum and buzz into the companion amplifier. So if you have the very best amplifier in your system, you can expect the Denon not to add any noise apart from a teeny amount of hiss which you might hear if you put your ear right up to the tweeter.

Finally, as you might expect with a product from a specialised audio manufacturer, the Denon DCD-700AE is not cheap and is certainly vastly more expensive than run-of-the-mill DVD players which are made in huge quantities. On the other hand, used in a high-quality system, it will sound a lot better.

The DCD-700AE is priced at $699 including GST. For further information on Denon products and availability, contact 1300 134 400 04 or log on to **www.audioproducts.com.au** SC

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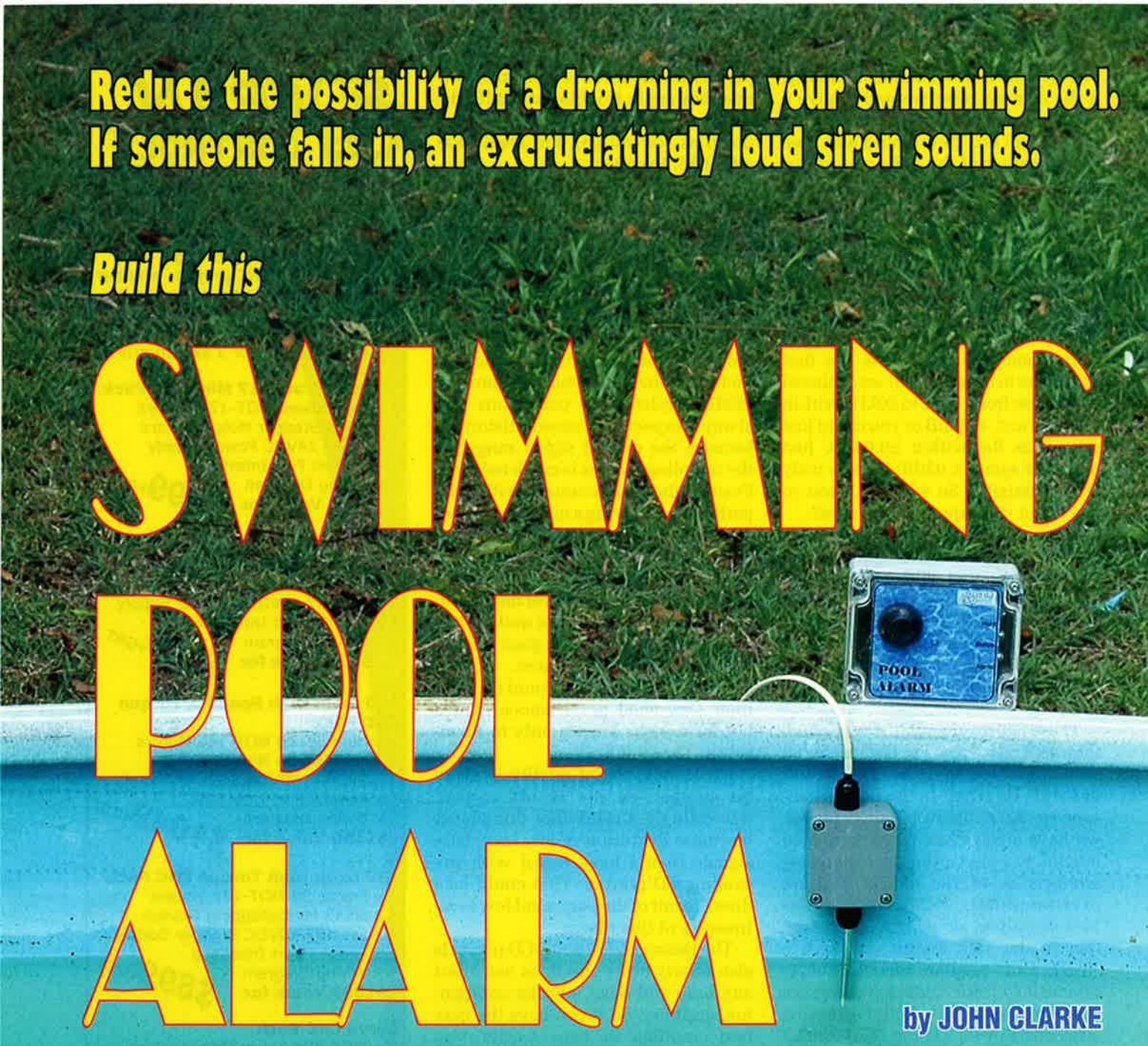


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Reduce the possibility of a drowning in your swimming pool. If someone falls in, an excruciatingly loud siren sounds.

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SWIMMING POOL ALARM



by JOHN CLARKE

SWIMMING POOLS are dangerous places, especially for toddlers – as the table above right chillingly shows. And the pool in your own back yard is certainly not exempt; in fact, statistics show that's where more than half of all toddler drownings occur.

Even while taking the photographs for this article, with mother millimetres out of shot and grandfather (Ross) in front taking the picture, 14-month-old Keira (who cannot swim) needed no prompting to attempt to get in the pool – not once but again and again.

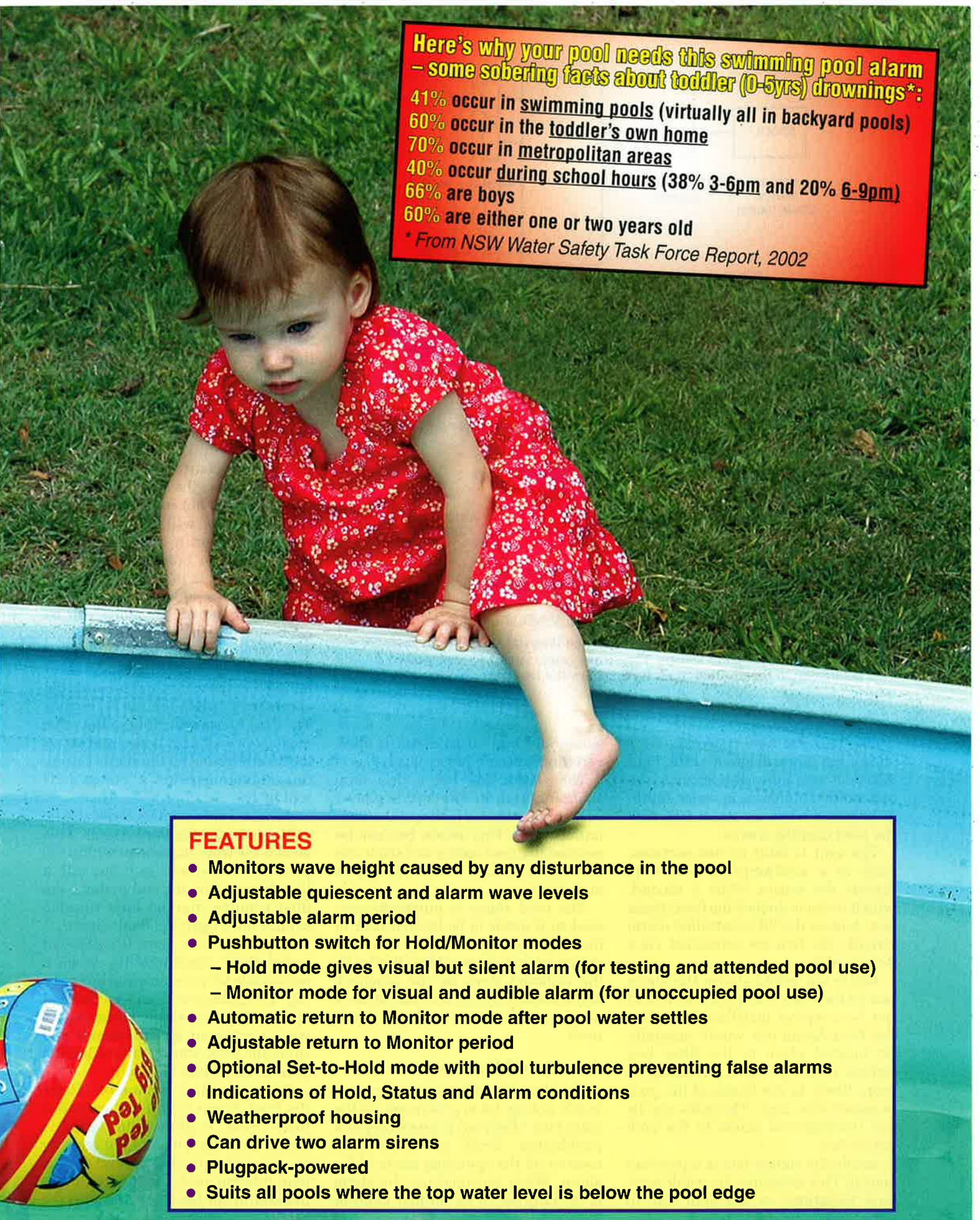
While swimming pools these days must be fenced off, there is always the possibility that a toddler will find a way in. That can be as simple as a gate not latching properly or a determined youngster climbing the fence.

So while fences may appear to make a pool secure, they are never foolproof. A secondary defence, one that warns if someone falls into the pool, can literally be the difference between life and death.

A way to add secondary safety is with a pool alarm. The type of pool alarm described here monitors the amount of pool water movement and sounds an alarm when this exceeds a preset level.

Of course, wind can also create movement in the pool water – after all, that's what makes waves in the ocean. The last thing you want is false alarms – remember the boy who cried "Wolf!"?

The SILICON CHIP Pool Alarm can be set to a level which ignores typical wind movement but screams its head off when that level is exceeded – ie, someone falls in.



Here's why your pool needs this swimming pool alarm – some sobering facts about toddler (0-5yrs) drownings*:

41% occur in swimming pools (virtually all in backyard pools)
60% occur in the toddler's own home
70% occur in metropolitan areas
40% occur during school hours (38% 3-6pm and 20% 6-9pm)
66% are boys
60% are either one or two years old

* *From NSW Water Safety Task Force Report, 2002*

FEATURES

- Monitors wave height caused by any disturbance in the pool
- Adjustable quiescent and alarm wave levels
- Adjustable alarm period
- Pushbutton switch for Hold/Monitor modes
  - Hold mode gives visual but silent alarm (for testing and attended pool use)
  - Monitor mode for visual and audible alarm (for unoccupied pool use)
- Automatic return to Monitor mode after pool water settles
- Adjustable return to Monitor period
- Optional Set-to-Hold mode with pool turbulence preventing false alarms
- Indications of Hold, Status and Alarm conditions
- Weatherproof housing
- Can drive two alarm sirens
- Plugpack-powered
- Suits all pools where the top water level is below the pool edge

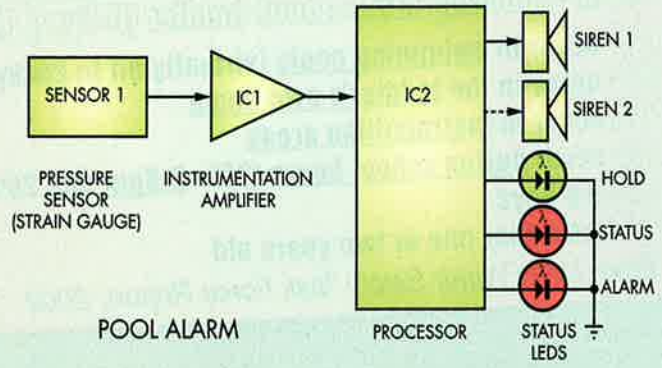


Fig.1: the Pool Alarm in block diagram form. Pressure variations due to changes in the water level are detected by Sensor 1. Its weak output is amplified and then processed by the PIC microcontroller which controls the alarms and drives the status LEDs.

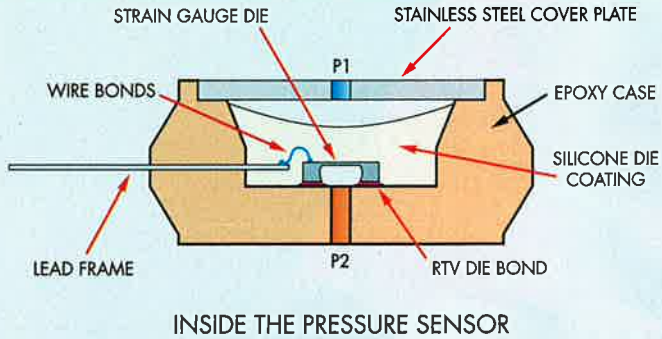


Fig.2: this cross-section diagram shows the internal structure of the MPX-2010DP pressure sensor. The strain gauge varies its resistance according to the applied load. P1 & P2 are the two port openings.

OK, let's see how it works. Fig.1 shows the block diagram of the Pool Alarm. It uses a pressure sensor to detect sudden increases in water depth, as happens when an object falls into the pool creating waves.

The unit is built in two sections, each in a weatherproof box. One houses the sensor while a second, which we have dubbed the Pool Alarm box, houses the PIC-controlled alarm circuit. The two are connected via a 4-way cable.

While our photo shows the alarm box on the side of the pool, this would not be a typical installation. Rather, the Pool Alarm box would normally be located close to the filter box (where mains power is available) or more likely in the house, if the pool is reasonably close. The cable can be run underground across to the pool sensor box.

Inside the sensor box is a pressure sensor. This measures the water pressure variations in the pool due to waves and sets off an alarm if these variations reach a preset level.

The sensor box has a thin tube emerging from it. The box is placed so that the probe tip is about 60-90mm under water. This sensor box can be secured to a pool ladder or fixed to the side of the pool, as we have shown in our photos.

The pool alarm is plugpack-powered so it needs to be located near to the mains. Complete safety from the mains power is provided firstly by the isolation given by the plugpack and secondly by the fact that there is no electrical contact with the water itself.

Additional features

Our Pool Alarm has several features worth noting. Most prominent on the main Pool Alarm box is a weatherproof pushbutton "Hold" switch. This is used to set the operating mode of the alarm. When powered up, the alarm is initially set to its normal monitor mode where it checks for pool wave movement. It takes about 10 seconds after power up to begin monitoring and during this time, the green "Hold" LED remains lit. After the 10 seconds, the LED flashes briefly every 1.5 seconds, indicating that the alarm is in the monitor mode.

If the Pool Alarm senses that the pool wave movement is sufficient, it will sound the alarm. The alarm period can be varied from between zero and five minutes, with typical settings around the 30s to 3-minute range. During the alarm period, an Alarm LED flashes on and off at five times per second.

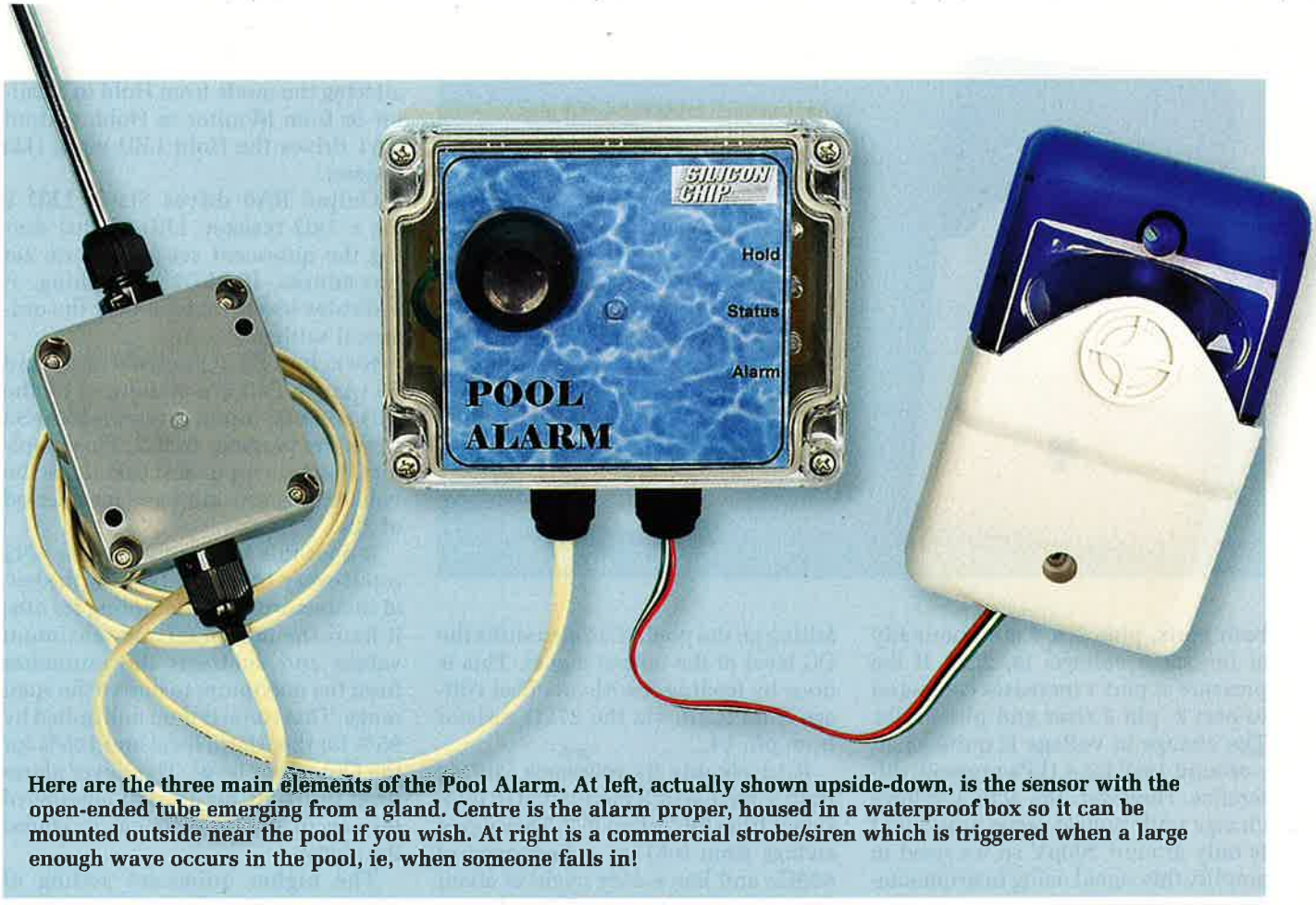
The alarm siren can be stopped at any time by pressing the Hold switch. This will also stop the Alarm LED flashing. The Hold LED will also stop flashing but unlike the Alarm LED, it will remain constantly on. The Pool Alarm is now in the Hold mode where the alarm will not sound. The Alarm LED, however, will flash whenever wave movement is above the alarm threshold. The hold mode is used when the pool is in use.

The degree of wave movement required to set off the alarm can be calibrated to suit your pool. This is done by dropping a weighted bucket into the pool (simulating a small child falling into the water) and pressing the alarm level switch (on the PC board). The Pool Alarm will monitor the wave movement over a 10s period and set up the level required for the alarm. During this calibration period, a "Status" LED will be lit.

A second quiescent level can also be calibrated into the Pool Alarm. This level is the wave movement within the pool when no-one is in it but with a light breeze blowing and perhaps the filter running (normal filter running should not trigger the Pool Alarm).

In practice, the level is calibrated under these conditions (ie, when a reasonable wind is blowing) by pressing the Quiescent Level calibration switch. The Pool Alarm then monitors wave movement for 10 seconds and stores the level. During this calibration period, the Status LED is lit.

Quiescent level calibration allows the Pool Alarm to provide extra features. First, it allows the mode to return from the Hold to the monitor mode automatically. So when the pool is being used, the Hold switch is pressed to set the Pool Alarm to the



Here are the three main elements of the Pool Alarm. At left, actually shown upside-down, is the sensor with the open-ended tube emerging from a gland. Centre is the alarm proper, housed in a waterproof box so it can be mounted outside near the pool if you wish. At right is a commercial strobe/siren which is triggered when a large enough wave occurs in the pool, ie, when someone falls in!

Hold mode so that the alarm will not sound. However, during this time, the Pool Alarm continues to monitor the wave movement. Typically, during pool use, the wave movement will continue to be over the quiescent level and the Pool Alarm will remain in the Hold mode.

When the pool is not in use, wave movement within the pool will settle to below the quiescent level. In this case, the Pool Alarm will change from Hold mode to Monitor mode, after a preset period of "no pool" activity. The period of inactivity can be adjusted to allow for the way the pool is used.

If the pool is often vacant for a short time before it is used again, the period can be made sufficiently long to prevent the return to Monitor happening in that time period. The adjustment range is from 1.25 - 75 minutes. One setting prevents the monitor return function.

The change from Hold to Monitor and from Monitor to Hold can also be toggled with the Hold pushbutton switch. The Hold LED then flashes for Monitor and is continuously lit for the Hold mode.

During the monitoring mode, windy conditions may cause wave movement which could exceed the quiescent level but may be below the alarm level. The Pool Alarm has an option that can return it to the Hold mode if the quiescent level is exceeded for 30 seconds without the alarm level being exceeded. This feature is included to prevent false alarms from the siren in windy weather. The Pool Alarm will then return to the monitoring mode after the wave movement has reduced to below the quiescent level.

Should the alarm sound and time out before the Hold switch is pressed, the alarm will return to Hold after the alarm period expires. The "return to hold" option can be enabled or disabled with a jumper pin selection.

Just which option you select depends on your pool and whether it is subject to windy conditions. Protected pools may not need the "return to Hold" feature. This is a compromise between preventing false alarms and providing continuous pool protection.

The sensor

An air-pressure sensor, the MPX-2010DP manufactured by Freescale Semiconductor, is used to measure wave movement. Its internal arrangement is shown in Fig.2. The sensor comprises a strain gauge that provides a resistance variation with applied load. In this case, the load is the air pressure exerted on the gauge due to a tube inserted into the pool.

The sensor is called a differential type because it measures the difference in pressure between one port and the other. For our application we use port 1, which has a silicone gel protective layer to prevent moisture affecting the strain gauge element. Port 2 is left disconnected and is vented to the inside of the enclosure.

By the way, this is the same pressure sensor as used in the Water Tank Level Meter, currently described in this and past issues.

Circuit description

The circuit of the Pool Alarm is shown in Fig.2 and comprises the pressure sensor, an instrumentation amplifier and a PIC microcontroller, plus associated switches, LEDs and other components.

Sensor 1 has differential outputs at pins 2 & 4. With the same pressure at



The Jaycar Cat. LA-5308 (left) and LA-5256 (right) piezo sirens are ideal for use with the Pool Alarm. The LA-5308 includes a strobe as well.

both ports, pins 2 & 4 are nominally at the same voltage; ie, 2.5V. If the pressure at port 1 increases compared to port 2, pin 2 rises and pin 4 falls. The change in voltage is quite small – around 1mV for a 1kPa pressure difference. However, the actual voltage change with typical wave movement is only around 200µV so we need to amplify this signal using instrumentation amplifier IC1.

Since we are concerned with wave movements (ie, pressure variations) rather than the absolute pressure levels, the output from the sensor is AC-coupled via 1µF non-polarised capacitors to op amps IC1a & IC1b. The non-inverting inputs of IC1a & IC1b (pins 3 & 5 respectively) are biased via 470kΩ resistors to a +2.5V reference derived using two 2.2kΩ resistors and a 100µF capacitor.

IC1a & IC1b are set up as non-inverting amplifiers with 39kΩ feedback resistors and a single 10Ω resistor between their inverting inputs. A 470pF capacitor across the 39kΩ resistors rolls off signal above about 8.7kHz and this prevents possible oscillation. The gains of IC1a & IC1b are each 1 + 39kΩ/10Ω, or close enough to 3900.

The outputs of IC1a & IC1b are summed in differential amplifier IC1c which effectively adds the two outputs together. IC1c's gain is 2 x 27kΩ/22kΩ or 2.45 (for the two outputs), so the overall gain is 3900 x 2.45 or 9555.

Rain filtering

IC1c's output is filtered using a 2.2kΩ resistor and 10µF capacitor to remove high-frequency signals above 7.2Hz. This prevents detection of rain falling on the pool. IC1c also shifts the DC level of the output signal. This is done by feeding it with an offset voltage from IC1d, via the 27kΩ resistor from pin 14.

IC1d obtains its reference voltage from a pulse width modulated (PWM) signal from PIC micro IC2. This signal swings from 0-5V at a frequency of 490Hz and has a duty cycle of about 50%. The PWM signal is filtered using a 220kΩ resistor and 10µF capacitor and fed to pin 12 of IC1d.

The PWM signal is adjusted automatically during calibration so that IC1c's output is at 2.5V when there is no signal from Sensor 1.

Microcontroller functions

IC2, the PIC16F88-I/P microcontroller, processes the signal from IC1c and drives the alarm and the Hold, Status and Alarm LEDs. IC2 also monitors inputs at RB1, RB2 and RB3 for the switches, the linking options at RA2, the RB4-RB7 inputs for BCD1 and the voltage at the wiper of trimpot VR1.

Output RA7 drives the flashing Alarm LED while output RA6 drives transistors Q1 & Q2 which are the siren drivers.

Trimpot VR1 is monitored by the AN4 input and its wiper voltage converted to a digital value from 0-255 for its 0-5V range, to give a timeout period in minutes. This value is placed in a counter that is decremented every 1.18s until it reaches zero and the alarm goes off.

Hold switch S1 connects to the RB3 input which is normally held high (+5V) via an internal pull-up resistor. When S1 closes, IC2 responds by altering the mode from Hold to Monitor or from Monitor to Hold. Output RA1 drives the Hold LED via a 1kΩ resistor.

Output RA0 drives Status LED 2 via a 1kΩ resistor. LED2 lights during the quiescent set and Alarm set procedures. If LED2 is flashing, it indicates levels that are over the quiescent setting.

Switches S2 (Quiescent Set) and S3 (Alarm Set) are monitored by the RB1 and RB2 inputs. Pressing S2 or S3 starts the program in IC2. This monitors the AN3 input and calculates the voltage range encountered for a period of 10s.

It does this by monitoring the AN3 input every 100ms and storing the level in memory. After sampling for 10s, it finds the minimum and maximum values and subtracts the minimum from the maximum to derive the span range. This value is then multiplied by 95% for the Alarm level and 105% for the Quiescent level. The lower alarm level provides for a small amount of leeway in pool movement to sound the alarm.

The higher quiescent setting of 105% is so that the quiescent level for the pool will normally be less than this. The resulting values are then used to check for quiescent or alarm levels at the AN3 input.

Whether to return to Hold from monitoring or not is selected with the linking at input RA2. RA2 is pulled high with the link in LK2 and low with the link in LK1.

Rotary switch BCD1 selects the monitor return period. When BCD1 is in position 0, all the switches are open and the RB4-RB7 inputs are pulled high via internal pull-up resistors. This setting is for a "no-return to monitoring" from hold. Other settings of the BCD switch will pull at least one of the RB4-RB7 lines to ground via its common pin and select a time period as shown in Table 1.

As already noted, the CCP1 output at pin 6 produces the PWM signal. It is initially preset so that the output of IC1c is nominally at +2.5V. However, because of manufacturing tolerances in IC1, the output could vary and so there is a set-up procedure (to set the output to 2.5V).

Pressing switch S2 before power is applied to the circuit runs this procedure. The program within IC2 then adjusts the PWM percentage so that

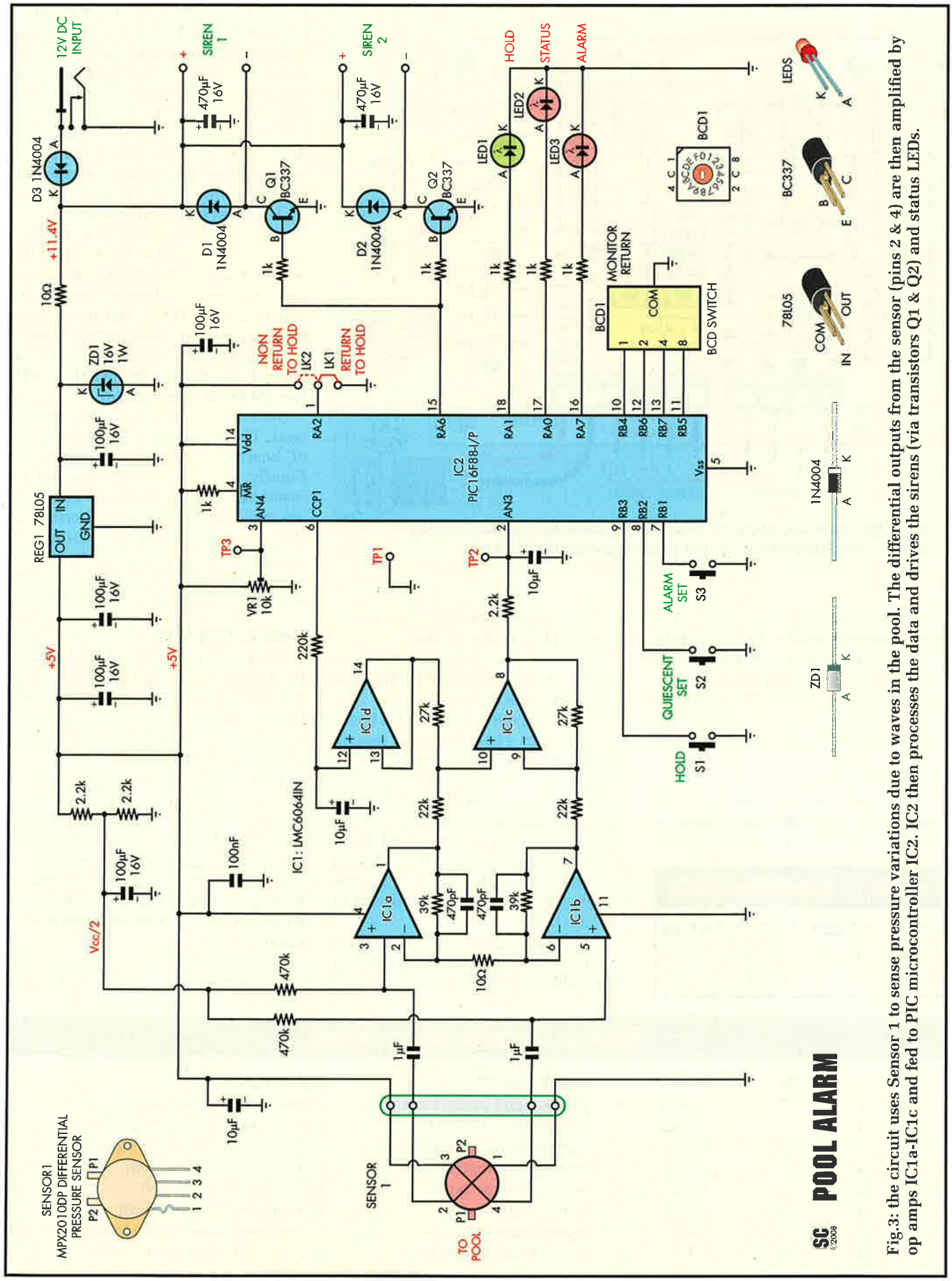


Fig.3: the circuit uses Sensor 1 to sense pressure variations due to waves in the pool. The differential outputs from the sensor (pins 2 & 4) are then amplified by op amps IC1a-IC1c and fed to PIC microcontroller IC2. IC2 then processes the data and drives the sirens (via transistors Q1 & Q2) and status LEDs.

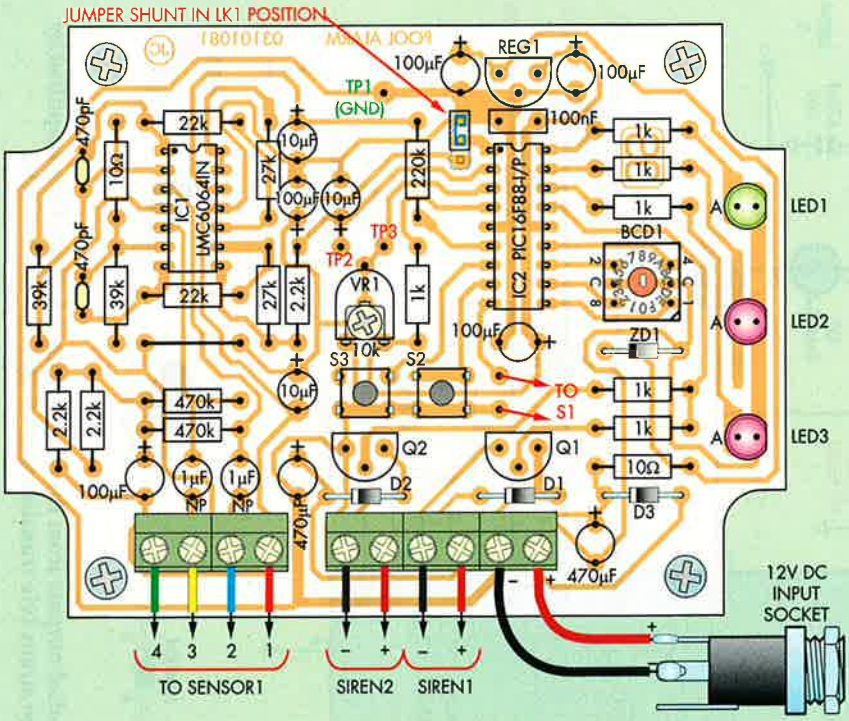


Fig.4: the parts layout for the Pool Alarm. Note the jumper pins (top centre) which must be set as per your requirements – see text.

the reading at AN3 is at +2.5V. This process takes about 60s. The new PWM value is then stored and used every time the pool alarm is powered up.

IC2 operates at 500kHz using an internal oscillator and is run from a 5V supply derived from regulator REG1.

Construction

The Pool Alarm is built on a PC board coded 03101081 and measuring 102 x 77mm. This is housed in an IP65 sealed polycarbonate enclosure with a clear lid (115 x 90 x 55mm).

Similarly, the pressure sensor is housed in an IP65 sealed ABS case measuring 64 x 58 x 35mm.

The wiring details for the PC board are shown in Fig.4. Start the assembly by checking the PC board for any defects such as shorted tracks and breaks in the copper. You should also check the hole sizes. The holes for the corner mounting screws need to be 3mm in diameter, while the holes for the screw terminals need to be 1.2mm. Check also that the PC board will fit into the box.

Install the single wire link and the resistors first. Use the resistor colour code table as a guide to finding each value. Better still, use a digital multimeter to check each resistor before installing it. That done, install the PC stakes for test points TP1-TP3 and for the connections to S1, then fit the 3-way header for links LK1 and LK2.

Next, install diodes D1-D3 and zener diode ZD1. IC1 can then be mounted but just insert and solder in the socket for IC2 at this stage. Both the IC and socket must be oriented correctly.

The capacitors can go in next. Note that the electrolytic types must be oriented with the correct polarity, as shown. Now install transistors Q1, Q2 and regulator REG1, taking care not to mix them up, then install trimpot VR1 and the BCD switch (BCD1). **The correct orientation for BCD1 is with the dot to the lower right.**

Switches S2 & S3 can be inserted next. These will only fit easily on the PC board with the correct orientation. Finally, the screw terminals can be inserted. Note that the 6-way terminals are made up of three 2-way terminals that are interconnected using the moulded dovetails that attach the pieces together. The 4-way terminals are made using two 2-way terminals.

Pool alarm box

Work can now be done on the main Pool Alarm Box. First, drill a hole in the lid for S1, plus holes in the box for the cable glands for the sensor and siren wiring. You will also need a hole for the DC panel socket.

That done, place the PC board in the box and secure it with four M3 x 6mm screws. You can now attach the panel label to the lid, install switch S1 and insert the neoprene seal that is pressed into the lid surround. **Note: a front-panel label can be downloaded from the SILICON CHIP website if necessary.**

Next, wire up the DC socket to the screw terminals and wire switch S1

Table 1: Capacitor Code

Value	µF Code	IEC Code	EIA Code
100nF	0.1µF	100n	104
470pF	n/a	470p	471

Table 2: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	470kΩ	yellow violet yellow brown	yellow violet black orange brown
❑	1	220kΩ	red red yellow brown	red red black orange brown
❑	2	39kΩ	orange white orange brown	orange white black red brown
❑	2	27kΩ	red violet orange brown	red violet black red brown
❑	2	22kΩ	red red orange brown	red red black red brown
❑	3	2.2kΩ	red red red brown	red red black brown brown
❑	6	1kΩ	brown black red brown	brown black black brown brown
❑	2	10Ω	brown black black brown	brown black black gold brown

to the two terminals on the PC board. That done, connect a 12V DC plugpack to the DC socket and apply power. Check that there is +5V between pins 11 & 4 on IC1 and at pins 5 & 14 on IC2's socket. If the voltage is within the range of +4.75V to +5.25V, then power can be disconnected and IC2 installed in its socket.

Apply power again and measure the voltage between TP1 (GND) and TP2. **This should be about 2.5V but if this differs by 0.25V, you will need to run the set-up to adjust TP2 to sit at 2.5V.** This needs to be done at a later stage when the pressure sensor is connected.

Sensor box assembly

The full assembly details for the sensor box are shown in Fig.5.

First, a baseplate is made up using sheet aluminium measuring 31 x 26mm. This is then fitted with two M3 x 20mm screws and M3 nuts for the sensor and attached to two central mounting posts in the box using M3 x 6mm screws.

That done, the sensor can be slipped onto its mounting screws (notched pin to the left) and secured using two more M3 nuts. Note that the sensor is oriented so that port 1 is the one that is connected to the tubing.

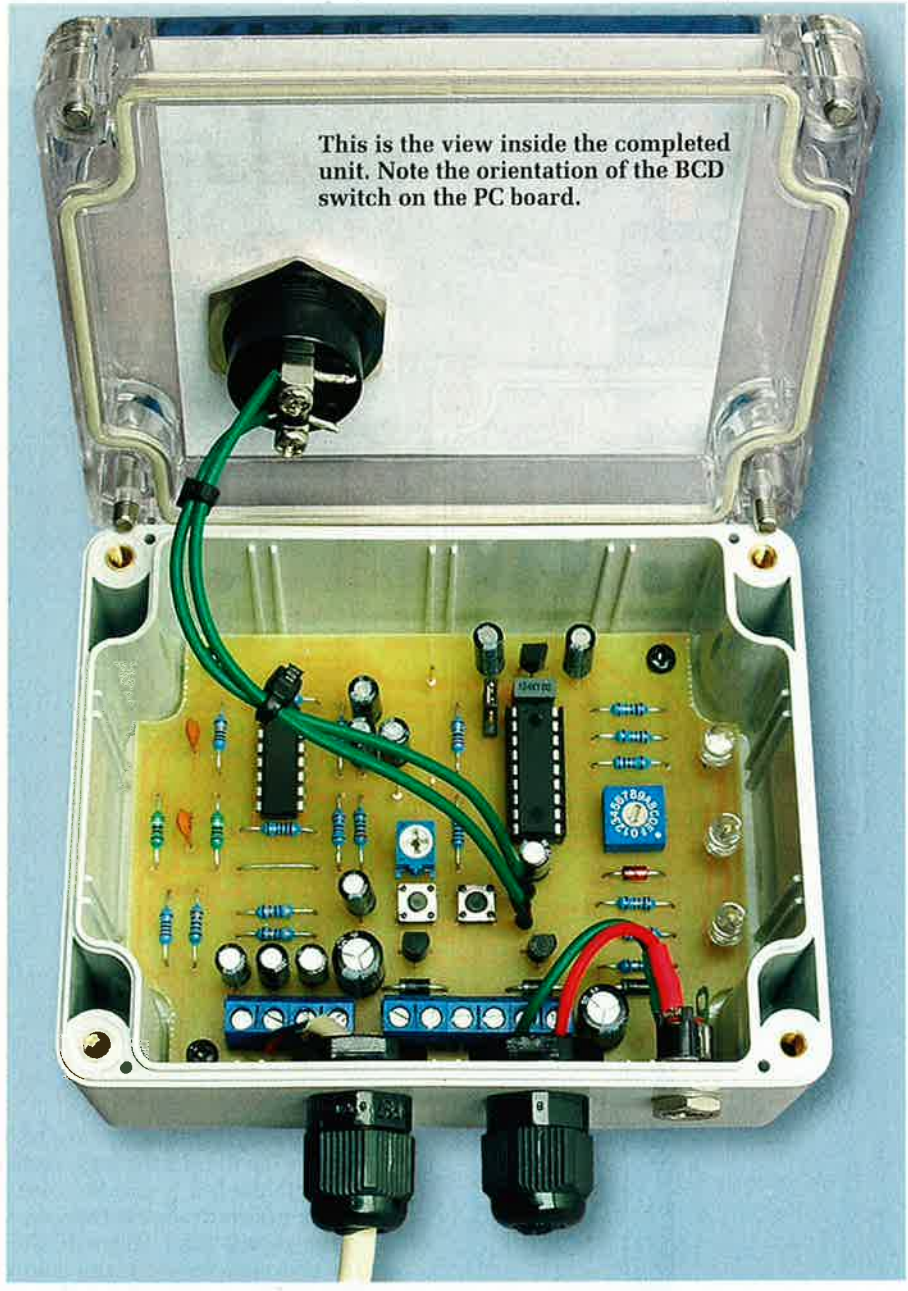
The wiring can now be connected to the four sensor pins, with the cable exiting through the adjacent end of the box via a cable gland. Take care with this wiring and make a note of the wire colour used to make each connection.

If you are using flat 4-way cable, it will not form a watertight seal within the gland. Applying a small amount of silicone sealant around the wire where it passes through the gland can provide this waterproofing.

The port 1 connection to the sensor consists of a 3mm PVC tube that's covered with a 145mm length of metal tubing. This assembly is passed through the cable gland and clamped in place.

The metal tube maintains an even temperature inside the vinyl tube, keeping it at the same temperature as the pool water. The metal tube also keeps the vinyl tubing straight and holds it in place at a fixed depth in the water.

If you need to run the TP2 set-up, this can be done now. With power off, temporarily connect the sensor to the alarm PC board terminals, taking care that everything is correct. Now press switch S2 and re-apply power. The Status LED should light and the TP2 voltage will be seen to vary and finally settle at about 2.5V after 60 seconds.



This is the view inside the completed unit. Note the orientation of the BCD switch on the PC board.

The sensor box can now be mounted at the pool, with the probe tip immersed by about 60-90mm. The box can be attached to the side of the pool using brackets to the ladder or secured to the side of the pool using an underwater-curing epoxy such as Bostik Titan Bond Plus.

Note that when using the box mounting holes, it has two mounting screw points that are effectively located outside of the box enclosure but are accessed with the lid off.

The sensor box must be located so that it does not receive the force of the filter pump outlet. In addition, the filter outlet nozzle should be adjusted so that it does not cause turbulence at the top of the water.

The wiring between the sensor box and Pool Alarm needs to be protected from damage by using conduit in areas where it is exposed. This conduit can be placed underground.

You can use one or two sirens with the alarm. These can be located in different parts of your property to provide full sound coverage. It is best to have these disconnected until the Pool Alarm is calibrated.

Calibration

The calibration is carried out by using on-board switches S2 & S3 to

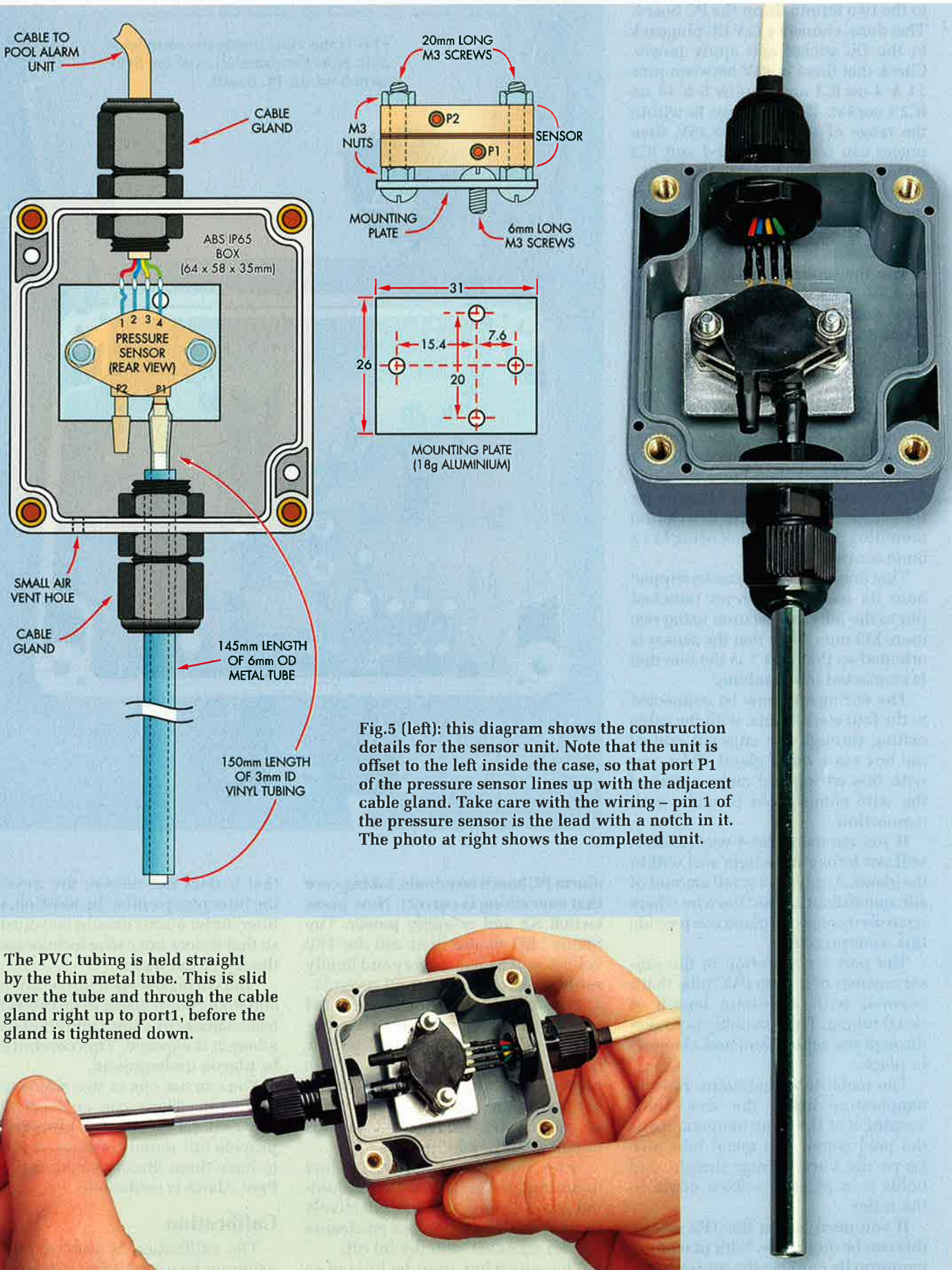


Fig.5 (left): this diagram shows the construction details for the sensor unit. Note that the unit is offset to the left inside the case, so that port P1 of the pressure sensor lines up with the adjacent cable gland. Take care with the wiring – pin 1 of the pressure sensor is the lead with a notch in it. The photo at right shows the completed unit.

The PVC tubing is held straight by the thin metal tube. This is slid over the tube and through the cable gland right up to port1, before the gland is tightened down.

Table 3: Setting The Alarm Period

VR1 Setting (measured between TP1 & TP3)	Alarm Period
0.5V	30 seconds
1.0V	1 minute
1.5V	1.5 minutes
2.0V	2 minutes
2.5V	2.5 minutes
3.0V	3 minutes
3.5V	3.5 minutes
4.0V	4 minutes
5.0V	5 minutes

Table 4: Monitor Return Settings

BCD Setting	Return Period
0	No return
1	1.25 minute
2	2 minutes
3	3 minutes
4	4 minutes
5	5 minutes
6	6 minutes
7	7 minutes
8	8 minutes
9	9 minutes
A	10 minutes
B	20 minutes
C	30 minutes
D	45 minutes
E	60 minutes
F	75 minutes

Parts List – Pool Alarm

1 PC board, code 03101081, 102 x 77mm
1 IP65 sealed polycarbonate enclosure with clear lid, 115 x 90 x 55mm (Jaycar HB-6246 or equivalent)
1 IP65 sealed ABS case, 64 x 58 x 35mm
1 sheet of 18g aluminium, 26 x 31mm
1 12V 400mA DC adaptor
1 piezo siren (Jaycar Cat. LA5308 or LA5256)
1 piezo siren as above (optional)
1 MPX2010DP Freescale Semiconductor pressure sensor (Jaycar ZD-1904 or equivalent) (Sensor1)
1 SPST waterproof momentary switch (Jaycar SP-0732 or equivalent) (S1)
2 SPST micro tactile switches (Jaycar SP-0600 or equivalent) (S2,S3)
1 BCD DIL rotary switch (0-F) (Jaycar SR-1220 or equivalent) (BCD1)
5 2-way PC-mount screw terminals with 5mm or 5.08mm spacing
1 2.5mm DC panel socket
4 3-6.5mm diameter IP68 waterproof cable glands
1 2-way pin header, 2.54mm spacing
1 18-pin DIL IC socket
2 M3 x 20mm screws
6 M3 x 6mm screws
4 M3 nuts
3 PC stakes
1 150mm length of medium duty hookup wire
1 30mm length of 0.8mm tinned copper wire
1 length of 2-pair (4-wire) telephone sheathed cable or 4-core alarm cable (to suit)
2 100mm cable ties
1 150mm length of 3mm ID (5mm OD) vinyl tube
1 145mm length of 5mm ID (6mm OD) metal tubing
1 10kΩ horizontal trimpot (code 103) (VR1)

Semiconductors
1 LMC6064IN quad op amp (IC1)
1 PIC16F88-I/P microcontroller programmed with "Pool Alarm.hex" (IC2)
2 BC337 NPN transistors (Q1,Q2)
3 1N4004 1A diodes (D1-D3)
1 16V 1W zener diode (ZD1)
1 5mm green LED (LED1)
1 5mm red LED (LED2,LED3)

Capacitors
2 470µF 16V PC electrolytic
5 100µF 16V PC electrolytic
3 10µF 16V PC electrolytic
2 1µF NP electrolytic
1 100nF MKT polyester
2 470pF ceramic

Resistors (0.25W 1%)

2 470kΩ	2 22kΩ
1 220kΩ	3 2.2kΩ
2 39kΩ	6 1kΩ
2 27kΩ	2 10Ω

set the water movement levels that correspond to your pool.

For the alarm level, you need to simulate pool water movement when a small child falls into the water. To do this, fill a 10-12 litre bucket with water about one-third full and drop the bucket from about 30mm above the pool water into the pool. Press S3 (Alarm Set) to record the movement. The status LED will light during this procedure.

Note that the calibration may not be successful if the wave from the bucket does not reach the sensor during the 10s calibration period. If it doesn't calibrate, try again (after the pool water has settled) and wait until the wave caused by the bucket has almost reached the sensor before pressing S3. You will need to try this at different points around the pool.

Quiescent alarm calibration should be done with the filter pump operating and with a typical breeze blowing across the pool. Press S2 (the Quiescent Set switch) during these events to record the water movement levels. The Status LED will light during this time and extinguish after 10 seconds.

Note that this quiescent level must be less than the alarm level in order for the return to monitor function and for the set to hold feature to work.

Now set the alarm period using VR1, noting that the voltage at TP3 will show the timeout. A 1V setting gives a 1-minute alarm while 2V gives two minutes and a 5V setting provides a 5-minute alarm – see Table 3.

Next, select whether you want the "return to hold" feature with LK1 or LK2 and set BCD1 for the required return to monitor period – see Table 4. If "return to monitor" is used (for settings other than 0), then select the setting that best suits your pool use.

If you tend to vacate the pool area after swimming, then the return to monitor period can be set to a short period. If you tend to swim and then sunbake, then a longer period may be necessary to prevent the pool alarm sounding when you return for a swim. SC

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$4.99
SAVE $4.99

HALF PRICE! THIS MONTH ONLY



Auto LED Turn Indicator Lamp
Cluster of 19 High Intensity Yellow LEDs designed for 12V DC automotive operation as a turn indicator lamp. Offers longer operating life than incandescent light bulbs. P8600

$4.99
SAVE $4.99

NORMALLY 80¢/M SAVE 26¢/M THIS MONTH ONLY



59¢/m

Oxygen Free Copper Speaker Cable
High conductivity, low loss Fig 8 Oxygen Free Copper (OFC) cable with ultra-flex translucent PVC insulation, and tinned copper conductors on one side of the Fig 8 flex to aid in polarity identification/matching. Conductors: 30 x 0.12mm OFC, cross-sectional area: 0.34mm². Price per metre. W2008

HALF PRICE! THIS MONTH ONLY



Auto LED Tail Lamp, White LED
Cluster of 19 High Intensity White LEDs designed for 12V DC automotive systems to suit tail lamp bayonet fitting. P8634

$9.99
SAVE $9.99

HALF PRICE! THIS MONTH ONLY



Auto Tail Lamp, Red LED
Cluster of High Intensity Red LEDs designed for 12V DC automotive systems to serve as bayonet fitting tail lamp assemblies. P8636

$4.99
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NORMALLY $2.25/M SAVE 12% THIS MONTH ONLY

High Quality Quad Shielded TV Cable
The W 2087 is an RG-6 quad shield version which is designed to allow the use of standard crimp type F-connectors while offering better than 85dB screening.
Quality RG-6 75 Ohm television cable with 4 layers of shielding for 100% screening aimed to satisfy and is recommended for digital, pay TV and satellite TV needs.
W2087



$1.98/m

HALF PRICE! THIS MONTH ONLY



Auto LED – 42 x 10mm Interior Festoon LED, White Light
Array of 6 High Intensity White LEDs, designed for 12V DC operation. Offers longer life than incandescent filament lamps (up to 20,000 hrs). Shock and vibration resistant.
P8621

$3.99
SAVE $3.99

42% OFF THIS MONTH ONLY



Auto LED - 42 x 10mm Interior Festoon Lamp, Blue Light
Array of 6 High Intensity Blue LEDs designed for 12V DC automotive systems. Set the mood in your car cabin with a soothing blue light! P8622

$3.99
SAVE $2.99

EVEN MORE SAVINGS! 25¢/M OFF THIS MONTH

TV Cable 75 Ohm Air Space
AIR SPACED TV COAX
High-quality, low-loss 75 ohm coax for low signal areas. Provides lower loss than standard RG59 cables, especially at UHF frequencies. W2082
$1.60 per metre Sep.

75 Ohm Air Spaced TV Cable
W2082/ 278-9522



$1.19/m

HALF PRICE! THIS MONTH ONLY



Auto LED – 35 x 10mm Interior Festoon, White Light Lamp
Array of 4 High Intensity White LEDs to replace the yellowy incandescent light found in smaller car interiors.
P8624

$2.99
SAVE $2.99

NORMALLY $8.98. ONLY $2.50 - THIS MONTH ONLY. SAVE A MASSIVE 72%!



3AG Waterproof Fuseholder
Durable yellow fuseholder suitable for 12V or 24V DC applications. Silicon rubber boots protect against benzene-based solvents, and it is protected against UV (ultraviolet) light.
P7917

$2.50
SAVE $6.48

SAVE 25% PER METRE THIS MONTH ONLY

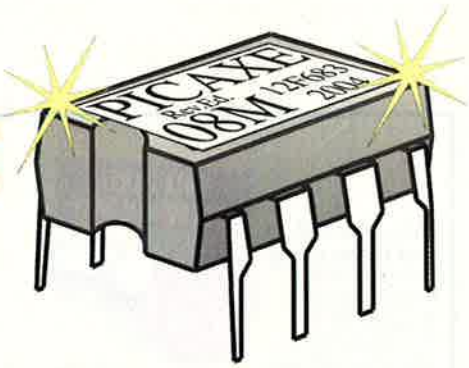


Auto Heavy Duty Power Cable
Similar to Figure-8 cabling but provides a larger conductor area with the added safety of a double insulation sheath for protection in automotive applications.
W2027

$2.54/m
HALF PRICE

Terms and conditions: Offers start 26/12/07 and end 29/01/08 or while stocks last.
No rainchecks. No layby. Offers may not be available in some reseller or franchise stores.

PICAXE VSM: The PICAXE Circuit Simulator!



Ever wondered whether your latest scathingly brilliant PICAXE project idea would actually work? Well, now you can find out before you build it, with the new PICAXE circuit simulator software! Mr PICAXE, Clive Seager, talks us through the latest PICAXE software offering from Revolution Education.

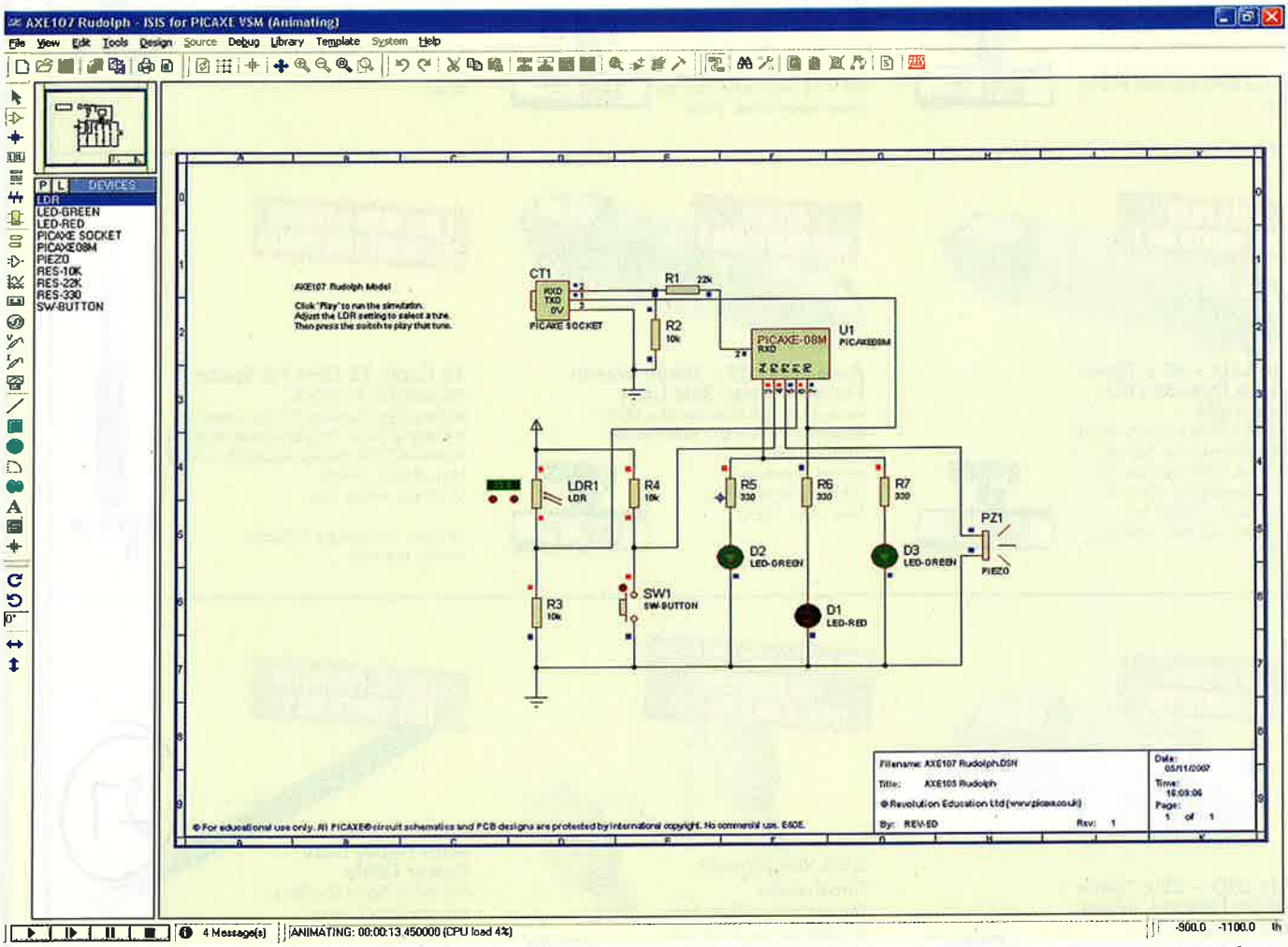


Fig.1: circuit simulation of the AXE107 Rudolph Project Kit (SILICON CHIP, September 2004). What you can't see from the screenshot is the "Rudolph the Red-Nosed Reindeer" tune playing from the piezo (simulated via the computer's speaker)!

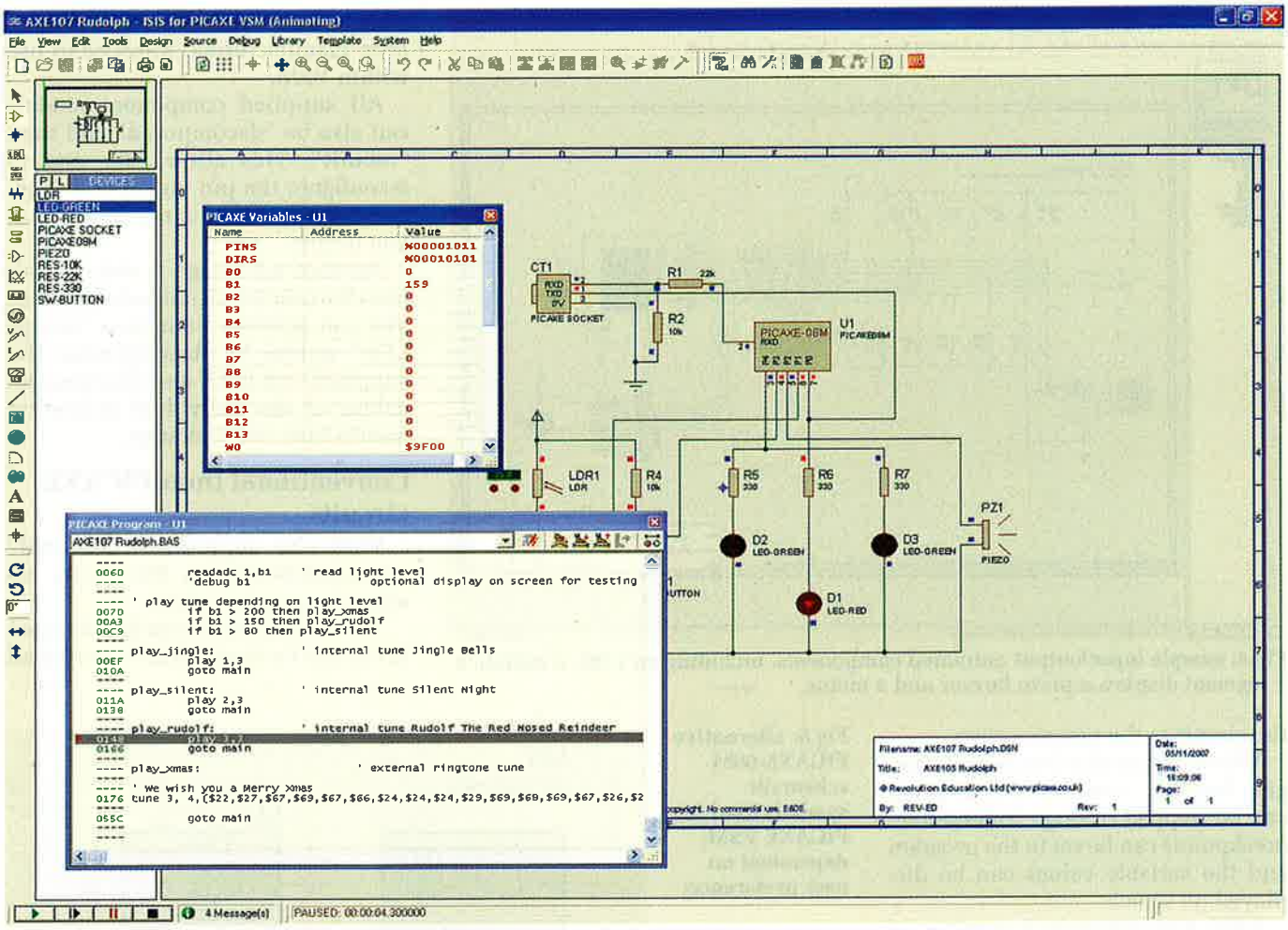


Fig.2: the program can be stepped through line-by-line and variable values studied on screen.

PICAXE Virtual System Modelling (VSM) is a new software circuit simulator that combines a "virtual" PICAXE chip with animated components and Berkeley SPICE circuit analysis to produce a simulation of a complete PICAXE project – and it operates in real time on most modern computers!

PICAXE VSM is a joint venture between two UK companies, Revolution Education, the developers of the PICAXE system, and Labcenter Electronics, a world leader in circuit simulation products which has been producing commercial SPICE and microcontroller simulators for almost 20 years.

To use the system, you first draw your circuit schematic on screen, using the library of over 10,000 popular analog/digital components and automated wiring to build up your circuit. You then associate your PICAXE BASIC program to the PICAXE chip component and click "Play!" to watch the circuit in operation!

On-screen animation & virtual instruments

The on-screen output components (eg, LEDs, motors and displays) all animate as the PICAXE program runs and input devices such as LDRs, temperature sensors, switches and keypads can be activated by clicking on the animated model in the circuit simulation.

This allows the user to interact with

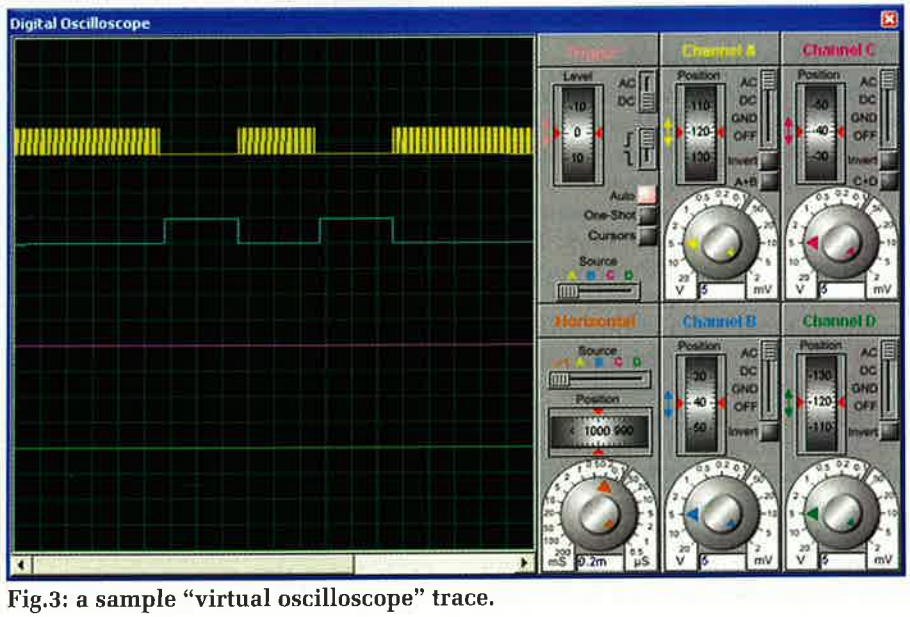


Fig.3: a sample "virtual oscilloscope" trace.

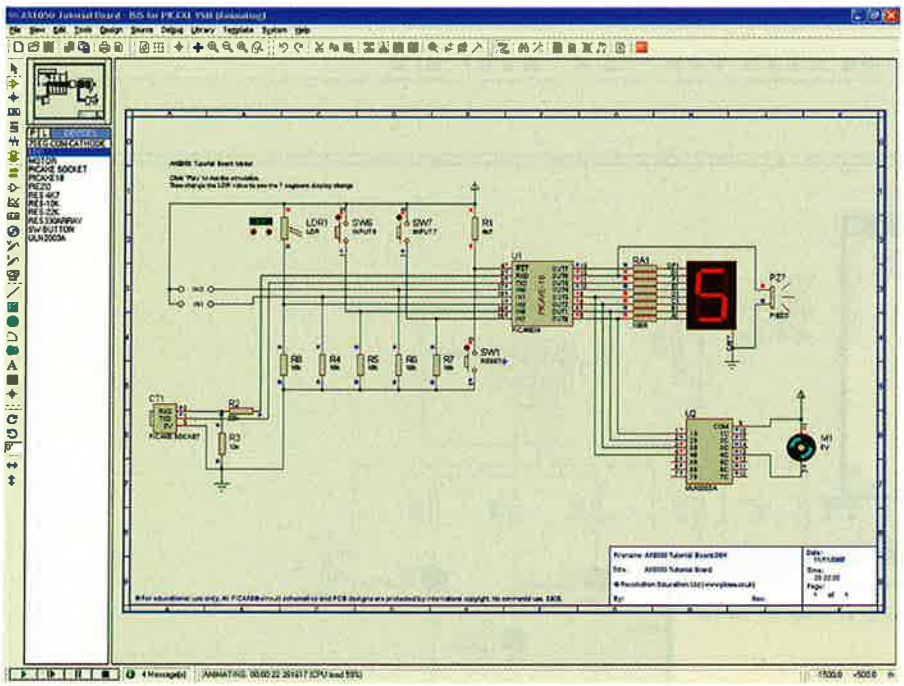


Fig.4: sample input/output animated components, including an LDR, a switch, a 7 segment display, a piezo buzzer and a motor.

the circuit as the program runs.

VSM also provides extensive debugging facilities – the PICAXE program can be stepped through line-by-line; breakpoints can be set in the program and the variable values can be displayed on screen.

VSM also contains a number of virtual instruments including a voltmeter, ammeter, oscilloscope, signal generator, logic analyser, timer, serial terminal and I²C and spi debuggers.

So, for instance, you can connect an oscilloscope probe to the "simulated" infrared sensor and watch the infrared demodulation on the oscilloscope trace.

PICAXE components

VSM is supplied with a library of over 10,000 components and supports all the major protocols including RS232, spi, I²C, 1-wire, etc.

As well as all the conventional components (resistors, capacitors, LEDs, transistors, etc), the software supports many advanced components not often found in other simulation products; eg, I²C EEPROMS, iButtons, digital 1-wire temperature sensors, serial LCDs, stepper motors, radio-control servos and in fact, all the commonly used PICAXE interfacing devices!

VSM supports the popular Berkeley SPICE model format, which many electronic manufacturers provide for their components and so it is also possible to download additional models from manufacturers' websites to use within VSM.

All supplied component models can also be "decomposed" and then "rebuilt". This allows the user to reconfigure the pin layout of a schematic symbol if it is not laid out as you desire.

Another advantage is that this allows the user to edit animated models. You can generate your own "orange LED" model by decomposing the supplied "red LED" and changing the colour of the individual animation frames from red to orange.

Conventional (non-PICAXE) circuits

VSM also supports "traditional" components such as 555 timers, op amps, logic gates, etc.

These components can be simulated in circuits by themselves or combined

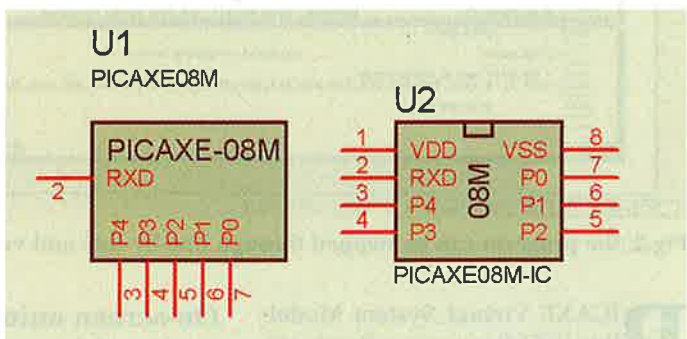


Fig.5: alternative PICAXE-08M schematic symbols used in PICAXE VSM, dependent on user preference.

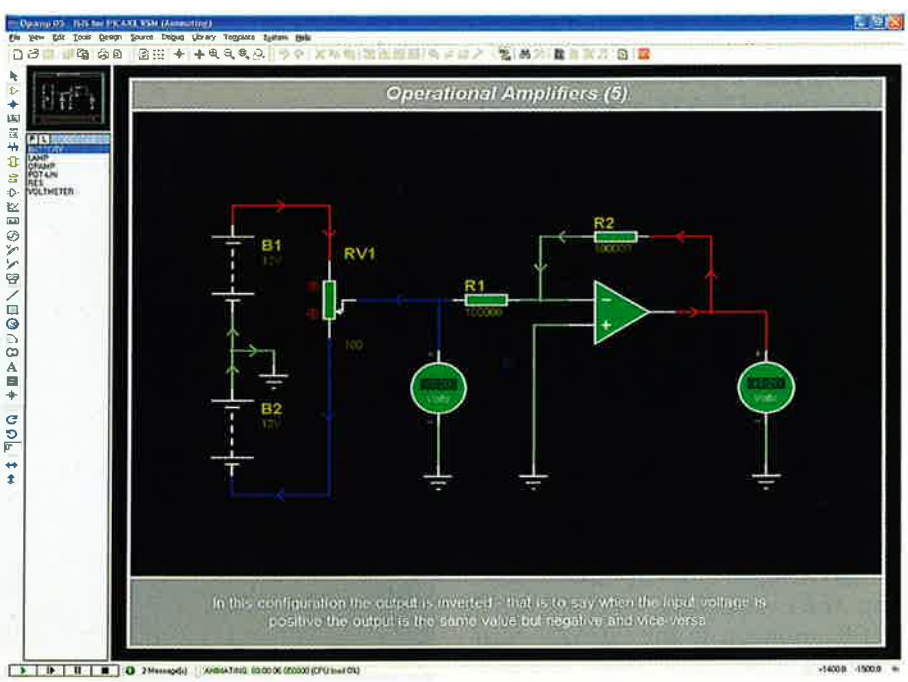


Fig.6: one of the free op amp tutorials.

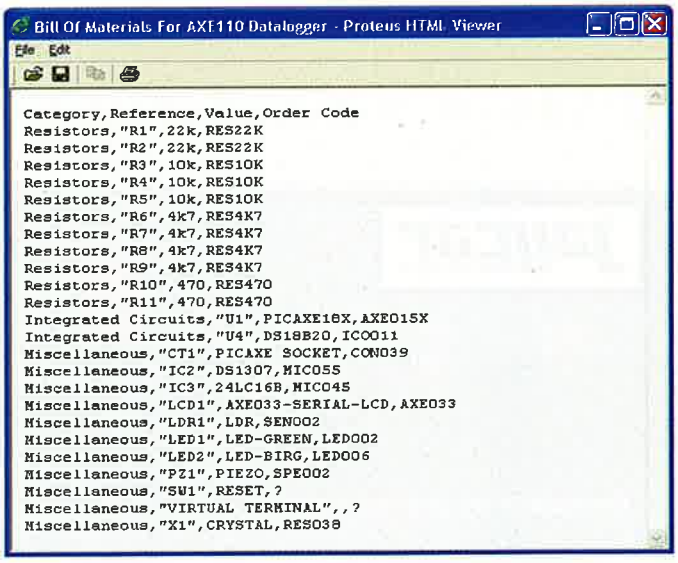


Fig.7: Bill of Materials exported from PICAXE VSM in CSV format.

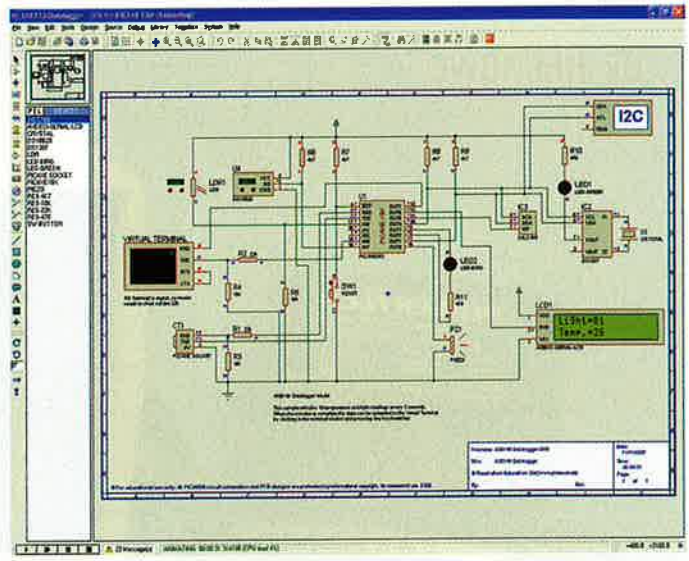


Fig.8: AXE110 Datalogger Circuit, simulating three advanced protocols – RS232, 1-wire and I²C – in one design!

into a PICAXE circuit. The software also includes a series of over 75 free "electronics principles" tutorial files which explain the operation of logic gates, timers, op amps, etc.

VSM can also be customised to your own preferred graphics. As can be seen from Fig.6, a customised dark background helps highlight the current and voltage colour coding of the animated wires when a simulation is run.

Netlist and Bill Of Materials export

VSM can export a Bill of Materials for the circuit schematic and can also generate a netlist that can be imported into a PC board layout application to generate a board design.

A dozen different netlist formats are available, including popular freeware PC board layout applications such as Eagle.

Example VSM circuit

The model shown is of the AXE110 PICAXE-18X datalogger, which was described in SILICON CHIP between January and March 2004.

An animated LDR and DS18B20 temperature sensor provide the inputs to the system, while the data is saved to an I²C EEPROM memory chip.

The AXE033 serial LCD module shows the current temperature and light readings, and the DS1307 real-time-clock allows the datalogger to take samples at specific time/date slots.

Finally the RS232 link allows the stored data to be uploaded when the datalogging session is complete.

Further details

A single user licence for PICAXE VSM costs $AU115.

Licences are delivered by email. To buy online, or for further information including a free demo version, please visit the PICAXE VSM website at www.picaxevsm.com SC

COMING NEXT MONTH

In our February issue we will look at a step-by-step tutorial on how to build up a PICAXE circuit from scratch using PICAXE VSM.

Radio, Television & Hobbies: the COMPLETE archive on DVD



This remarkable collection of PDFs ***covers every issue*** of R & H, as it was known from the beginning (April 1939 – price sixpence!) right through to the final edition of R, TV & H in March 1965, before it disappeared forever with the change of name to EA.

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.

Please note: this archive is in PDF format on DVD for PC. Your computer will need a DVD-ROM or DVD-recorder (not a CD!) and Acrobat Reader 6 or above (free download) to enable you to view this archive. This DVD is NOT playable through a standard A/V-type DVD player.

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By JIM ROWE



Emergency 12V Lighting Controller

This easy-to-build project automatically turns on the power for 12V emergency lights within a second or two of a mains power failure. Build it and you won't have to search for candles or your torch in the event of a blackout.

WHAT HAPPENS AT your place if there's a sudden "blackout" or mains power failure? It's a familiar story – if it's at night, you're left floundering in the darkness, searching for some candles or your torch. And if you do find the torch, it's more than likely that the batteries have gone flat.

This project means that you should never have to search around in the darkness during a blackout again. As soon as the mains power fails, it automatically turns on the power for some 12V emergency lights within a second or two. It then keeps them operating until either the mains power is restored or its internal 12V sealed lead-acid (SLA) battery is discharged to the safe minimum level.

Basically, the project is designed to be used in conjunction with a small 12V/1A automatic SLA battery charger, such as the Powertech MB-3526 unit sold by Jaycar stores and dealers. This unit normally keeps the internal SLA battery at full charge and we use this project to monitor the charging voltage so that it can determine when there is a mains failure.

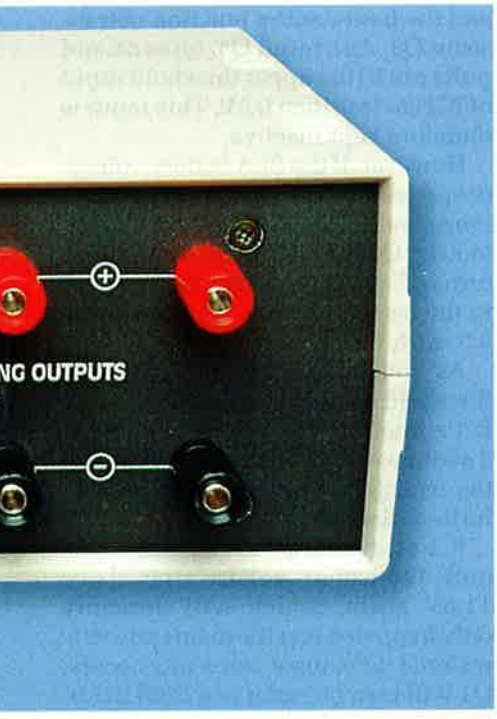
That's how it knows when to switch on your 12V emergency lights.

Running time

The 12V SLA battery specified has a rated capacity of 7.2Ah (ampere-hours), which should be enough to power typical domestic 12V emergency lights for the duration of all but the most prolonged mains failures. For example, it will power a couple of 12V/16W (twin 8W tubes) fluoro fittings like the Jaycar ST-3016 for around two hours or for a little over one hour if you hook up a 12V/11W single fluoro as well.

How can you work out the time it will run a certain combination of 12V emergency lights? As a rough guide, you need to work out how much current each light fitting draws, then add up the total current. Then if you divide the battery capacity by this total current, the answer will be the approximate running time in hours.

The reason why this gives only a rough guide to running time is that the nominal capacity of a battery is based on it being discharged over a 20-hour period – ie, at a discharge current rate of C/20, where "C" is the battery's



nominal capacity (in this case 7.2Ah, so C/20 = 360mA).

When you discharge the battery at a higher rate than this, its effective capacity drops somewhat. For example, if you reduce the discharge time to 10 hours, its effective capacity drops to 6.7Ah. If you want to discharge it in five hours, the effective capacity drops to 5.95Ah. And if you want to discharge it in just one hour, its effective capacity drops to 4.0Ah.

So if you want to run say three of the ST-3016 12V/16W fluoro fittings, which each draw around 1.35A, this will result in a total current of 3 x 1.35A = 4.05A. The battery will be able to run these for 4.0/4.05, or just a whisker under one hour.

Similarly, you could run, say, four 12V/11W fluoro fittings which each draw about 0.9A (giving a total current of 4 x 0.9 = 3.6A) for a little over an hour (4.0/3.6 = 1.11).

In either case, if you just run one lamp, it will probably run for a few hours.

A manual over-ride switch is included so that you can turn off the 12V lights manually if they're not needed – for example, if there's a blackout during the day.

How it works

Refer now to Fig.1 for the circuit details. As you can see, there's not a lot to it.

At its heart is the 12V/7.2Ah SLA battery, which is maintained at full charge by the external automatic charger when mains power is present. The charging current flows through D1 and directly into the battery. Note that D1 is a 1N5822 Schottky diode, which has a low forward voltage drop (typically 390mV for a charging current of 1A), so it doesn't significantly effect the charger's operation.

The DC input voltage from the charger is also applied to LED1 via a series 1.5kΩ resistor, with the LED current also flowing through the base-emitter junction of transistor Q1. As a result LED1 turns on whenever mains power is present and Q1 is forward biased as well. This causes Q1 to turn on and pull its collector voltage down to a low level (around 400mV).

The collector of Q1 is connected to the reset input (pin 4) of IC1, a 555 timer IC used here as a dual comparator and flipflop. So while ever mains power is present and Q1 is on, IC1 is held in its reset state with its pin 3 output switched low. As a result, the gate of Q4, an N-channel power Mosfet, is also held low also and so Q4 remains off.

Basically, Q4 functions as the switch for the 12V emergency lights. When Q4 is off, the lights are off as well.

Now consider what happens when the mains power fails. When this happens, there is no charging voltage from the SLA charger and so D1 becomes reverse biased. As a result, LED1 turns off and there is no longer any base current for Q1 which turns off as well.

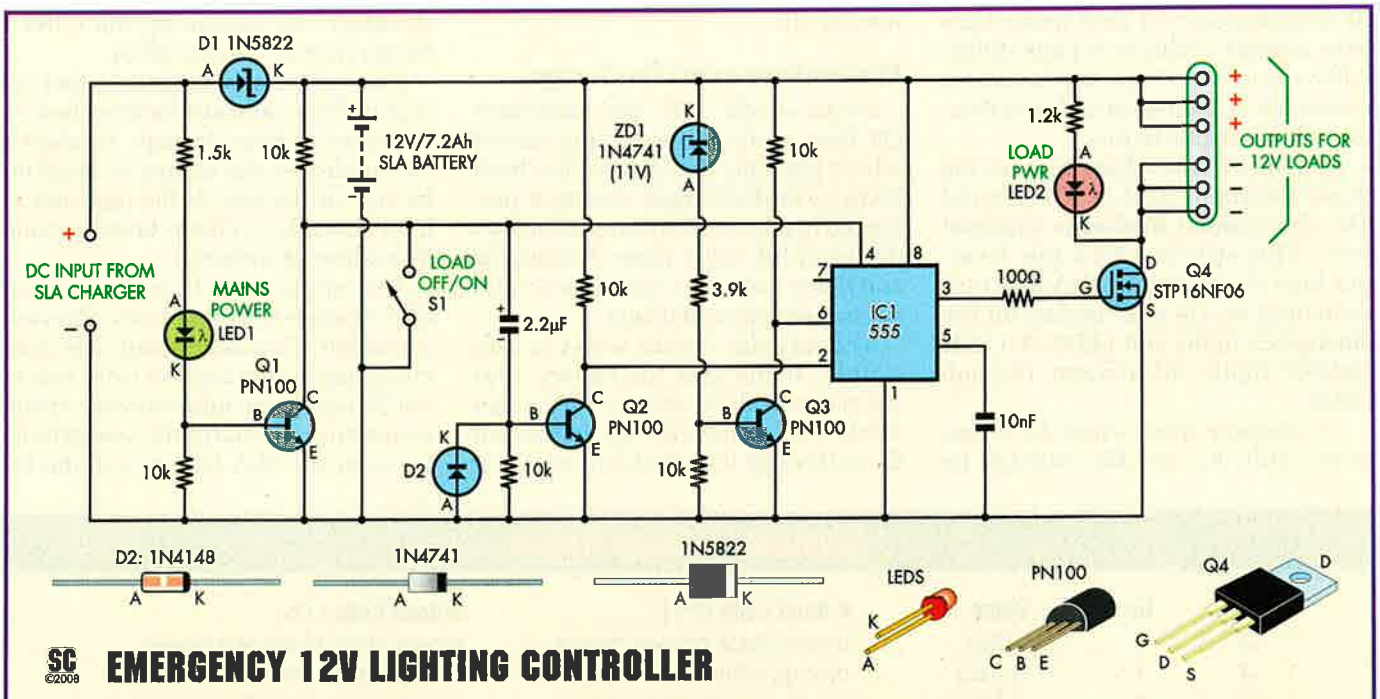


Fig.1: the circuit uses transistors Q1 & Q2 and 555 timer IC1 to detect when the mains fails. When it does, pin 3 of IC1 switches high and Q4 turns on and connects an SLA battery to the emergency lights. Zener diode ZD1 and transistor Q3 trigger IC1 and turn the lights off again to prevent over-discharge if the battery voltage drops below 11.6V.



The Powertech 12V 1A SLA battery charger (Jaycar MB-3526) is ideal for use with the Lighting Controller.

Q1's collector is now pulled high (ie, to the battery voltage) via a 10kΩ resistor, thus removing the reset signal from IC1. At the same time, the 2.2µF capacitor on the reset line pulls the base of transistor Q2 high. Q2 thus turns on and pulls pin 3 (the "lower threshold" comparator input) of IC1 low.

The 2.2µF capacitor now charges via a 10kΩ resistor and as it does so, its charging current (and hence Q2's base current) reduces exponentially. After a very short time, the transistor comes out of saturation and its collector voltage begins to rise.

As soon as this voltage reaches the lower threshold level of IC1 (around 4V), the internal flipflop is triggered "on". This switches IC1's pin 3 output high (ie, to nearly +12V), in turn switching on Q4 and turning on the emergency lights and LED2. A 1.2kΩ resistor limits the current through LED2.

In summary then, when the mains power fails, IC1 quickly switches its pin 3 output high and Q4 and the emergency lights turn on.

If necessary, the lights can be turned off manually or prevented from turning on automatically at all, using override switch S1. When this is closed, IC1's pin 4 reset input is pulled low permanently, regardless as to whether transistor Q1 is conducting or not. As a result IC1 is kept in the reset state and so Q4 and the emergency lights remain off.

Preventing over-discharge

Zener diode ZD1 and transistor Q3 form a simple protection circuit which prevents the SLA battery from being over-discharged during a prolonged blackout. SLA batteries are not designed for really deep discharging and if that did occur, the battery could suffer permanent damage.

The way this circuit works is very simple. While ever the battery voltage remains above about 11.6V, zener diode ZD1 conducts and so current flows through its 3.9kΩ series resistor and the base-emitter junction of transistor Q3. As a result Q3, turns on and pulls pin 6 (the upper threshold input of IC1) to less than 0.5V. This input is therefore kept inactive.

However, if the SLA battery voltage drops just below 11.6V, there is no longer sufficient current through ZD1 to keep Q3 turned on. As a result, Q3 turns off and its collector voltage rises to the battery voltage, taking pin 6 of IC1 with it.

As soon pin 6 reaches its upper threshold level of about 8V (12V x 2/3), IC1's internal flipflop resets and pin 3 switches low. This turns off Q4 and the emergency lights to prevent any further discharging of the battery.

IC1 is now kept in the reset state until the battery voltage rises above 11.6V again, which will normally only happen when the mains power is restored. Of course, once this occurs, Q1 will turn on again and hold IC1 in the reset state, thereby preventing Q4 and the lights from turning on until the mains fails on another occasion.

Construction

Apart from the SLA battery, all of the parts for the Emergency 12V Lighting Controller are installed on a single PC board coded EC8274 and measuring 204 x 64mm. This board has been designed to mount vertically behind the front panel of a vented plastic instrument case measuring 260 x 190 x 80mm (Jaycar Cat.HB-5910).

This case size was chosen so that the SLA battery could also be fitted inside, to protect it from damage. As shown in the photos, the battery is fitted on its side at the rear of the case and is held down by a clamp bracket made from sheet aluminium.

The output cable from the external SLA charger is brought into the case at rear left, via a cable gland. The individual leads then connect to the rear of the PC board via quick-connect spade connectors. Similarly, the connections between the SLA battery and the PC

Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	6	10kΩ	brown black orange brown	brown black black red brown
❑	1	3.9kΩ	orange white red brown	orange white black brown brown
❑	1	1.5kΩ	brown green red brown	brown green black brown brown
❑	1	1.2kΩ	brown red red brown	brown red black brown brown
❑	1	100Ω	brown black brown brown	brown black black black brown

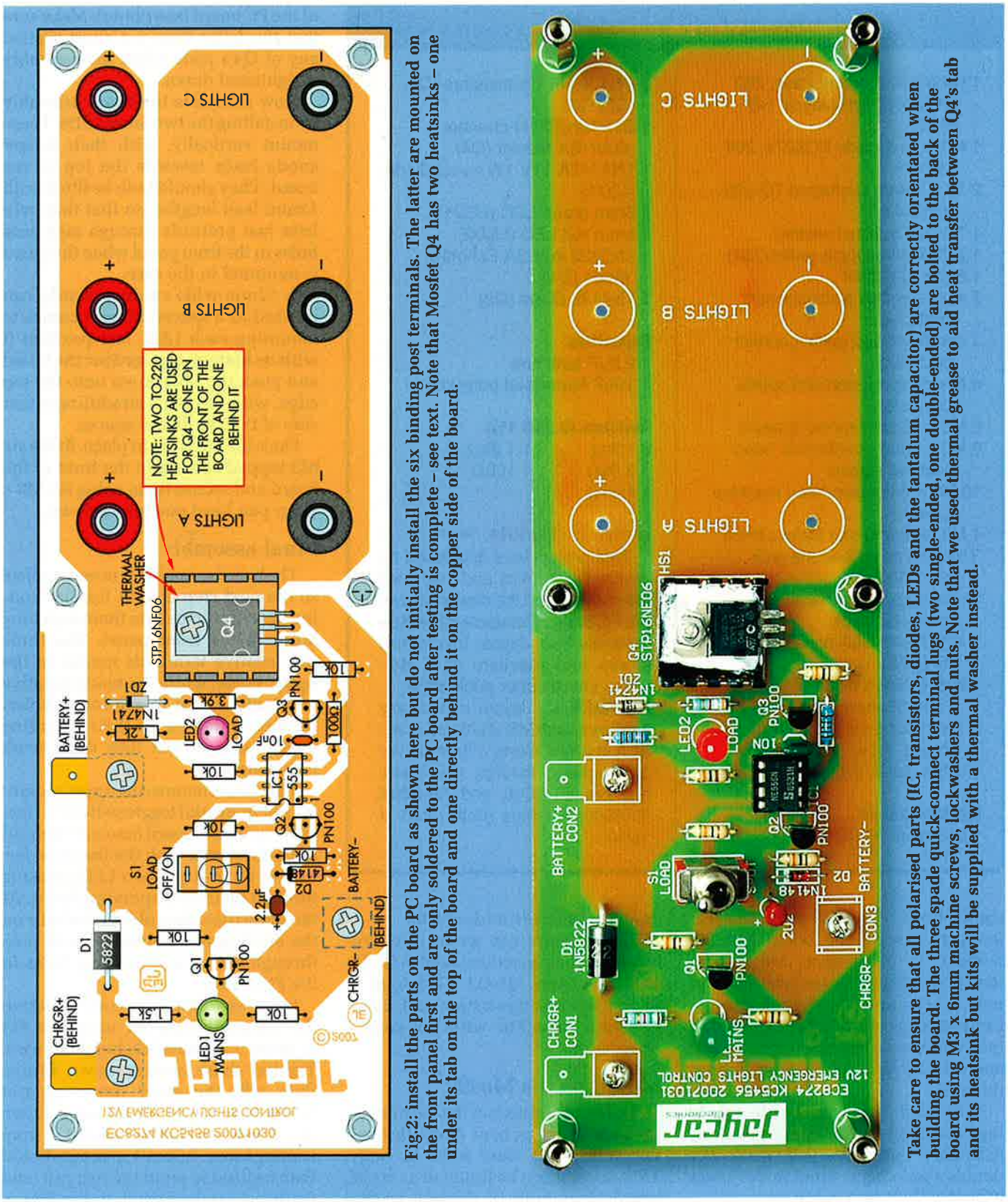


Fig.2: install the parts on the PC board as shown here but do not initially install the six binding post terminals. The latter are mounted on the front panel first and are only soldered to the PC board after testing is complete – see text. Note that Mosfet Q4 has two heatsinks – one under its tab on the top of the board and one directly behind it on the copper side of the board.

Take care to ensure that all polarised parts (IC, transistors, diodes, LEDs and the tantalum capacitor) are correctly orientated when building the board. The three spade quick-connect terminal lugs (two single-ended, one double-ended) are bolted to the back of the board using M3 x 6mm machine screws, lockwashers and nuts. Note that we used thermal grease to aid heat transfer between Q4's tab and its heatsink but kits will be supplied with a thermal washer instead.

board are made via short lengths of heavy-duty cable, fitted with female quick-connect spade connectors at each end.

The six 12V output terminals (binding posts) for the emergency lights (or some other load) are actually initially mounted on the front panel of the case rather than the PC board. Their terminals are then later soldered directly to the PC board copper when the otherwise completed PC board assembly is attached to the panel via six M3 x 15mm tapped spacers.

Fig.2 shows the parts layout on the PC board. The first step in the assembly is to fit the three male spade lug connectors for the charger and battery

Parts List

1 vented instrument case, 260 x 190 x 80mm (Jaycar HB-5910)
1 PC board, code EC8274, 204 x 64mm
2 19 x 19mm U-shaped TO-220 heatsinks
1 TO-220 thermal washer
1 SPDT mini toggle switch (S1)
1 8-pin IC socket
2 single-ended quick-connect spade lugs
1 double-ended quick-connect spade lug
6 female quick-connect spade connectors
6 M3 x 15mm tapped spacers
6 M3 x 6mm countersink head machine screws
10 M3 x 6mm pan-head machine screws
4 M3 nuts and star lockwashers
3 binding posts/banana jack terminals, red
3 binding posts/banana jack terminals, black
1 12V 7.2Ah SLA battery (Jaycar SB-2486)
1 295 x 75mm piece of 18g (1.3mm) aluminium sheet
3 10mm long self-tapping screws, 4g or 5g
1 cable gland, 3-6.5mm cable size

Semiconductors
1 555 timer IC (IC1)
3 PN100 NPN transistors (Q1, Q2, Q3)
1 STP16NF06 N-channel 60V/16A Mosfet (Q4)
1 1N4741A 11V 1W zener diode (ZD1)
1 5mm green LED (LED1)
1 5mm red LED (LED2)
1 1N5822 40V/3A Schottky diode (D1)
1 1N4148 diode (D2)

Capacitors
1 2.2µF tantalum
1 10nF metallised polyester

Resistors (0.25W 1%)
6 10kΩ
1 3.9kΩ
1 1.5kΩ
1 1.2kΩ
1 100Ω

Where To Buy Kits

This project was developed by Jaycar Electronics and they hold the copyright on the design and on the PC board. Complete kits will be available from Jaycar Electronics stores and resellers (Cat. KC-5456) shortly after publication.

In addition, Jaycar can supply the Powertech MB-3526 automatic SLA charger, along with whatever 12V lighting fixtures you need; eg, the ST-3016 and ST-3006 fluorescent lamps (both rated at 16W).

connections. These all fit on the rear (copper) side of the board and are fastened in place using M3 x 6mm machine screws, star lockwashers and nuts. These must be tightened quite firmly to ensure a reliable connection (you will need a Posidrive screwdriver and a small shifting spanner to hold the nut).

Note that the two single spade lugs are fitted in the upper positions (Charger+ and Battery+), while the double spade lug is fitted in the lower (Charger-/Battery-) position.

Once all three spade lugs have been fitted, you can fit the socket for IC1 (with its notch end towards the left), followed by mini toggle switch S1. The switch mounts vertically, with its connection lugs passing down through matching holes in the board and soldered to the pads underneath.

The resistors can go in next, followed by the capacitors, diodes D1-D3 and transistors Q1-Q3. Take care to fit the diodes, transistors and 2.2µF tantalum capacitor with the correct orientation.

Mounting the Mosfet

Mosfet Q4 is next on the list but first its leads must be bent down through 90° at a point 7mm from its body. That done, it can be fastened to the PC board along with its thermal washer and two heatsinks. Secure it using an M3 x 6mm machine screw, flat washer and nut.

As shown in Fig.2, the thermal washer goes between Q4's tab and the heatsink on the top of the board. The second heatsink mounts on the back of the PC board (see photo). Make sure that the latter does not short against any of Q4's pads when the assembly is tightened down.

Now complete the board assembly by installing the two 5mm LEDs. These mount vertically, with their longer anode leads towards the top of the board. They should both be fitted with 12mm lead lengths, so that they will later just protrude through matching holes in the front panel when the board is mounted in the case.

A 12mm-wide cardboard strip can be used as a spacer when it comes to mounting each LED. Just position it with its bottom edge against the board and push the LED down onto the top edge, with the leads straddling either side of the cardboard spacer.

Once the LEDs are in place, fit the six M3 tapped spacers to the front of the board and secure them using six M3 x 6mm pan head machine screws.

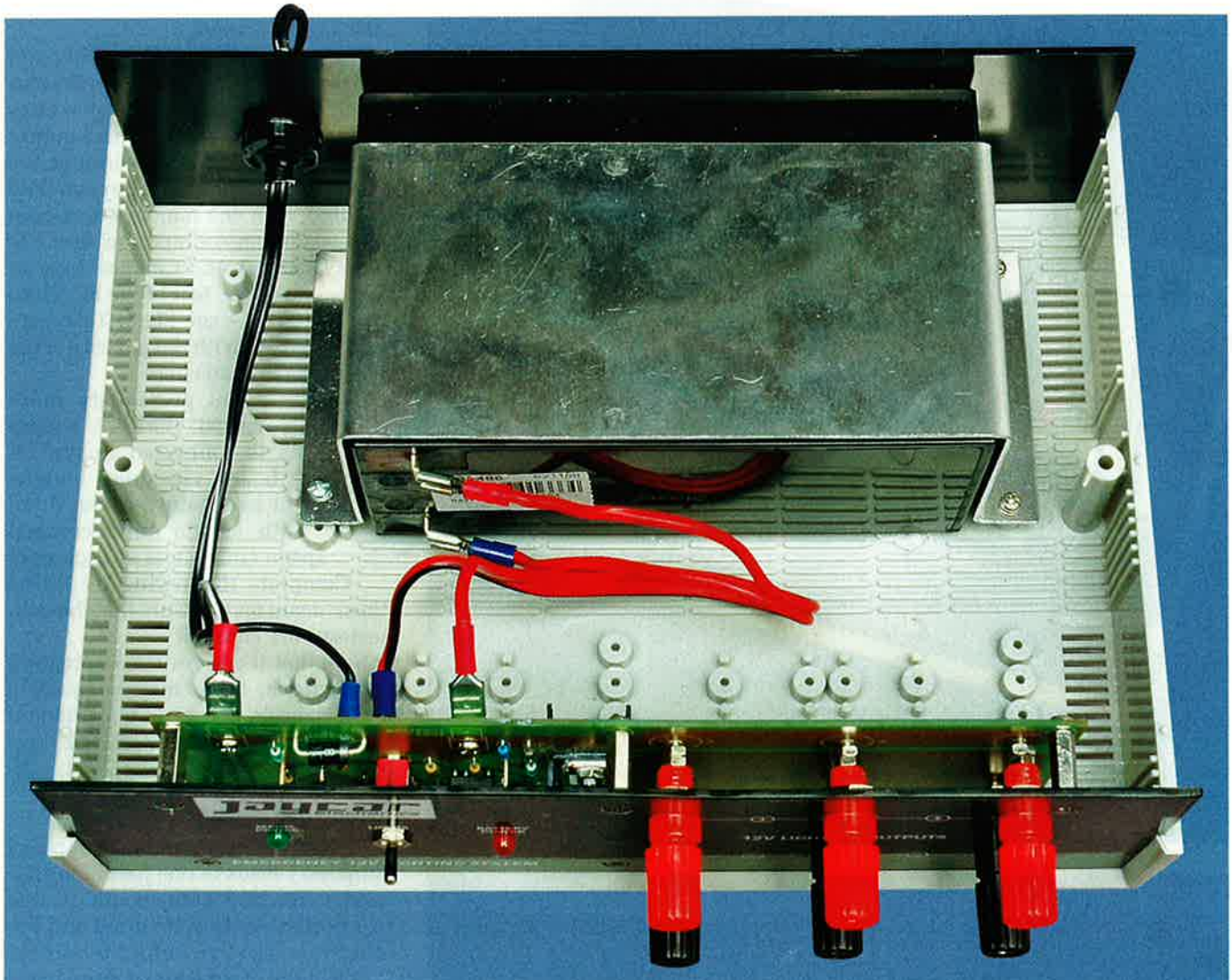
Final assembly

The board assembly is now complete so the next step is to fit the six binding post terminals into their matching holes in the front panel. The three red positive terminals mount in the upper holes, while the black negative terminals mount in the lower holes. Be sure to tighten up their mounting nuts firmly, so that they don't work loose later.

That done, remove the upper mounting nut from mini toggle switch S1, then offer up the PC board assembly behind the front panel, with the threaded ferrule of S1 and the two LEDs passing through their corresponding holes. At the same time, the solder terminals on the binding post sockets should pass through their corresponding holes in the PC board.

Once everything is correct, fasten the assembly together using six M3 x 6mm countersink-head screws. Tighten these screws down firmly, then refit the outer mounting nut to the front of S1, screwing it down just firmly enough to prevent it from coming loose. A small spanner should then be used to wind the rear nut (and washers) up the ferrule to the rear of the panel, to prevent the panel from bowing down when the front nut is tightened.

Do not solder the terminals of the binding posts yet. That step comes later, after the unit has been tested. If you do solder these terminals, you



This is the view inside the completed Emergency 12V Lighting Controller. The battery in the prototype was secured using an aluminium clamp but kit versions will come with large cable ties to secure the battery.

will not be able to access any of the on-board components if something is wrong.

The board/panel assembly can be slipped into the lower half of the case – see photo. That done, you can then turn your attention to making up the mounting clamp bracket for the SLA battery. This is fashioned from the piece of sheet aluminium provided – see Fig.4.

Note that three 4mm diameter holes need to be drilled in the bracket for the mounting screws; it's easier to drill these holes before you bend it into shape.

Fitting the battery

Before fitting the battery into the case, you'll need to cut away some of the short spacing pillars moulded into the base, so the battery will rest on the bottom (this is necessary in order to provide clearance for the case top). The pillars to be cut away are those in the centre, directly below where the battery sits. **Make sure you don't cut away those at either end, which are**

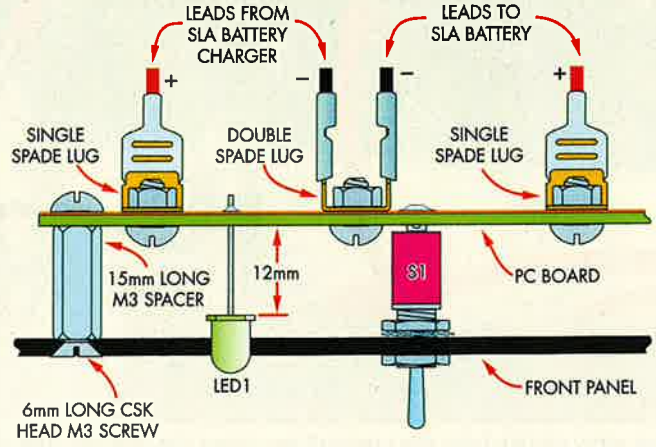
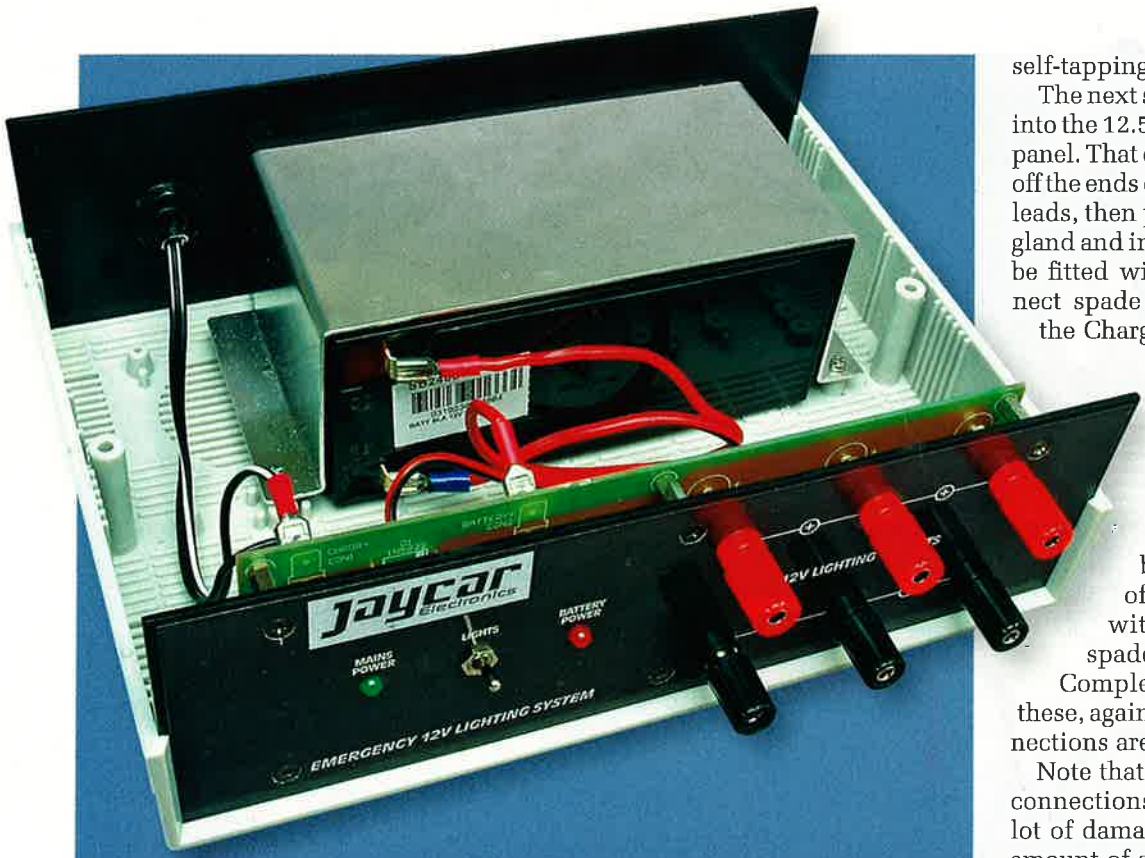
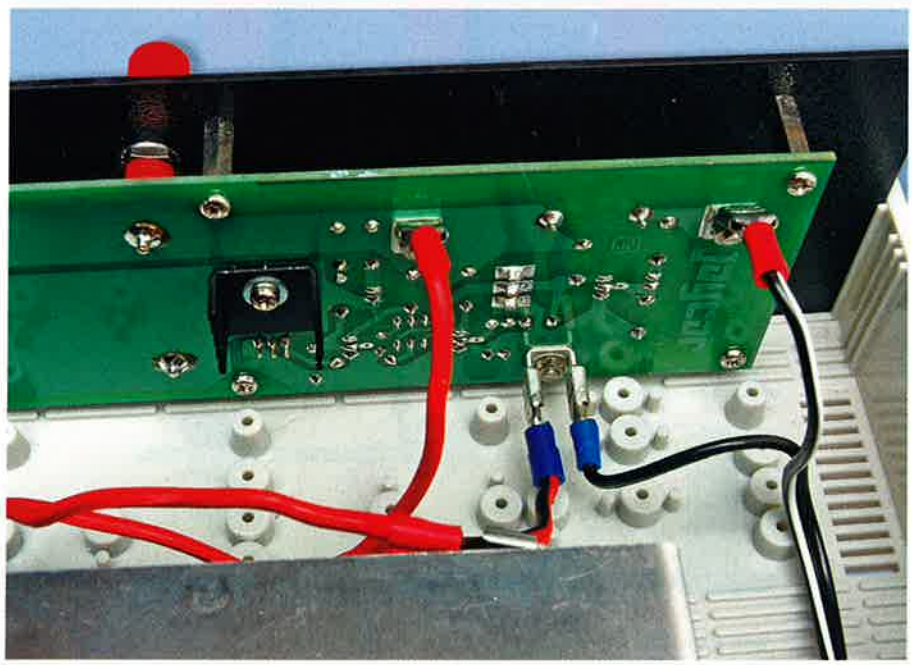


Fig.3: the leads from the battery and the charger are connected to the spade lugs on the back of the PC board using female quick-connect terminals. Note also how switch S1 is secured.



The PC board mounts behind the front panel on six M3 x 15mm tapped spacers, secured at the front using countersink head M3 screws. Note how the charger's leads are secured to the rear panel using a cable gland.



This close-up view shows how the connections from the charger and the SLA battery are run to the PC board, via the quick-connect terminals. Note also the U-shaped heatsink on the back of the board.

used to screw down the battery clamp bracket – see photos.

You should now be able to place the battery on its side in the case and slide the clamp bracket down over it. Complete the job by fastening the clamp bracket to the bottom of the case bottom using three 10mm-long self-tapping screws.

The next step is to fit the cable gland into the 12.5mm round hole in the rear panel. That done, cut the alligator clips off the ends of the SLA charger's output leads, then pass the leads through the gland and into the case. They can then be fitted with the female quick-connect spade connectors and fitted to the Charger+ and Charger- lugs on the rear of the PC board – see Fig.3. Take care with the polarity of the leads here.

As previously mentioned, the SLA battery is connected to the PC board via short lengths of heavy-duty cable, fitted with female quick-connect spade connectors at each end. Complete the wiring by fitting these, again making sure that the connections are correct.

Note that if you reverse the battery connections, there may be quite a lot of damage done and a significant amount of smoke released! You have been warned.

Checking it out

First, lightly tack solder a couple of temporary leads to one pair of output pads on the back of the board (ie, one to a positive output terminal and the other to a negative output terminal). Connect the other ends of these leads to your multimeter and set the meter to the 20V range.

Now plug the SLA charger's mains lead into power outlet and switch on. This should cause the Lighting Controller's green "Power" LED (LED1) to light, indicating that the charger is supplying power to the circuit and to the SLA battery.

If the SLA battery has very little charge in it at this stage, this will be indicated by the charger's red LED glowing. In that case, leave things for a while until the battery charges, with its terminal voltage up to at least 12.5V. This will be indicated by the red LED on the charger going out and the green "trickle" LED turning on instead.

Now make sure that switch S1 is in the "Lights On" (down) position, then switch the charger off at the mains outlet. Within no more than a second or two, LED1 on the Lighting Controller should go out and LED2 should light instead. This indicates that Mosfet Q4 has turned on and that 12V power

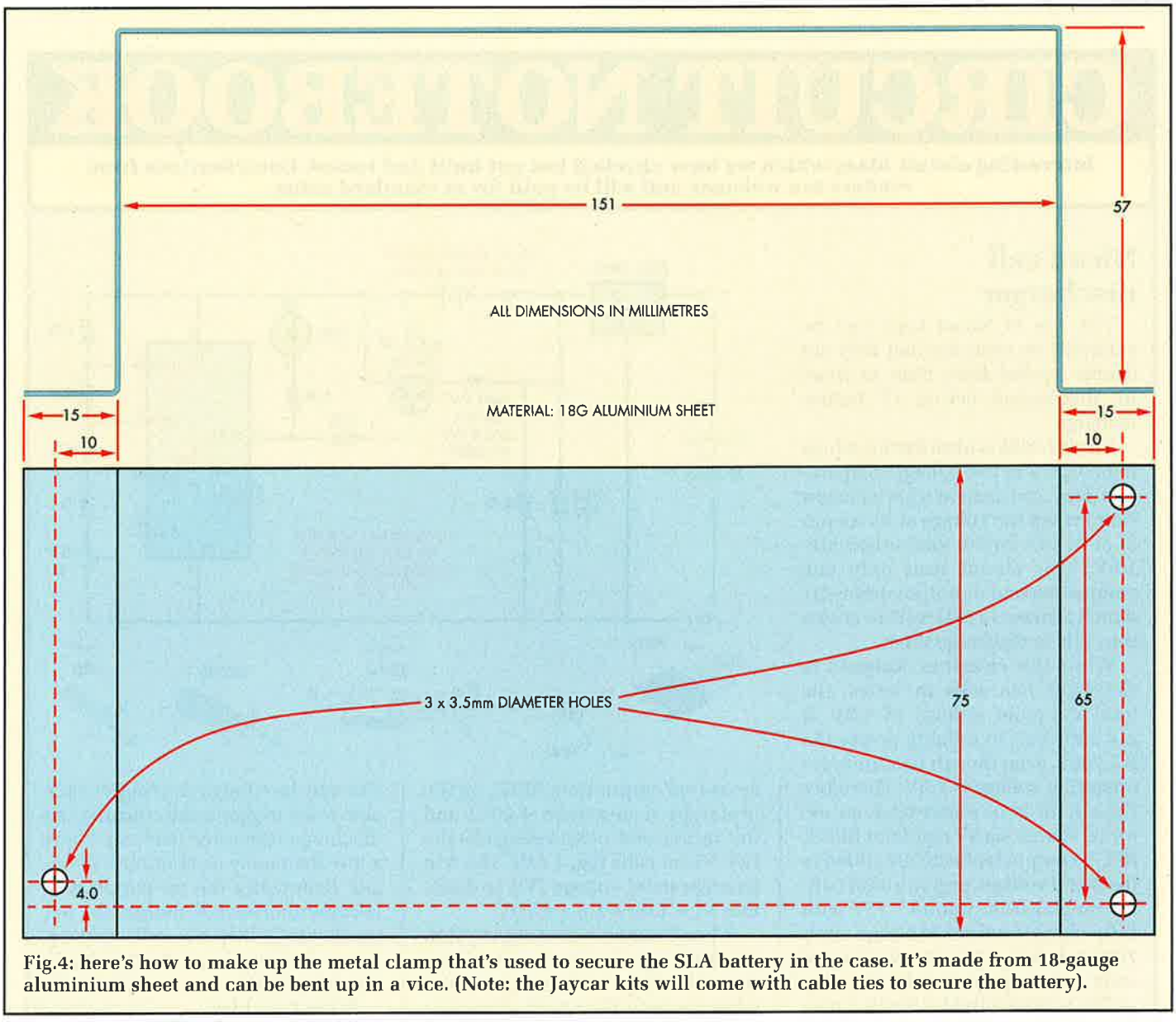


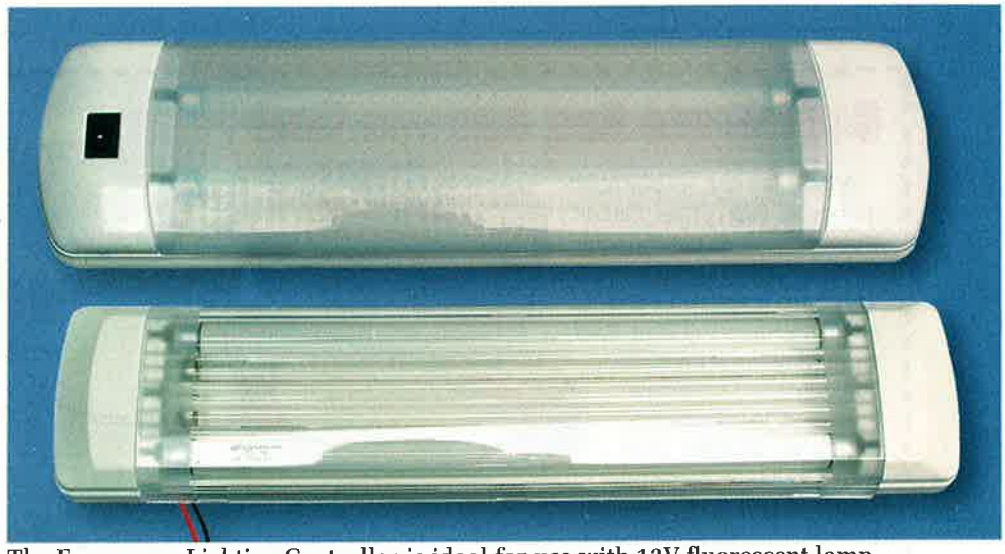
Fig.4: here's how to make up the metal clamp that's used to secure the SLA battery in the case. It's made from 18-gauge aluminium sheet and can be bent up in a vice. (Note: the Jaycar kits will come with cable ties to secure the battery).

from the battery in now available via the output terminals (this should be indicated on your multimeter).

In fact, if you connect a 12V emergency light in place of the meter, it should immediately light.

Assuming it all works, switch off, remove the temporary leads and solder all six binding post terminals. Your Emergency 12V Lighting Controller is now ready for use, so fit the top of the case and fasten it down using the two machine screws supplied. **Once that's done, switch the charger back on so that it can complete the job of topping up the battery's charge.**

While it's doing that, you can now start mounting your 12V emergency lights and running the cabling to them. Be sure to mount the lights in locations where they will be useful when the next blackout occurs. SC



The Emergency Lighting Controller is ideal for use with 12V fluorescent lamp fittings of the type shown here. Both these units are available from Jaycar Electronics (ST-3006 top, ST-3016 bottom), feature twin fluorescent tubes and are rated at 16W.

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.

Nicad cell discharger

The life of Nicad cells can be extended by ensuring that they are deeply cycled from time to time, ie, discharged below 1V before recharge.

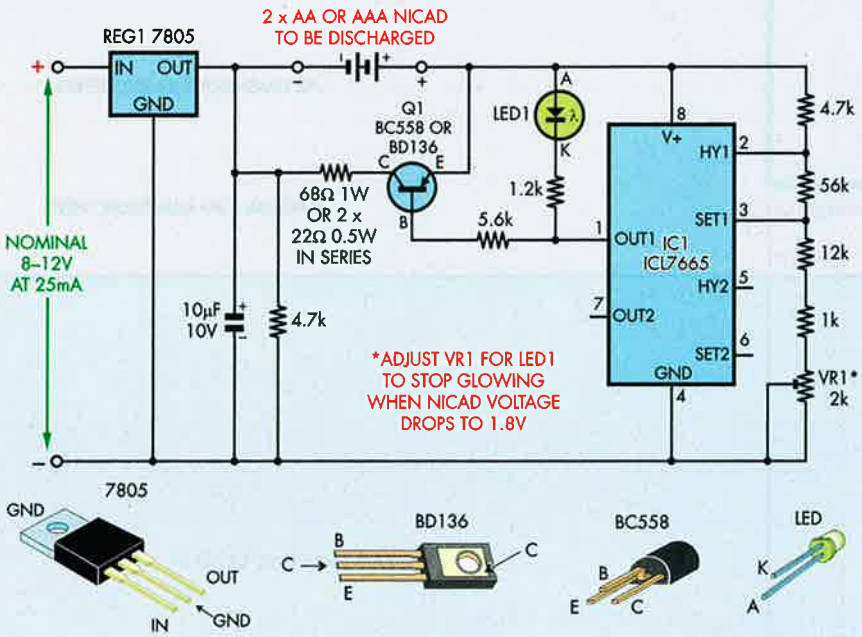
The ICL7665 is ideal for this job, as it incorporates two voltage comparators. Each comparator trips (changes state) when the voltage at its set pin (3 or 6) falls below Vref, nominally 1.3V. This circuit uses only one comparator and its output drives Q1 which connects a 68Ω resistor across the cells to discharge them.

While this circuit is designed to discharge two cells in series, the total-end-point voltage of 1.8V is not sufficient to reliably power the ICL7665, even though its minimum operating voltage is 1.8V. Therefore the circuit is powered from an external source via 5V regulator REG1. REG1's output is effectively added to the 2-cell voltage, to give a total voltage ranging from around 7.75V with fully charged cells and a high-limit 7805 to below 6.7V with discharged cells and a low-limit 7805.

The resistive divider feeding pins 2 & 3 has been calculated using the measured output from REG1 (in the prototype it measured 4.99V) and the desired end-point voltage for the two Nicad cells (eg, 1.8V). The trip (change state) voltage (Vt) is therefore Vt = 4.99 + 1.8 = 6.79V

When Vt reaches the trigger point, the discharge load is removed and the cell voltage will rise again after a few seconds. Despite the presence of a hysteresis resistor (56kΩ), the rise may be enough to bring Vt back above the trigger point, turning the discharge transistor back on. Thus a low frequency oscillation will occur. Eventually the on period will become shorter and shorter, the net result being that the cells end up being discharged to the "no load" voltage of 1.8V.

Brian Critchley,
Elanora Heights, NSW. ($40)



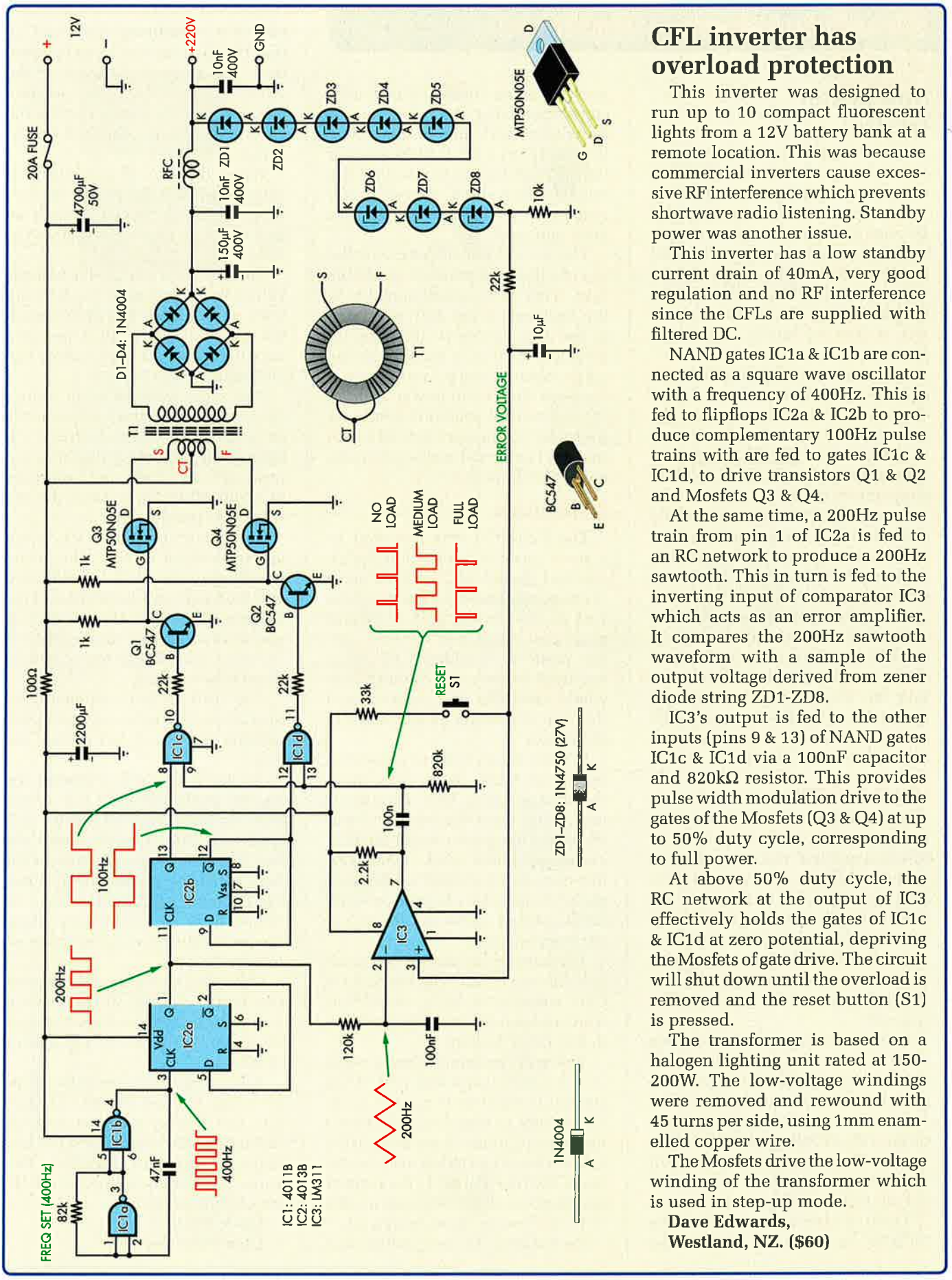
Contribute And Choose Your Prize



As you can see, we pay good money for each of the "Circuit Notebook" items published in SILICON CHIP. But now there are four more reasons to send in your circuit idea. Each month, the best contribution published will entitle the author to choose the prize: an LCR40 LCR meter, a DCA55 Semiconductor Component Analyser, an ESR60 Equivalent Series Resistance Analyser or an SCR100 Thyristor & Triac Analyser, with the compliments of Peak Electronic Design Ltd **www.peakelec.co.uk**

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CFL inverter has overload protection

This inverter was designed to run up to 10 compact fluorescent lights from a 12V battery bank at a remote location. This was because commercial inverters cause excessive RF interference which prevents shortwave radio listening. Standby power was another issue.

This inverter has a low standby current drain of 40mA, very good regulation and no RF interference since the CFLs are supplied with filtered DC.

NAND gates IC1a & IC1b are connected as a square wave oscillator with a frequency of 400Hz. This is fed to flipflops IC2a & IC2b to produce complementary 100Hz pulse trains with are fed to gates IC1c & IC1d, to drive transistors Q1 & Q2 and Mosfets Q3 & Q4.

At the same time, a 200Hz pulse train from pin 1 of IC2a is fed to an RC network to produce a 200Hz sawtooth. This in turn is fed to the inverting input of comparator IC3 which acts as an error amplifier. It compares the 200Hz sawtooth waveform with a sample of the output voltage derived from zener diode string ZD1-ZD8.

IC3's output is fed to the other inputs (pins 9 & 13) of NAND gates IC1c & IC1d via a 100nF capacitor and 820kΩ resistor. This provides pulse width modulation drive to the gates of the Mosfets (Q3 & Q4) at up to 50% duty cycle, corresponding to full power.

At above 50% duty cycle, the RC network at the output of IC3 effectively holds the gates of IC1c & IC1d at zero potential, depriving the Mosfets of gate drive. The circuit will shut down until the overload is removed and the reset button (S1) is pressed.

The transformer is based on a halogen lighting unit rated at 150-200W. The low-voltage windings were removed and rewound with 45 turns per side, using 1mm enamelled copper wire.

The Mosfets drive the low-voltage winding of the transformer which is used in step-up mode.

Dave Edwards,
Westland, NZ. ($60)

Spa heater control

This circuit can be used to replace old or faulty electronic thermostat units for spa/pool gas heaters.

Any spa/pool heater over about 10 years old is likely to use a simple continuous pilot gas valve. The pilot remains alight and a 24V solenoid valve, controlled by a relay and a simple analog electronic thermostat, is used to turn the main gas jets on.

This circuit is a big improvement over the original as it has a digital display and the temperature can be accurately set and controlled. It is based on a PICAXE-18X microcontroller and a Dallas DS18B20 temperature chip.

Because the PICAXE cannot easily drive multiple 7-segment displays, a 74C925 4-digit counter is used to do the job; it only requires three control lines from the micro to drive it. All the program does is reset the 74C925's internal counters, pulse its clock line by the number that is to be displayed and then latch this count into the display register. Because the latch is pulsed at the end of the count cycle all the user sees is the new value being shown.

Safety features

The old controller had two safety features which are incorporated in this design. First, there is a pressure switch which is connected to the heat exchanger. When there is pressure in the pipe (ie, the pump is on), this switch is closed. The original controller had this in series with its power switch so whenever the pump was turned off the controller shut off.

In the new design, it was desirable to be able to read the temperature with the pump off, so the pressure switch is in series with the power feed to the relay. When the pump is turned off, no voltage is fed to the relay coil. This automatically shuts off the main gas supply but still leaves the controller with power.

There is also a sense line to the PICAXE so it knows whether the pump is on or off and immediately stops energising the relay control transistor (Q3) and extinguishes the pump-on LED (LED2) Even if the PICAXE fails to de-energise the relay due to a glitch, the relay can't remain on as the power feed has been removed.

The second line of defence is the use of a high-temperature resettable fuse. This is mounted directly to the heat exchanger and will open if there is excessive temperature detected. As it is in series with the valve solenoid and power supply, if it opens there is no power to drive the gas control solenoid. While on the subject of the gas valve, be aware that the Honeywell valve solenoids have inbuilt diodes.

Brass tubing

The DS18B20 was mounted in a short piece of brass tubing with one end closed with a small piece of copper (soldered). Thermal paste was applied to the chip to ensure good heat transfer to the end copper plate. A shielded USB cable was used for the connection and the whole assembly was inserted into the heat exchanger in place of the old sensor.

It is important to try to isolate the sensor as much as possible from the surrounding heat exchanger metal; you want the sensor to read the water temperature, not the heat exchanger metal work. Even with this care, I still noticed a difference of about one to two degrees between the displayed value and the actual spa temperature.

The software (spaheater.bas, available for download from the SILICON CHIP website) is fairly straightforward and should be easily modified to suit other heaters.

The main program is just a series of subroutine calls and one of the general B registers is used as a status register to keep track of various heater conditions. Depending on the subroutine, it can either read the status of the relevant bit in the register and perform an action based on this or it can change the state of a bit.

For example, the *temp* subroutine executes a **readtemp** command on the DS18B20 and the value is stored in a free register. However, if the return value is zero, the program assumes there is a fault reading the chip and sets the fault bit on the status register.

When the *gascall* subroutine is called (operates the relay), the first thing it does is check this fault bit and if set, always de-energises the relay.

There are four changeable variable values in the program. The low and high point values are set to match the spa/pool heater minimum and maximum temperature values (eg, 20°C and 40°C).

The other two set-point values determine when the heating cycle stops and then restarts. Setting it 1°C above and 1°C below the set-point produced an on-off cycle duration of about 10 minutes, once the spa was up to temperature.

For example, if the set temperature was set to 37°C, the heater would stay on until it read 38°C and then not come back on until the temperature dropped back to 36°C. If you want to increase the on-off cycle duration, just change one or both of these offset values.

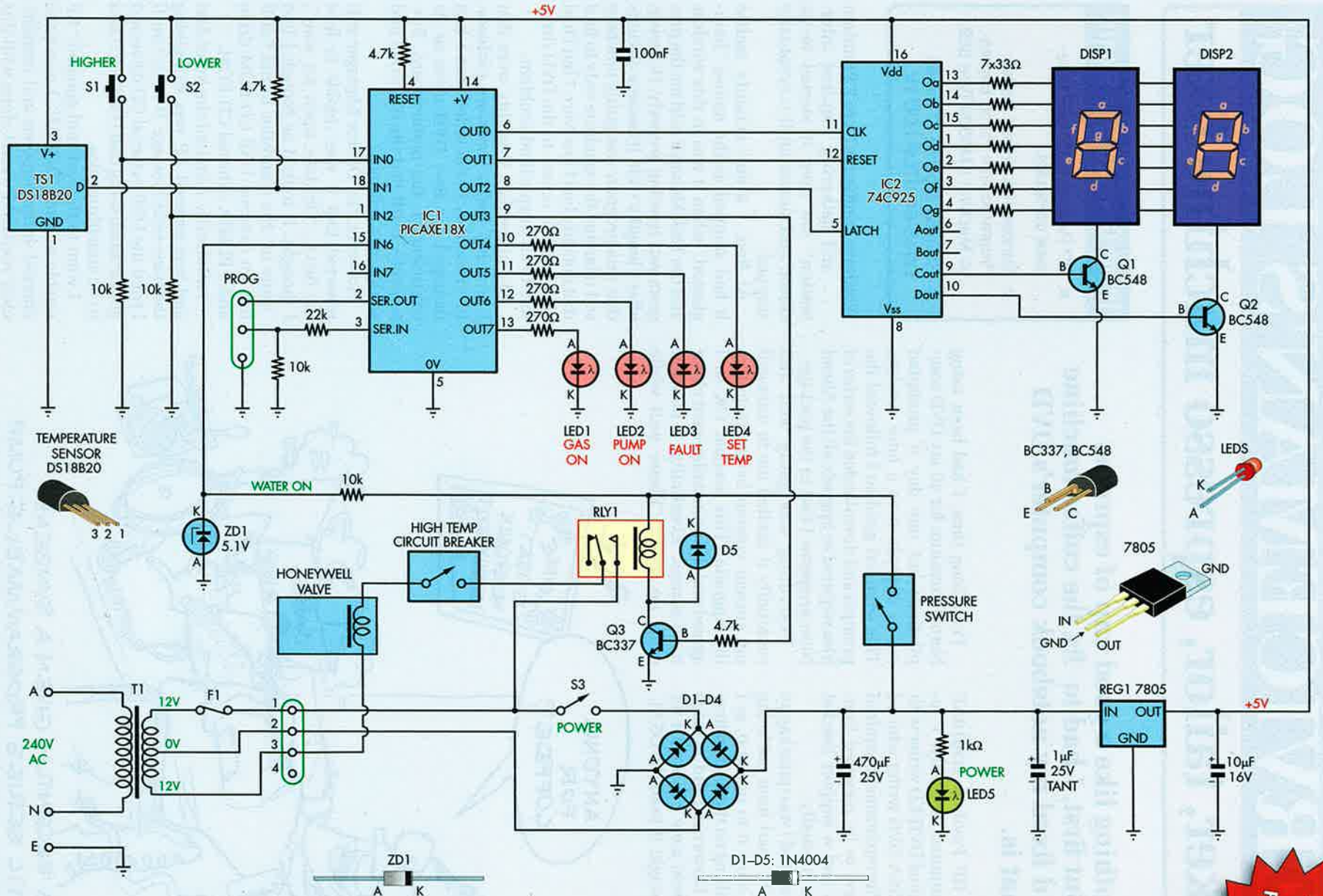
The unit is fully automatic in operation. There are only two push buttons and the on/off switch visible.

To set a desired temperature, simply push and hold one of the buttons until the "set temp" LED turns on. The display shows the last "set temp" value. As soon as the LED turns on, repeatedly pushing the Up button will increase the set temperature and likewise pushing the down button will lower the set temperature.

Once the preconfigured temperature limit is reached, further pushing will not change the display higher or lower than the preconfigured range.

After about 1.5 seconds of no pressing, the "set temp" LED goes out, the display resumes showing the actual temperature and the new value is stored in EEPROM. This value is recalled the next time the unit is turned on.

Clive Allan,
Glen Waverley, Vic.



This spa heater control circuit is based on a PICAXE-18X microcontroller (IC1) and a Dallas DS18B20 temperature chip (TS1). The micro drives transistor Q3 to control relay RLY1 and also drives a 74C925 4-digit counter (IC2). IC2 in turn drives two 7-segment LED displays.

Clive Allan is this month's winner of a Peak Atlas Test Instrument

SERVICEMAN'S LOG

Tinker, tailor, espresso machine fixer

There nothing like a good cup of espresso coffee. But first, I had to fix the coffee machine – after I'd fixed my notebook computer's DVD drive, that is.

I have an HP Pavilion zt3010AP notebook computer. Recently, I replaced its original DVD/CD writer with a Sony DW-P50A DVD writer which I got on eBay. The replacement required only one screw to be removed from the notebook and a support bracket swapped over internally.

All went well and I was quite happy with the results apart from not being able to multi-zone it to region 0, as I could find nothing on the web on how to change it. However, I did manage to change it from zone 2 to zone 4 for Australia (I bought it from the USA).

For a long time, I had been using Nero 7 Premium for all my DVD compilations but one day it prompted me to upgrade it to a later version. This sounded good so I followed the prompts and downloaded the series of files required to upgrade all the Ahead Nero programs I had in the package.

Everything was going well and eventually it invited me to uninstall my current version before installing the upgrade. This seemed OK so I agreed and the uninstaller went about its business. Eventually, a message came up saying "Please wait while Windows configures Nero 7 Premium . . . and gathering required information" but then it started to go slower and slower until it eventually stopped.

At first, I didn't actually realise it had stopped as the mouse "hourglassed" when it was in this window and the Task Manager told me the program was running properly. However, after a lengthy wait, it became obvious that this program was going nowhere so I rebooted the machine only to find that not only had I lost Nero 7 but I had also lost full access to the DVD drive due to an unspecified problem.

My immediate thoughts were that I probably had a hardware problem. In particular, I concluded that I had damaged the new DVD drive or its controller on the motherboard. Fortunately, I still had the old drive and so this was refitted.

However, the Device Manager still reported that it was unable to find the drive. "Oh dear, upon my soul", I thought. It looked as though I had "done in" the controller IC but I still had an external USB CD-ROM drive and a PCMIA external CD-ROM.

I arbitrarily installed the latter first and was amazed XP was still giving the same error message. It wasn't until I tried the USB external CD drive and got the same thing that I realised it had to be something else.

I went to the web and googled "XP unable to find CD-ROM". I was quite amazed at the response and immediately realised I wasn't alone with this particular problem.

Items Covered This Month

- HP Pavilion zt3010AP notebook computer.
- Sunbeam Aromatic Series Programmable Pump Espresso Machine EM5800 Type 569.
- Grundig Arganto 17 model LW4S-6410TOP LCD TV



Apparently, when messing around with burning software, XP can sometimes become confused. The fix is to first go to the Device Manager and uninstall the device (ignoring any warnings). That done, you then run REGEDIT and go to HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Class\{4D36E965-E325-11CE-BFC1-08002BE10318}, delete the UpperFilters and LowerFilters entries and then reboot.

This fixed the problem and even when I reinstalled the original DVD burner, it still worked. I then reinstalled Nero 7 and everything was back to normal again.



Anyone for coffee?

I was recently given a Sunbeam Aromatic Series Programmable Pump Espresso Machine EM5800 Type 569. It was only a few years old and apart from being a bit dirty, still looked pretty good.

Mrs Serviceman was ecstatic and after cleaning it, filled it up and made us both a nice cappuccino. Everything went well and we enjoyed the coffee but when she went back into the kitchen, the machine smelt very hot and was, in fact, too hot to touch.

She called me in and I checked to see if the machine was switched on. It wasn't, although it was still plugged in. I unplugged it, left it to cool down for several hours and then plugged it in again to try to see what was happening.

Unfortunately, it was now completely dead and I was subsequently unable to locate a service manual or even a circuit diagram for it.

Undaunted, I removed the rear panel by undoing the screws and prizing it off and then had a good look around to see if I could spot the problem. Immediately, I noticed a big black burn mark next to a hole that had burned through a relay in the middle of the PC board. This 12V relay turned out to be an SPST type which switches 240V at up to 7A.

I ordered a replacement from RS Components and by the time it arrived the next day, I had already cleaned up the mess on the PC board from the fire. I immediately fitted the new relay and hopefully switched the machine on but it was still dead.

Next, I followed the 240V mains cabling around from the bottom of the machine to the mains transformer on the PC board and soon found that the Active lead disappeared into some spaghetti sleeving on top of the boiler. I then removed (with difficulty) the top cover of the machine by undoing four self-tapping screws and found that the spaghetti concealed a thermal fuse rated at 240V and 10A. Fortunately, WES Components had these in stock (MT 240) and a new one at last restored power to the unit.

I switched the machine on and the boiler immediately began to heat up. After a few minutes, though, all the lights on the front panel started to flash and nothing else would work.

So there was good news and bad news. The good news was that the boiler was still working and the element hadn't burnt out. The bad news was that the microcontroller was switching into protection mode and shutting everything down.

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I TRIED ABOUT HALF A DOZEN DIFFERENT WAYS TO INSULATE THE CABLE BUT IT STILL CONTINUED TO ARC

So what was prompting the microcontroller to do this? I looked around and tried to decipher how it all worked. The power supply delivered 16V and 5V rails to operate the relay and the microcontroller. The microcontroller monitored a number of sensors as well as the control panel. Its outputs also controlled two optoisolators which in turn switched the sensitive-gate Triacs.

The tactile switches on the control panel were all OK, so I looked at the outputs to the boiler elements and the pump. Though fused, they were all OK, so using a suitable lead, I temporarily connected 240V to the pump from the Triac. It worked, so the pump and the boiler were both OK.

But what was closing it down? I now decided to look at the input sensors, starting with the water reservoir level switch. I unplugged its lead from the PC board and then tried switching on the power. I also tried shorting its terminals on the board but neither approach worked.

Next, I checked out the temperature thermostat. This has a sender in a brass collar that's screwed into the boiler head. The only trouble was one of its white leads had broken off right where it disappeared into the brass collar.

I removed the assembly and carefully dug out the glass temperature sender from the silicone rubber.

There was no way of knowing its value or even what type of temperature sender it was. In fact, the glass envelope looked like a neon and not like a thermistor.

Anyway, I was lucky in that not only was the glass envelope still intact but there was also enough wire outside for me to resolder the lead. I then dipped it into heatsink compound and pushed it back into the brass collar before sealing the end with silicone.

This time when I switched it on, the whole machine began to function correctly. However, I subsequently noticed that the boiler was leaking all over the place when steam was in it. Tightening the screws on the head improved this but I suspect that the gasket was probably left the worse for wear when the relay failed and the boiler overheated.

The espresso machine is now in regular use and apart from still leaking quite a bit and the temperature being a bit low, works well enough to have a regular cappuccino.

There is a trimpot on the PC board but I have no idea what it is for. It might set the temperature but I'm not sure, so I have left it as it is.

Faulty Grundig LCD TV

A 2-year old Grundig Arganto 17 model LW4S-6410TOP LCD TV came in, its owner complaining that there was no picture. The client was somewhat upset because this $1500 17-inch (43cm) LCD TV was just out of warranty.

The first thing I noticed was that the AC adapter he brought in was labelled "Philips" and had an output of 16V, whereas the set was rated at only 12V. I quizzed the client about this and he said he had bought the last model in stock at the time and this AC adapter had been packed up with the set by the salesman.

I did not really know how significant it was to overrun the set by 33%, so I let this go while I tried to find out what had failed. When I switched it on, the front-panel LED changed from red to green but just as the client said, there was no sound or picture.

Dismantling this set is generally straightforward, although you do have to remove the internal metalwork screening and bend the edges out to clear the AV sockets. Once inside, my suspicion was that the motherboard had probably been manufactured by Philips but there were no real clues on this.

Next, I tried powering up the set again and checked the remote. It was able to go in and out of Standby OK and I noticed that there was a flash on the screen for about a second when the set was switched on.

The two boards accessible with the covers off are the tuner board and the main board. However, getting at the inverter board involves removing the display and the main chassis as it is situated between them.

The display is both screwed in and clipped into the front escutcheon. Once it was out, I could see the dual inverter and the leads going to the four 400 x 2mm backlights at the top and bottom of the Fujitsu display. I could also see that the insulated silicone leads supplying the high voltage to the top backlight pair had been burnt.

I carefully supported these leads to prevent any arcing and switched the set on. All the backlights lit and so did the display, so I was now getting somewhere.

Now that I could see the on-screen menus, I navigated through them and tuned the set to my local area trans-

mitters. The picture was excellent and with the speakers plugged in, the sound was good too.

This meant that all I had to do was insulate the leads to the backlight and use the correct 12V 5A power supply to complete the repair – or so I thought. In fact, I tried about half a dozen different ways to insulate the cable but it still continued to arc. This was no doubt due to the fact that it lay in a very constricted area, so that it was up against the earthed metalwork. I even cut the offending lead and put heatshrink sleeving and silicone rubber around the join but it still arced.

Next, I tried swapping over the top and bottom backlights but in the end it looked as though it was actually arcing through the backlight end plastic supports! I tried to purchase the backlights through the internet but couldn't find any. These are part and parcel of the Fujitsu display and are no longer available as a spare part from Grundig.

Grundig refused to accept that this set was under warranty because an incorrect power supply had been used (despite the clearly marked labels) and they were well within their rights. I wouldn't have accepted it either.

In the end, it was the store that was liable – after all, it was the salesman who had packed the wrong supply. They came to the party and swapped the set for a later model for free.

Philips LCD set

Back in September 2007, I ran a story on a Philips I5PF9936/69 (LC03 chassis) LCD TV with a no-picture fault. At the time, I concluded that this was due to an intermittent short on the 5V rail inside the display itself.

However, I finally managed to disprove this when another identical set came in with a defective backlight inverter. Taking advantage of this, I swapped the display over and it made no difference! So much for my faulty display theory.

In the end, it turned out to be the scalar board that was at fault. This totally threw me, as I had been able to artificially bring up the picture by supplying a 5V rail to the display.

Unfortunately, I didn't manage to locate the precise component that was causing the problem. However, I did at least manage to reduce it to the board above.

Digital set-top boxes

We had five Toshiba Digital Set-Top Boxes (DSTB) come in and were told that these were regarded as non-repairable devices. This means that there is no support, no circuits and no spare parts. If it is under warranty it will be replaced; if it isn't it normally becomes landfill.

The models we were dealing with were Toshiba HDS23 and HDS25. The earlier HDS23 model had an insensitive remote control function and in fact, the range was down to just one metre. This was due to noise on the 5V rail feeding the infrared remote receiver in the set-to box itself. Replacing the electros around the 5V IC regulator fixed that problem.

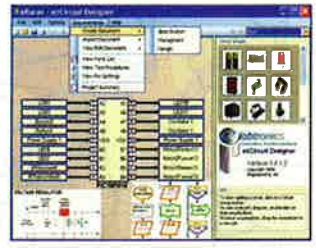
The four HDS25s had a number of different faults. First, the two units with no output each had a faulty switchmode power supply which was fixed by replacing electrolytic capacitors C8, C9 & C17 (all 1000µF).

The third unit kept displaying no signal and couldn't locate any stations. In this case, electrolytic capacitor EC52 (470µF 16V) was close to bursting.

The fourth HDS25 DSTB locked up on "Initialise" and wouldn't boot up. In this case, there was substantial sawtooth ripple on the 5V output from regulator U40 (LDS1085). Capacitor EC29 (100µF 25V) was the main cause but EC49 and EC30 were also at fault.

Generally speaking, many of the electros were dodgy, the favourite value being 470µF 16V 85°C, especially EC31,

NEW! ezCircuit Designer (ezCD)
(See SC Dec 07)
Graphical microcontroller-application design suite



PIC Application Design made simple with ezCD
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b) Part List
c) Test Procedures
d) CoreChart test program

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32, 35, 44, 45, 46 & 51. So if you have one of these units beginning to display some of these symptoms, simply buy yourself some 105°C electrolytics and replace them all.

Hitachi plasma TV

A 2003 Hitachi plasma TV monitor 42PD5000(PWI) came in with no picture or sound.

Switching it on produced a dull raster which meant the plasma display panel was working but there was no picture or on-screen display. This suggested that there was a problem with the main microcomputer in the Formatter Unit.

I tried a factory reset by pressing the "Sub-Power", "Input Select" and "Program Up" buttons at the same time but that made no difference. I also tried a variety of inputs but the symptoms didn't change.

Next, I removed the back cover and immediately noticed the Audio PW1 board on the righthand side, above the Formatter Unit. This board has only five plug connections.

Plug EAJ1 is meant to have 5V and 12V on its pins but the 5V rail was missing. This was a good (not to mention lucky) start.

EAJ1 also plugs into EAJ1 on the JOINT board to its left and the 5V is derived from 5-pin IC regulator TH101 SJ-8050JF (actually a stepdown 5V DC-to-DC converter). I checked the voltages around this IC and could see +30V going into pin 1 but then it got a bit confusing. There was supposed to be 5V out on pins 2 & 4 (pin 3 is ground) but I was getting weird and unusual readings on the voltmeter, ranging from 1.2V to 30V. At one stage, I even read 30V on the pin 2 side of coil LH101 and 1.2V on the other pin 4 side!

Something spooky was going on here – I checked my coffee in case it was spiked but it was OK. The meter was OK too.

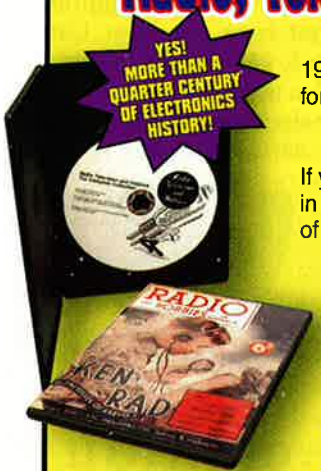
My conclusion was that a new IC regulator was needed and so this was promptly ordered from Hitachi (part No. CP08391). I was very surprised to be informed later that this part was not available and that only the whole JOINT board could be supplied for $287 plus freight!

In view of that, I decided to see if there was a cost-effective work around. I removed the IC and the coil and had a good look around the circuit but couldn't find anything wrong. I then resoldered the IC and coil back in place and switched the set on again to check the voltages.

This time the set came on and the voltages were now all spot on.

It has remained like this for the last three weeks, so it looks like it was only a dry joint that was causing all the problems! SC

Radio, Television & Hobbies: the COMPLETE archive on DVD



This remarkable collection of PDFs ***covers every issue*** of R & H, as it was known from the beginning (April 1939 – price sixpence!) right through to the final edition of R, TV & H in March 1965, before it disappeared forever with the change of name to EA.

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.

Please note: this archive is in PDF format on DVD for PC. Your computer will need a DVD-ROM or DVD-recorder (not a CD!) and Acrobat Reader 6 or above (free download) to enable you to view this archive. This DVD is NOT playable through a standard A/V-type DVD player.

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NEW FOR '08 @ Jaycar Electronics

NEW DIY KITS

Audio Playback Adaptor for CD-ROM Drives

NEW



Ref Silicon Chip Nov 2007. Put those old CD-ROM drives to good use as CD players using this nifty adaptor kit. The adaptor accepts signals from common TV remote controls and operates the audio functions of the drive as easily as you would control a normal CD player. Kit includes a double sided PCB, all electronic components, pre-programmed microcontroller & IDC connectors for the display panel.

Cat. KC-5459 **$64.95**

Motorcycle Construction Kit

Learn about mechanical & electrical construction principles while building your own electric-powered motorcycle. Everything's included, even tools to put it all together. The instructions are excellent, with colour and a detailed parts list.

- 187 piece kit
- Suitable for ages 10+ (contains small parts)
- Measures: 210(L) x 147(W) x 56(H)mm

NEW



Cat. KJ-8900 **$12.95**

301 Piece Construction Kit

NEW

Build a solar-powered motorcycle, a front-end loader or whatever else your imagination can come up with. All parts, fasteners and tools are included as well as an illustrated instruction booklet with colour photos and a comprehensive parts list.



- Tools included
- Motor and solar panel included
- Requires 1 x AA battery

Cat. KJ-8905 **$29.95**

Emergency 12V Lighting Controller

Refer Silicon Chip Magazine January 2008

Automatically supplies power for 12V emergency lighting during a blackout. The system has its own 7.5Ah SLA battery which is maintained via an external smart charger. Includes manual override and over-discharge protection for the battery. Kit supplied with all electronic components, screen printed PCB, front panel and case. Charger and SLA battery available separately.

NEW



Kit may vary from picture.

Cat. KC-5456 **$69.95**

NEW BLUETOOTH MANIA

Stereo Bluetooth Adaptor

Add Bluetooth capability to virtually any audio output device. Just connect your iPod, mobile phone, CD player, or anything with a 3.5mm audio socket to the Bluetooth adaptor and you can transmit stereo audio signals wirelessly.

- Function range: 10 metres



Cat. AR-1854 **$69.95**

Bluetooth Boom Box

Play your MP3s wirelessly on this excellent powered speaker system. Can also be used with wired audio devices.

- Function range: 10m
- Dimensions: 380(L) x 160(H) x 190(D)mm



Cat. AR-1856 **$149.95**

Tiny Bluetooth Adaptor

Don't be fooled by its tiny size. This little beauty has all the functions of larger adaptors but will sit almost unnoticed in your notebook's USB port.



- Measures 23mm long including USB connector

Cat. XC-4892 **$39.95**

Must Have Desk Accessory

Colour Weather Station with Digital Photo Viewer

One display shows up to 50 photos or a simple weather image while the other shows indoor/outdoor temperatures, humidity, barometric pressure on colourful bargraphs as well as clock, calendar and moon phase functions.

- Single image or slideshow
- Unit measures 70(L) x 55(W) x 200(H)mm
- Mains adaptor included or can stand alone using 3 x AAA batteries
- Wireless RF transmitter with 75m range



Cat. XC-0344 **$129.95**

NEW

Watch TV Anywhere

TFT 3.5" Portable LCD Digital TV

Catch local digital TV broadcasts with crystal clear reception and audio quality. Rechargeable battery, plugpack, headphones, car adaptor and AV lead included.

- Resolution: 480 x 234 pixels
- A/V decoding: MPEG2
- 135(L) x 85(H) x 30(D)mm

Cat. QM-3775 **$299.00**

NEW



Onselling Power Made Easy

Mains Power Meter

The meter can tell you how much an appliance is costing to run and tracks the actual power being used. It can also display the instantaneous voltage or current being drawn as well as peak levels etc. 10A max rating.



Cat. MS-6115 **$39.95**

Personal Safety

Mini 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



NEW

Cat. LA-5182 **$9.95**

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49

ENTERTAINMENT REDUCTIONS

Watch Foxtel All Over The House



Hassle-free sharing of audio and video signals all over the house without the inconvenience and cost of running wires. This powerful 5.8GHz sender will ensure crystal clear reception.
- Not ACA approved
- Extra receivers available

SAVE $50.00

Was $249.00

Cat. AR-1840 **$199.00**

Video Enhancer & Stabiliser



By adding a small amount of high frequency boost you can improve the video signal from your old video tapes when copying them to DVD etc. Picture quality & stability can also be enhanced by removing the "piggyback" information found on some signals to give a cleaner, better quality video signal for recording or viewing. Mains plugpack and RCA cable supplied. Was $49.95

SAVE $10.00

Cat. AR-1820 **$39.95**

30W Professional PA Amplifier - Mains or 12VDC Powered



A versatile PA amplifier that can be powered from either mains power for home, office or factory use, or 12VDC for portable applications like busking or spruiking.
- 20WRMS @ 4ohm (30W Max @ 4ohm)
- Output impedance: 4 to 16 ohms
- 245mm wide

SAVE $10.00

Was $99.95

Cat. AA-0415 **$89.95**

Stereo Amplifier

This is a good looking, no-nonsense stereo amplifier that is rated at a generous 100 watts RMS per channel and will form the heart of an impressive stereo system.
- Inputs for Mic, Tape, Tuner, AV1, AV2, CD, Phono
- Approx 420mm wide

Was $199.00

SAVE $20.00



Cat. AA-0470 **$179.00**

Wireless Remote Control Extender



This stylish device extends the transmitting range of your infrared remote controlled appliances in the home or office. Ideal if you have your DVD or Foxtel box in one room, but watch the TV in another. Supplied with two AC power adaptors.

Was $49.95

SAVE $10.00

Cat. AR-1810 **$39.95**

UHF VHF TV Indoor Antenna



The ultimate indoor antenna - built-in mixer for UHF/VHF/FM - wide frequency band from 40MHz to 890MHz. Directional fine tuning possible with variable direction inner reflector - easy to mount - 75 ohm impedance with coaxial cable and plug.

Was $17.95

SAVE $8.00

Cat. LT-3130 **$9.95**

CHEAPER THAN HIRING!

15" Party Speakers



These specialised party speakers provide good performance in back yards, tents, party rooms or community halls etc. Although rated at 120 Watts RMS plus, they can be driven by amplifiers with modest outputs and still provide impressive sound. Overload protected
- 15 inch Woofer
- Piezo tweeters

Cheaper than Hiring

Cat. CS-2515 **$179.00**

Dual Channel UHF Wireless Microphone



This two channel system supports two separate microphones. Each channel has a separate balanced XLR output. A single unbalanced (mixed) line output is also available. The system includes 2 microphones and batteries, receiver unit and plugpack.

Cat. AM-4078 **$199.00**

Rave Fog Machine



Produces clouds of white fog on demand. Fantastic for use with laser light shows, mirror balls and other party lighting. Mains powered.
- 70m³/min fog output
- 800ml fog juice capacity
- Measures 330(L) x 160(W) x 140(H)mm

Cat. AF-1214 **$79.95**

Fog juice available separately - AF-1212

Cat. AF-1212 **$11.95**

200W PA Combo Amp/Speaker

A PA system in a box. 3 channels with balanced and unbalanced inputs, RCA inputs for an auxiliary source. The ideal small PA for schools, sports organisations, churches, weddings, conferences or solo acts.
- 12" speaker
- 2 channel equaliser
- Line level RCA inputs
- Tough moulded enclosure
- Balanced and unbalanced line outs
- 200WRMS power output
- Dimensions: 600(H) x 410(W) x 325(D)mm



Cat. CS-2517 **$399.00**

Tweet Tweet NEW

25mm Dome Tweeter

A compact dome tweeter for bookshelf or satellite speaker applications Magnetically shielded, ferrofluid cooled.
Specifications:
Nominal impedance: 5 ohms
Power handling: 15WRMS
Sensitivity: 92dB at 1m Crossover frequency: 2500Hz.



Cat. CT-2000 **$34.95**

See website for our full speaker range

Jogging Radio

AM/FM Jogging Radio

NEW

This portable radio is perfect for the exercise junkie. The handy external control attachment allows you to tuck the main unit in a secure pocket or bum bag but still control the volume and station.
- Earphones supplied
- Requires 2 x AAA batteries.
- Main unit 88(L) x 20(W) x 50(H)mm



Cat. AR-1743 **$39.95**

Look After Your Environment!

Home Theatre Power Board



Comprehensive protection for your home theatre system! Mains power surge protection and filtering is provided on all mains outlets. Overload protection via the in-built circuit breaker. The power board also includes protection for telephone, network data connection, satellite/cable TV video and TV aerials connections.

Cat. MS-4024 **$59.95**

Universal Remote Control



This universal remote can operate up to 8 different devices and comes pre-programmed for over 100 brands. Large backlit cool-blue display.
- 210mm high
- Batteries included

Cat. AR-1725 **$34.95**

NEW Game Console Leads

Playstation® A/V Cable - 1.8m
A/V cable for connecting Playstation®, PS1®, PS2® or PS3®. RCA connections with composite video and audio.



WV-7430

Playstation 3® Cable 1.8m
Playstation 3® to RGB component video, composite video and stereo audio. 1.8m long.



WV-7432

PS3® S-Video Upgrade Cable
Upgrade and get better, clearer, video from your PS3®. Also has standard composite video and stereo audio. 1.8m long.



WV-7434

Nintendo Wii® S-Video Upgrade Cable
Upgrade and get better, clearer video from your Wii®. Also has standard composite video and stereo audio. 1.8m long.



WV-7436

Nintendo Wii® Component Video Upgrade Cable
Get the ultimate in on-screen quality from your Nintendo Wii®. Includes stereo sound. 1.8m long.



WV-7438

FROM **$24.95**

HDMI In-Line Repeater/Extender

Extend the range of any HDMI device such as a monitor or TV, set-top box, DVD player, PC or gaming system up to 60 metres*.
*Note: Multiple extenders are required for cable runs above 10m to a maximum of 60m.



Cat. AC-1698 **$79.95**

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Travel in Peace

Noise Cancelling Folding Headphones

NEW



These hi-tech wonders have a built-in noise cancelling circuit that reduces background noise by as much as 18dB. A fold-away design makes for easy storage and adaptors are included for airline use. Batteries included. Great value!

Cat. AA-2055 **$59.95**

Pump it Up!

240VAC Low Pressure Air Pump

NEW

This convenient and versatile 240 volt air pump comes equipped with 4 adaptors to fit valves on pool toys, airbeds and other inflatable devices. It will inflate or deflate items in next-to-no-time and can run continuously for up to 30 minutes. Ideal for summertime fun. Just plug it into a power point.



Cat. GH-1111 **$24.95**

PREVENT DRIVEWAY ACCIDENTS

2.4GHz Wireless Reversing Camera

Simply splice the monitor's power line into the car's reversing light cable at the front of the car and the camera at the back of the car. Selecting reverse gear activates the camera and monitor and you get a clear view of the area behind your car.

- 2.4" wireless colour LCD screen
- Colour CMOS camera
- 110° Camera viewing angle

NEW

Two models available
QC-3271 with number plate camera
QC-3725 with waterproof bullet camera



Cat. QC-3721 **$269.00**

Cat. QC-3725 **$249.00**

Battery, Charger and Alternator Tester

A nifty device to quickly indicate the condition of your 12V battery, charger or alternator. Uses three LEDs to indicate battery condition.
QP-2259 24V available separately $12.95



Cat. QP-2258 **$9.95**

Rack-Mount PA Amplifier

NEW

Fits a standard 19" rack and suitable for lower powered applications such as churches, schools etc.
Two types available:
AA-0476: Rack-Mount PA Amplifier 2 x 80WRMS
S/N ratio: 85dB
Dimensions: 440(W) x 90(H) x 245(D)mm
AA-0478: Rack-Mount PA Amplifier 2 x 160WRMS
S/N ratio: 95dB
Dimensions: 480(W) x 135(H) x 245(D)mm



Cat. AA-0476 **$199.00**

Bluetooth Rear Vision Mirror LCD Monitor

NEW

Why settle for a simple rear view mirror when you can have the added functionality of this Bluetooth capable monitor? Connect it to an in-car DVD player or use it with your Bluetooth phone for hands-free communication or connect it to a reverse camera. The high reflectivity of the device allows you to use it as a regular rear vision mirror when not in use.



- 2 composite video inputs
- Built-in caller id
- Remote control included

Cat. QM-3763 **$299.00**

AUTOMOTIVE DIY KITS

Digital Speedometer/Speed Alert

Refer Silicon Chip November/December 1999

A combined speedometer / speed alert that fits neatly into a small jiffy box for mounting on your dashboard. Features a 3-digit LED display, 0-255km/h range with visual and audible alert. Kit includes PCBs, with laser cut silk-screened black jiffy box, red acrylic, pre-wound speed sensor bobbin and wire, pre-programmed microprocessor, magnets and all electronic components.



Cat. KC-5279 **$64.95**

Screecher Car Alarm MKII

Ref: Electronics Australia January 1999

The Screecher MK II is very effective and produces an ear-piercing scream that will scare the pants off any would be thief. It is easy to construct and features entry delay with a soft warning tone, exit delay and high intensity deterrent LED.

- Kit includes PCB, siren, all electronic components and two adhesive warning stickers for no extra cost.



Cat. KA-1813 **$29.95**

SOUND ACCESSORIES

RESPONSE Subwoofers

These impressive new speakers look as good as they sound. They feature huge power handling and will really lift the performance of your system.
Two models available.



CS-2352 - 10"
Specifications:

Nominal impedance:	4 ohms
Power handling:	250WRMS
Efficiency:	84dB SPL @ 1W
Qts:	0.46
Fs:	30.3Hz
Vas:	29.8 litres

Cat. CS-2352 **$199.00**

CS-2354 - 12"
Specifications:

Nominal impedance:	4 ohms
Power handling:	300WRMS
Efficiency:	86dB SPL @ 1W
Qts:	0.42
Fs:	25.8Hz
Vas:	72.5 litres

NEW

Cat. CS-2354 **$249.00**

Response Under-Seat Active Subwoofer

This integrated amp/subwoofer will fit under your car's seat for that pounding seat-of-the-pants bass experience. It also has a wired remote control unit with mute and volume controls. Line level (RCA) inputs or speaker signal inputs.

- 130mm polycone woofer
- Power: 90W RMS
- Frequency response: 80 - 200Hz
- Dimensions: 288(L) x 200(W) x 69(H)mm

NEW



Cat. CS-2273 **$129.95**

4 x 100WRMS Full Range Car Amplifier

This is a very efficient amp designed to drive full range speakers and is able to produce 550W bridged. It has insert-type connectors, pass through RCA outputs, variable high and low pass filters and variable bass boost.
Specifications:
Power / channel @ 4ohm 14.4V: 100WRMS x 4
Power / channel @ 2ohm 14.4V: 150WRMS x 4
Power / bridged @ 4ohm 14.4V: 300WRMS x 2

NEW



Cat. AA-0456 **$399.00**

AUTOMOTIVE SAVINGS

7" LCD Roof Mount Monitor with Media Player

The feature packed monitor supports SD, MMC, MS, XD and CF cards. It has has dual AV input and a USB port to connect to a laptop or PC game consol. It will play MP3, MP4, AVI, WMA files and has a built-in FM transmitter and stereo IR sound output for use with headphones etc. Versatility plus. **Was $299.00**



SAVE $50.00

Cat. QM-3764 **$249.00**

MP3 Player Cassette Adaptor

Lets you play your favourite MP3 tracks on any car cassette player. Excellent sound quality!

- Built-in 3.7V 250mAh battery
- Supports SD, mini SD and MMC cards. **Was $69.95**



SAVE $20.00

Cat. AR-1764 **$49.95**

Economy Car Alarm

An economy alarm that has many of the advanced features you would normally only expect to find on more expensive systems. Fantastic value. Includes

- Electronic black box controller
- Shock sensor
- Ignition cut-out relay
- Wiring looms **Was $89.00**



SAVE $10.00

Cat. LA-9000 **$79.00**

SOLAR LIGHTING

Solar Powered LED RGB Ropelights 5m

This is perfect outdoor lighting decoration and it doesn't need a power point. Just place the solar panel in direct sunlight and the system will switch on at night for a super light display. 6 lighting modes, Fully sealed for outdoor use.

2 lengths available
SL-2826 5m
SL-2828 10m



Cat. SL-2826 **$49.95**
Cat. SL-2828 **$79.95**

Solar LED Outdoor Umbrella Light

Provide light at any time for your outdoor setting. The solar panel screws onto the top of the pole to charge during the day and connects into the light fixture via the 1m power lead included.



- 200mm Dia.
- Suitable for umbrella poles 35-50mm
- Rechargeable batteries included

Cat. ST-3293 **$39.95**

Self Contained Solar Lighting System

Everything you need for a basic solar lighting setup. Includes a 5 watt solar panel, 7Ah SLA battery and 2 x 12V 5W fluorescent lights, fittings, and connecting cables. Can also be recharged from the mains with an optional SLA charger, available separately.



NEW

- Replacement globes: SL-2854 $14.95
- Other models available in-store

Cat. MP-4551 **$179.00**

Solar Powered LED Spotlight

This attractive weather resistant spotlight is ideal for protected outdoor locations and has a companion polycrystalline solar panel to keep the internal SLA battery fully charged and ready for use. Runs for around 10 hours on a full charge.



- Lamp measures 145(W) x 95(H) x 75(D)mm
- Other models available in-store

Cat. SL-2716 **$129.00**

Deluxe Solar Educational Kit

A series of do-it-yourself experiments to acquire the basic knowledge of solar energy. Includes Solar cell module, musical unit, plastic lamp, motor accessories and plastic adaptors.



Cat. KJ-6694 **$24.95**

52

Orange Magnetic Strobe Light

With a magnetic base, this portable LED flashing strobe light will stick to any steel surface. Spruce up a party or just attract attention at any shopfront window.



- Requires 2 x AA batteries
- Optional mains adaptor available

Cat. SL-3329 **$19.95**

Solar LED Bicycle Tail Light

This solar powered tail light is a simple and versatile addition to your night riding equipment. The device uses 4 red LEDs that blink in unison creating an easily visible beacon to cars and trucks.



- Requires 2 x AA batteries

NEW

Cat. ST-3276 **$19.95**

1W Multicolour 4 LED Head Torch

Free up your hands with this extremely useful multi-function headlight. It includes 4 frontal LEDs in white, red, blue and green capable of more than 6 different light operations. It also includes one rear red LED to make known your position to those behind you.



NEW

Cat. ST-3288 **$29.95**

Clip-on Rechargeable LED Lamp

This will be the handiest light in the house. It clips on to any surface up to 25mm thick and the lamp can be removed and used as a separate torch. Mains charger included.



- Strong gooseneck
- 18 superbright LEDs
- 180mm high (approx)

Cat. SL-2811 **$39.95**

NEW

LED Table Lamp

Quick and easy lighting solution for your bedside table, living room, study, office or caravan. Six super bright LEDs brightens any dark area or you can dim the light for a softer ambiance.



- 6 LED Lights
- On/Dimmer/Off switch
- Pivoting light head
- Pivoting neck
- Requires 3 x AAA batteries

Cat. ST-3169 **$19.95**

NEW

NEW EASY LIGHTING

Adjustable LED Swivel Light

Brighten up those dark corners in your kitchen cupboards, pantry, garage or caravan. 3 swivelling heads each with 3 LEDs and a mounting bracket for easy installation.



Cat. ST-3168 **$19.95**

- One touch on/off/dimmer operation
- Requires 6 x AAA batteries
- Dimensions: 310(L) x 75(W) x 55(H)mm

Other styles available



Cat. ST-3165 **$9.95**
Cat. ST-3166 **$14.95**
Cat. ST-3167 **$14.95**

X-GLOW CREE LED TORCHES

These fantastic torches utilise Cree high performance LEDs to provide more light and longer globe life than other LED brands. The Cree super bright LEDs produce a clear smooth beam of brilliant white light and turn most of their energy into light without appreciable heat. The LED will last for hundreds of hours and will cold start in sub-zero temperatures. Not only are they incredibly functional but they are encased in a sturdy aluminium frame. If you're looking for reliable, stylish, solid LED torches, the Cree X-Glow are a sound investment.

NEW

80 Lumens



- Water resistant
- 1.5 hrs burn time
- Tactile switch for momentary or permanent lighting.
- Batteries, strap and nylon pouch included
- 97mm long

Cat. ST-3372 **$39.95**

136 Lumens

Perfect for everyday use.

NEW



- Batteries, strap and nylon pouch included
- 211mm long
- Burn time: up to 25hrs
- Water resistant

Cat. ST-3374 **$49.95**

176 Lumens

Perfect for heavy-duty lighting situations.

NEW



- 3 operational modes: High/Low intensity and flashing.
- 60 hrs burn time (High)
- 275mm long
- Requires 3 x D cells

Cat. ST-3376 **$59.95**

Rechargeable - 136 Lumens

Perfect for camping trips or outings where a mains power outlet is hard to find. Car and mains chargers included.



- Includes Nylon pouch & carrying strap
- Water resistant
- 4.5 hrs burn time (high)
- Multi-mode operation: high, low and flashing

NEW

Cat. ST-3378 **$89.95**

LIGHTING CLEARANCE

Solar Powered 6 LED Torch

The torch will run for several hours on a full battery and is ideal for camping or bushwalking. Just keep the torch exposed during the day and you will have a reliable light at night.



- 153mm long with a black rubber finish **Was** $19.95

SAVE $5.00

Cat. ST-3987 **$14.95**

16 LED Dynamo Powered Spot Light

This handy rechargeable spot light has two banks of eight high-brightness LEDs and is powered by a hand cranked dynamo housed in the body. A mains battery charger is included.



Was $39.95

SAVE $10.00

Cat. ST-3290 **$29.95**

FOR INFORMATION AND ORDERING
TELEPHONE> 1800 022 888 INTERNET> www.jaycar.com.au

OUR ANSWER TO SOLVING CLIMATE CHANGE

200 Watt Wind Turbine Generators

These are serious wind turbines at a breakthrough price. They will generate useful power at wind speeds as low as three metres per second (10kph) and deliver their rated output at around eight metres per second (28kph). Some skill is required in construction e.g. concreting, mechanical assembly and rigging etc. See our website or catalogue for full specifications. 12 volt & 24 volt models available. 80kg shipping weight.

12V model MG-4512

24V model MG-4510

New Improved Controller



Cat. MG-4512 **$499.00**

Can Sized 150W 230VAC Inverter

SAVE $10.00

Designed to fit neatly into your car's drink holder, this can sized inverter doesn't need permanent mounting. Featuring a 150W output it has the grunt to power up everything from battery chargers right through to your laptop computer.

Was $49.95

Large Inverter Range In-store

Cat. MI-5121 **$39.95**



SLA Deep-Cycle Gel Batteries

These are genuine deep cycle batteries suitable for remote area power. They can be charged in any position without leaking. Two styles are available.

SB-1696 12V 26Ah

SB-1698 2V 200Ah

Note:- These are high capacity batteries and weigh 14.5kg and 8.3kg respectively.

Cat. SB-1696 **$269.00**

Cat. SB-1698 **$99.95**

Huge Range of batteries In-store



New Year New Fire Alarm Batteries

Eclipse Lithium 9V Battery Pack 2

Essential for smoke detectors, wireless alarm systems etc. Very dependable.

- 200mAh
- Not rechargeable

Cat. SB-2396 **$22.95**



The Ultimate Driver Bit Set

This must be the best driver bit set around. It includes just about everything you could imagine and a few you might not! 100 pieces in all. It even has a wing-nut driver



Cat. TD-2038 **$16.95**

Two Speed 'T' Bar 4.8 Volt Cordless Screwdriver

The clever design minimises slippage or head damage while the T-bar handle gives you precise control. The power button falls naturally under your thumb and is easily operated for long periods without fatigue. Overall length 200mm. Mains charger included.



NEW

Cat. TD-2492 **$29.95**

Adel Nibbling Tool

The best hand nibbler going around. Ideal for chassis-bashing and all sorts of hobby applications. Cut, notch or trim simple or complex shaped holes in plastics, laminates, leather or metal.

Capacity:
Mild steel: 1.2mm
Aluminium: 1.6mm
Plastics: 2mm
Spare punch TH-1767 available separately $44.95





Cat. TH-1765 **$59.95**

NEW JAPANESE PRECISION

Fujiya 175mm Screw Removing Pliers

These Japanese made pliers have an oval serrated hole at the tip of the jaws. You can grab a pan or cheese head screw in this barbed recess, squeeze and turn. If the screw is completely stripped slot/hole these pliers are what you need!

- Soft grip handle

Cat. TH-2330 **$24.95**



Fujiya 110mm Precision Side Cutter

These precision cutters feature high quality tool steel construction with a sturdy box joint and are perfect for cutting super fine wire as well as general workshop use. They are tough with insulated spring-loaded handles for effortless use.

Cat. TH-2332 **$24.95**



Fujiya 110mm Precision Long Nose Pliers

Made to the same exacting specs as the side cutters (TH-2332), these beautifully made Japanese tools have sturdy box joints and insulated, spring-loaded handles.

Cat. TH-2334 **$24.95**



Electrical Insulation Tape

High quality insulation tape suitable for wrapping electrical wires. 8kV breakdown voltage.

- 19mm width x 20m length

Several colours available:
NM-2852 - Yellow/Green
NM-2853 - White
NM-2854 - Red
NM-2855 - Blue
NM-2856 - Black
NM-2857 - Grey



NEW

Each **$ 1.25**

SUPER SAVINGS WHILE STOCKS LAST

12VDC & 240VAC Ni-Cd & Ni-MH Battery Charger with USB Power

Charge your batteries almost anywhere. This universal battery charger runs from mains power, your car's cigarette lighter socket, or your computer's USB socket. Very handy.

Was $39.95



Cat. MB-3539 **$29.95**

SAVE $10.00

Solar Mobile Phone Charger

Simply charge the internal battery via the sun, USB port or mains adaptor for truly portable energy that allows you to charge your phone and other digital devices wherever you are! Keep the battery topped up using free power from the sun.

- Li-ion battery
- 1000mAh capacity
- Suits most phones
- Folded size - 120(L) x 17(W) x 62(H)mm Was $69.95



SAVE $15.00

Cat. MB-3588 **$54.95**

60 Watt Car/Aircraft Laptop Power Adaptor

Use it in the car or in the air. Many aircraft now have in-seat power so you can work from Sydney to London and still play games along the way.

Was $99.95



SAVE $20.00

Cat. MP-3468 **$79.95**

7 Piece Hex Nut Driver Set

Each driver contains a deep socket and duplex colour non-slip rubber handle

- 3mm, 3.5mm, 4mm, 5mm, 5.5mm & 6mm sizes supplied

Was $29.95



SAVE $10.00

Cat. TD-2007 **$19.95**

3 in 1 Stud Detector with Laser Level

This stud detector not only shows you when you are approaching a stud, it tells you when you are spot on as well. Also has live wire detection so you won't hammer a nail into the power wiring. Very handy.

- 9 volt battery included

Was $49.95



Cat. QP-2288 **$39.95**

SAVE $10.00

Cat III Auto Range DMM

Features large digits, Cat III 600V certification, and designed for serious enthusiasts or professionals.

Includes temperature probe

- Capacitance
- Frequency
- Relative measurement

Was $59.95



Cat. QM-1539 **$49.95**

SAVE $10.00

10.5" Digital Photo Frame

This is a fantastic way to show off your digital photos or videos. Huge 10" screen for maximum impact. The files can be loaded via memory card or USB cable (available separately).
Card formats: CF, MS,SD,MMC,SM,XD
Was $299.00

SAVE $50.00

WITH AUDIO



Cat. QM-3768
$249.00
While stock lasts

Two Channel SATA Hard Disk Controller with R.A.I.D.

Supports two SATA hard drives and comes with R.A.I.D. software. The controller can be set up as a R.A.I.D 0 or 1 sub-system to provide enhanced data security. ATA 1.0 compliant.
- 4 channel version XC-4869 also available separately $59.95



NEW

Cat. XC-4868
$39.95

Windows Media Center Remote Control

A Windows Media Centre PC can revolutionise your home entertainment and this remote will put you in command. The remote will let you control the system as easily as you now control the TV.
- Requires 3 x AAA batteries
- 210mm long



Cat. XC-4889
$24.95

DIY KITS

45 Second Voice Recorder Module

Refer Silicon Chip December 2007. This kit has been improved and can now be set up easily to record two, four or eight different messages for random-access playback or a single message for 'tape mode' playback. Also, it now provides cleaner and glitch-free line-level audio output suitable for feeding an amplifier or PA system. It can be powered from any source of 9-14V DC. Supplied with silk screened and solder masked PCB and all electronic components.

NEW



Cat. KC-5454
$39.95

USB Experimenter's Interface Kit

Interface your computer to the real world. There are five digital and two variable gain analogue inputs. Eight digital and two analogue outputs are available. Supplied with all components, silk screened PCB, assembly manual, and software.



Cat. KV-3500
$69.95

2 Port Automatic KVM Switch

This automatic keyboard, video / monitor (KVM) switch allows the user to connect 2 PCs to the one monitor, keyboard and mouse, and switch between them using keyboard hot keys.



Cat. YN-8095
$59.00

NAS Device with Built-in BitTorrent Client

Everything you would expect from a modern network attached storage device and more! Includes a built-in BitTorrent client that can be used to download and share files over the BitTorrent network without the need to have your computer turned on.
- Hard drive not included



Cat. XC-4877
$199.00

USB FUN

USB Bouncer

He'll turn away anyone trying to interfere with your stuff. His internal movement sensor will trigger a series of warnings with a Cockney accent. Six tough guy quotes. Can stand alone using 3 x AAA batteries.



Cat. GE-4088
$24.95

USB Optical Mouse/Skype Phone

This looks just like a normal USB optical wheel mouse, but if you flip up the lid you'll find a fully operational Skype phone. The phone works with common VoIP systems and allows you to make free calls to other computers and low cost calls to landlines and mobiles.



Cat. XM-5136
$59.95

COMPUTER CLEARANCE

USB Dog Camera

This cute camera can be used for video conferencing and features automatic brightness and white balance for optimal performance under varying light conditions.
- 640 x 480 pixel resolution

Was $34.95

SAVE $5.00



Cat. QC-3228
$29.95

USB to Parallel Printer Converter

Connect your standard parallel printer to the latest PDAs & slimline notebook computers with this compact, high speed bi-directional converter. Weighs just 115 grams and requires no external power. Compatible with most printers.
Was $39.95



Cat. XC-4830
$29.95

SAVE $10.00

ACCESS CONTROL

DVR Camera Kit with 2x Dome & 2 x IP56 I/R Cameras

NEW

This multiplexing DVR system comes complete with two mini-dome indoor cameras, two weatherproof outdoor cameras with infrared night vision and four 20 metre pre-wired camera connecting cables and power supply. See website for full specifications.

Cat. QV-3064
$999.00



19" Active Matrix TFT Security Monitor

This rugged high performance TFT monitor is purpose-built for demanding security applications and features a toughened screen to prevent damage. The monitor will accept VGA, S-Video, or composite video input and have interlaced to Progressive scan.
- Up to 1280 line resolution
- Accepts VESA 100 mounting



Cat. QM-3420
$649.00

4 Channel Colour Quad Video Processor

Incorporates freeze frame, zoom and picture in picture at a touch of a button. Alarm in and out connection. Slimline metal case.
While stocks last - not available in all stores

Cat. QC-3377
$249.95



B&W CCD Camera in Metal Case with Audio

This camera utilises a Samsung 1/3" CCD Image Sensor to produce high quality pictures, even in very low lighting conditions. The camera is supplied in a diecast metal case, and uses an onboard electret microphone for audio and small metal mounting bracket.
- 380 TV Lines
- 92° lens angle
- Size 39(L) x 39(W) x 26(H)mm

Was $69.00

SAVE $10.00

Cat. QC-3474
$59.00



Colour CCD Camera in Metal Case

This camera uses a Sony colour CCD sensor. It is mounted inside a diecast metal case and is ideal for use in retail stores & homes etc. Features adjustable focus and audio output.
Was $149.00

Cat. QC-3494
$129.00

SAVE $20.00



FOR INFORMATION AND ORDERING
TELEPHONE> 1800 022 888 INTERNET> www.jaycar.com.au

KITS FOR KIDS

Keep the kids entertained over the school holidays learning something usefull while having fun. Jaycar has an extensive range of Kits for Kids covering all science fields starting from only $9.95, with some suitable from as early as 5yrs+. All materials are supplied except some common household items such as sticky tape, scissors and batteries. See in-store or our website for the full range.

Science Time Kits

- 25 different kits to choose from

Robotic Ball Machine

Construct a miniature ball machine that will shoot foam balls.

- 8yrs+
- Requires 2 x AA batteries



Cat. KJ-8872 **$9.95**

Experimental Cubes

- 6 different kits sold separately

Mysteries of Nature

Water filtration, salt production, metal corrosion and even the formation of lunar craters is explained.

- 25 experiments
- 8yrs+

Cat. KJ-8826 **$29.95**



Kit Projects for Kids

- 8 different kits sold separately

Magnetism

Build an electromagnetic train and a magnetic racing car. Learn about magnetic attraction and opposing forces.

- 20 informative projects
- 5yrs+

Cat. KJ-8804 **$19.95**



Shiatsu Massaging Cushion

Relaxing, tension relieving massage for your back! Just attach to a high backed chair and let one of the 3 programmable settings soothe away those aches and pains. Comes with PSU and control pad.

NEW

- Due mid January

Cat. GH-1762 **$119.00**



Nitro Fueled 4WD Radio Controlled Cars

These cars GO! They are built around a strong yet lightweight aluminium alloy chassis and powered by a slick, 0.18 cubic inch dual speed engine that winds out to an incredible to 28,000rpm. Nitro-fueled. 400mm long.

NEW

- Recommended for ages 12+

While Stocks Last



Cat. GT-3612 **$399.00**

Cat. GT-3610 **$399.00**

Desktop Missile Launcher

Start your own office war. Pan and tilt allow full control over your missiles. No software or computer connection, requires 2 x AA batteries.

Was $29.95

Cat. GE-4082 **$14.95**

SAVE $15.00



RC Desktop F430 Ferrari

This 1/64th scale F430 Ferrari has rear wheel drive and an adjustable steering bias to ensure a straight and smooth ride. It's finished in Ferrari red and is sure to be a conversation starter.

- Remote control 100(L) x 25(W) x 53(H)mm
- Requires 6 x AA batteries
- Recharges from display base

Cat. GT-3213 **$24.95**



HELICOPTERS

Radio Control Apache Attack Chopper

Twin rotors with buckets of power, 3 channel radio control unit with throttle, rudder and trim controls. Finished in matt olive livery with twin rocket pods.

- Around 20 minutes flying time per charge
- Requires 8 x AA batteries
- Suitable for ages 10+

Cat. GT-3264 **$99.95**



Our mini helicopters are very easy to fly. The twin rotor design allows for excellent stability and manoeuvrability. Just hit the throttle and off they go!

- Throttle, rudder and stability trim controls
- Made from durable tough styrene or plastic
- Charge time varies per unit (approx. 20 mins for 8min flying time)
- Up to 15m IR remote
- Each requires 6 x AA batteries (except GT-3262 Mosquito which requires 1 x 9V)
- All suitable for 8yrs

RC Mini Helicopter

- 170mm longA

Was $49.95

Cat. GT-3215 **$39.95**

SAVE $10.00



RC Mini Mosquito Helicopter

- Green LED eyes
- 170mm long

Cat. GT-3262 **$59.95**



RC Mini M*A*S*H Helicopter

- 135mm Long

Cat. GT-3260 **$29.95**



6.6 MP Digital Video Camera

This amazing digital video camera includes an MP3 player, webcam, digital voice recorder, and 4x digital zoom. Has a colour TFT 1.5" LCD screen, 16MB internal memory and SD/MMC external memory card slot. All interface leads and software are supplied.

- Requires 4 x AAA batteries

Was $299.00

Cat. QC-3234 **$169.00**

SAVE $130.00



ICETANIC - Floating Icebox

Unlike the Titanic this really is unsinkable. A full size icebox that'll float around your pool. Unlock the top lid and it will hold around 18 cans or stubbies with plenty of ice and stay cold for hours, or simply take out the smaller lid and insert a bottle of your favourite bubbly or wine for your own floating champagne bucket. Around its rim it even holds up to 6 drinks (with stubby holders) and has little pockets for your nibblies. 600 (Dia) x 360(H)mm

NEW

Cat. GH-1902 **$79.95**



Voice Recorders

8hrs Digital Voice Recorder with USB Interface

This compact recorder is packed with features to suit students, real estate agents and executives. The USB interface allows files to be uploaded in no time. The recorder will store up to 8 hours of voice quality audio in a compact, light hand-held unit. Supplied with driver, editing software and USB interface lead.

Was $99.95

SAVE $20.00

Cat. XC-0255 **$79.95**



Digital Voice Recorder with MP3 Player

This sleek digital voice recorder will record up to 9hrs in high quality mode and 18hrs in short play mode. It uses the latest 'plug & play' technology with easy drag & drop file transfer and has 8 folders to organise your recorded messages. Use the provided software to download and edit the messages on your PC.

Was $199.95

SAVE $30.00

Cat. XC-0256 **$169.95**



iPod® Replacement Batteries

Keep your iPod® going! These replacement batteries come with special tools and instructions ro safely open and reseal an iPod®.

Cat No.	Generation
SB-2570	1st/2nd
SB-2572	3rd
SB-2574	4th
SB-2576	Mini
SB-2578	Shuffle
SB-2579	Nano 1st
SB-2580	Nano 2nd
SB-2575	Video 30GB
SB-2577	Video 60GB

FROM **$18.95**



OUTDOOR SAVINGS

Take your creature comforts when you go on any road trip as these inverters will produce mains power from your vehicle's battery. A 300W inverter & above will recharge laptops, power tools,run fluorescents & larger style TVs.

Was $79.95



SAVE $10.00

Cat. MI-5104 **$69.95**

Was $229.00



Cat. MI-5108 **$199.00**

SAVE $30.00

Megacatch Mosquito Trap

This trap does not blow insects apart with high-voltage electricity. It is almost noiseless. Very smart. Very safe. It uses an electronically controlled LED lighting and heating coil which produces intermittent light selected to coincide with spectral sensitivity peaks of many mosquito species.

- Approx. 300mm tall

Was $199.00



SAVE $100.00

Cat. YS-5518 **$99.00**

Motorcycle Headset for UHF CB

Connect to a compatible CB and you have instant hands-free communications. Designed to fit into a full-face helmet and can be easily removed when not in use. Handlebar-mounted push-to-talk button included. Compatible with our DC-1025, DC-1028, DC-1040, DC-1045 & DC-1060.

Was $99.00





Cat. DC-1037 **$79.00**

SAVE $20.00

Crash helmet and goggles not included

Six LED Head Torch

A headlight torch for the adventurous type! With flashing mode to attract attention in an emergency, you'll never get lost wearing this headlamp.

Was $39.95



SAVE $20.00

Cat. ST-3282 **$19.95**

Battery Powered BBQ Cleaner with Light

Clean off that built-up grime with this handy BBQ cleaner. It even has a built in scraper and LED light for those hard to see dark corners. Requires 8 x AA batteries.

- Measures: 295(L)mm

NEW



Cat. TH-2542 **$24.95**

KEEP IN TOUCH

3 Watt 38 Channel UHF CB Radio with Scrambler

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 and charger. SMA connector allows the use of external antennas.



Cat. DC-1060 **$169.00**

1.5W 38 Channel UHF CB Radio with Scrambler & CTCSS

A versatile transceiver with a maximum output of 1.5W and a 500mW power saving mode. All 38 legal channels are utilised as well as CTCSS sub channel calling, automatic squelch, and four level scrambling for private communications. Other features include dual-watch, VOX, and a built-in stop watch.



Cat. DC-1045 **$89.00**

38 Channel UHF CB Transceiver

Suitable for all manner of professional and leisure activities. Open field transmission range is an incredible 5kms.

- City range 1km
- Requires 4 x AAA Ni-MH rechargeable batteries



Cat. DC-1010 **$34.95**

Ultrasonic Distance Meter with Laser

This ultrasonic measurer measures distance, calculates area, sums total readings and stores data for later use in imperial or metric units from 0.6 - 16m (1.6 - 52ft). Backlit LCD, auto power-off, case and belt-clip included.

- Accuracy: ±1% of reading
- Response time: 2 seconds
- Dimensions: 175(L) x 62(W) x 45(D)mm

NEW



Cat. QP-2295 **$39.95**

Wireless Weather Station

This weather station is the best value we have ever seen in an all-in-one home weather station. It monitors inside and outside temperature, air pressure, rainfall, humidity wind speed, wind direction and wind chill factor.

- -40 to +60°C outdoor temperature
- 20 % to 95% relative humidity
- 0 to 100km/h wind speed
- 840 to 1200mb air pressure

Cat. XC-0293 **$149.00**



DIY KITS

Temperature Switch

This kit operates a relay when a preset temperature is exceeded and drops-out the relay when temperature drops. Ideal as a thermostat, ice alarm, or hydroponics applications, etc. Adjustable temperature range of approx -30 to +150 degrees Celsius. Kit includes NTC thermocouple. 12VDC required.



Cat. KG-9140 **$21.95**

The 'Flexitimer'

Ref. Electronics Australia March 1991.

We have revised the original design and now provide two modes of operation. The original one-shot count down mode is retained and we have added an interval mode with a 50% duty cycle.



Cat. KA-1732 **$18.95**

Pocket UV Meter NEW

Protect yourself from harmful UV rays with this excellent detector. It reads UV index, mW per cubic metre or a bargraph meter of low to very high UV radiation. Battery, lanyard and belt clip included.

- Dimensions: 60(L) x 40(W) x 9(D)mm



Cat. GH-1116 **$24.95**

YOUR LOCAL JAYCAR STORE

Australia Freecall Orders: Ph 1800 022 888

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Card No. |_|_|_|_| |_|_|_|_| |_|_|_|_| |_|_|_|_|

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Signature_____

PRICE GUIDE: SUBSCRIPTIONS

(Note: all subscription prices include P&P). (Aust. prices include GST)

Please state month to start.

Australia: 1 yr	$A89.50	2 yrs	$A172
1 yr + binder	$A105	2 yrs + 2 binders	$A203
NZ (air): 1 yr	$A96	2 yrs	$A190
Overseas (air): 1 yr	$A135	2 yrs	$A260

PRICE GUIDE: OTHER PRODUCTS

(all prices include GST on Aust. orders)

*SILICON CHIP BACK ISSUES in stock: 10% discount for 10 or more issues or photocopies. Australia: $A9.50 ea (including p&p). Overseas: $A13 each (including p&p by air).

*ELECTRONICS AUSTRALIA: project photocopies. Australia: $A9.50 each (including p&p). Overseas: $A13 each (including p&p by air).

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Classic circuit uses

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"state of the ark" technology

ssie Three": ashioned valve ireless" – 21st ntury Version!

So you thought valve technology was dead! Well it is – but we have exhumed enough of it to produce a 3-valve radio which has quite a respectable performance. It is a superheterodyne circuit, based entirely on readily available components. It is suitable for moderately-experienced constructors – even those who've never touched a valve in their lives!

By Keith Walters

WHY WOULD ANYONE want to build a valve radio, one that doesn't even pick up FM stations? If nothing else, to get a feel and understanding for old-fashioned technology.

There are lots of people who are attracted to valve amplifiers (particularly musicians) and lots of people busily restoring vintage radios, television sets and all manner of thermionic technology. So why not build a valve radio from scratch? Despite the relatively few parts the radio uses, this is certainly not a toy and it illustrates how much performance you can get out of just a few valves.

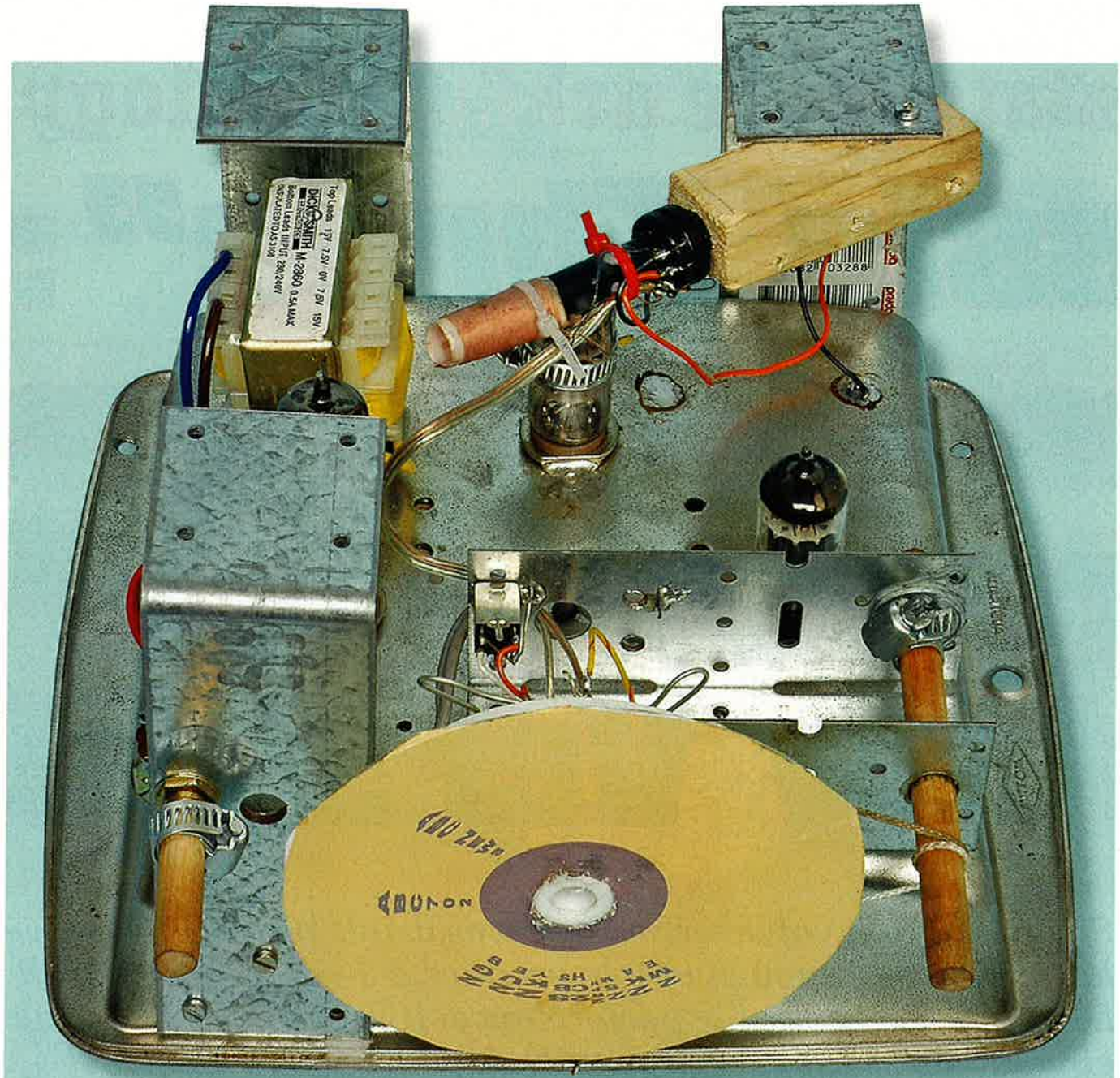
As far as its lack of FM reception is concerned, there were no FM radio stations in Australia during the valve era! (While experimental broadcasts started back in 1948, the first FM radio stations, 2MBS and 3MBS, did not start transmitting until 1975).

The "cabinet"

The prototype radio is housed in a whimsical gothic cabinet which pays homage to some of the "cathedral style" radio cabinets of yesteryear. Some people will hate it and others will like it. If you're in the first category, then build a more conventional cabinet.

Why "Aussie Three"?

Well that's a dig at the "All-American Five" concept that



Here's the front view of the Aussie Three removed from its Gothic-style cathedral case. We're willing to bet that the vast majority of Aussie Threes built will remain in this state!

emerged in the USA in the 1930s. As an alternative to the grandiose (and expensive) timber cabinet radios that are the delight of collectors now, some manufacturers started marketing the virtues of a basic, no-nonsense but perfectly serviceable superheterodyne that the "regular guy" could afford; the "Model T" of radios if you like. There was no RF stage (which wasn't really necessary in urban locations anyway) but any lack of sensitivity could be overcome by connecting a decent aerial and earth.

The valve line-up was the now-classic rectifier, mixer/oscillator, IF amplifier, detector/audio preamplifier and a pentode audio power output stage.

Our Aussie Three uses three triode-pentode valves, deletes the valve rectifier in favour of semiconductor diodes and adds a ferrite rod antenna to come up with quite a respectable performance.

To any non-technical user, it's just a radio: you turn it on and it works! Despite its tiny PVC tuning capacitor, there's surprisingly little frequency drift, even right up at the top of the AM band. From my home in the outer suburbs of northwest Sydney, it picks up all the Sydney stations with just its ferrite rod antenna, all at about the same volume.

Bake a cake – then build the radio

The hardware comes from a variety of sources. There are no PC boards, as all the wiring is "point-to-point" using old-fashioned tag strips and hook-up wire.

The chassis is actually a cake tin, purchased for less than $3 at Big W! Some of the other parts and materials came from Bunnings Hardware and no doubt you may want to improvise with some items you have in your junk box.

Parts List – Aussie Three Valve Radio

1 tinplate baking tin, approx. 245 x 222 x 50mm (eg, "Willow" brand)
3 9-pin valve sockets
2 sets AM IF/oscillator coils
1 ferrite rod and coil assembly
1 24 VAC 24VA (or higher rated) plugpack (see text)
1 240V to 7.5V mains transformer (for speaker transformer – see text)
4 8-way tagstrips (E-6-E)
1 4W 125mm or larger loudspeaker
1 2.5mm "DC" chassis-mounting power socket (for AC connection)
1 chassis-mounting RCA socket (for speaker connector)
1 RCA plug (to connect to speaker)
1 chassis-mounting screw terminal (for antenna)
1 100mm length stiff tinned copper wire (for mounting LED)
1 10mm length of wooden dowel
2 wooden drawer knobs
4 assorted hose clamps
1 dial drum assembly with dial cord (see text)
1 station dial (see text)
3 metal pergola hangers (L-shaped steel, 37mm wide, 130 x 50mm)
2 steel brackets, 45 x 45 x 110mm (to hold tuning assembly)
Small block of timber to mount ferrite rod
Various lengths of single and figure-8 hookup wire, various colours (some need 100V+ rating)
Wire for antenna (if required)
Cable ties
Screws and nuts as required
2 flat steel washers, 10mm internal

Valves
2 6BL8 (V1, V2)
1 6BM8 (V3)

Semiconductors
4 1N4004 1A power diodes (D1-D4)
1 5mm white LED (LED1)

Inductors
2 10mH miniature chokes (RFC1, RFC2)

Capacitors
5 47µF 160V electrolytic (C12, C19, C20, C21, C22)
1 22µF 16V electrolytic (C17)
1 10µF 160V electrolytic (C13)
1 10µF 16V electrolytic (C15)
2 220nF 200V polyester (C1, C4)
1 56nF 200V ceramic or polyester (C8)
1 47nF ceramic or polyester (C11)
1 10nF 200V ceramic or polyester (C14)
1 6.8nF 630V polyester (C18)
1 4.7nF ceramic or MKT polyester (C7)
3 3.3nF ceramic or MKT polyester (C2, C5, C16)
1 680pF ceramic (C9)
1 100pF ceramic (C10)
2 12pF ceramic (C3, C6)
1 60/160pF miniature tuning gang (variable capacitor) (VC1)

Resistors (0.5W, 5% unless otherwise specified)

2 470kΩ (R7, R11)	2 220kΩ (R3, R9)	1 100kΩ (R2)
3 47kΩ (R1, R4, R10)	1 15kΩ (R16)	1 10kΩ (R6)
2 3.9kΩ (R5, R8)	1 470Ω (R13)	1 330Ω (R12)
1 39Ω 10W (R15)	1 8.2Ω 10W (R14)	
1 10kΩ horizontal trimpot (VR1)	1 500kΩ switched log pot (VR2)	

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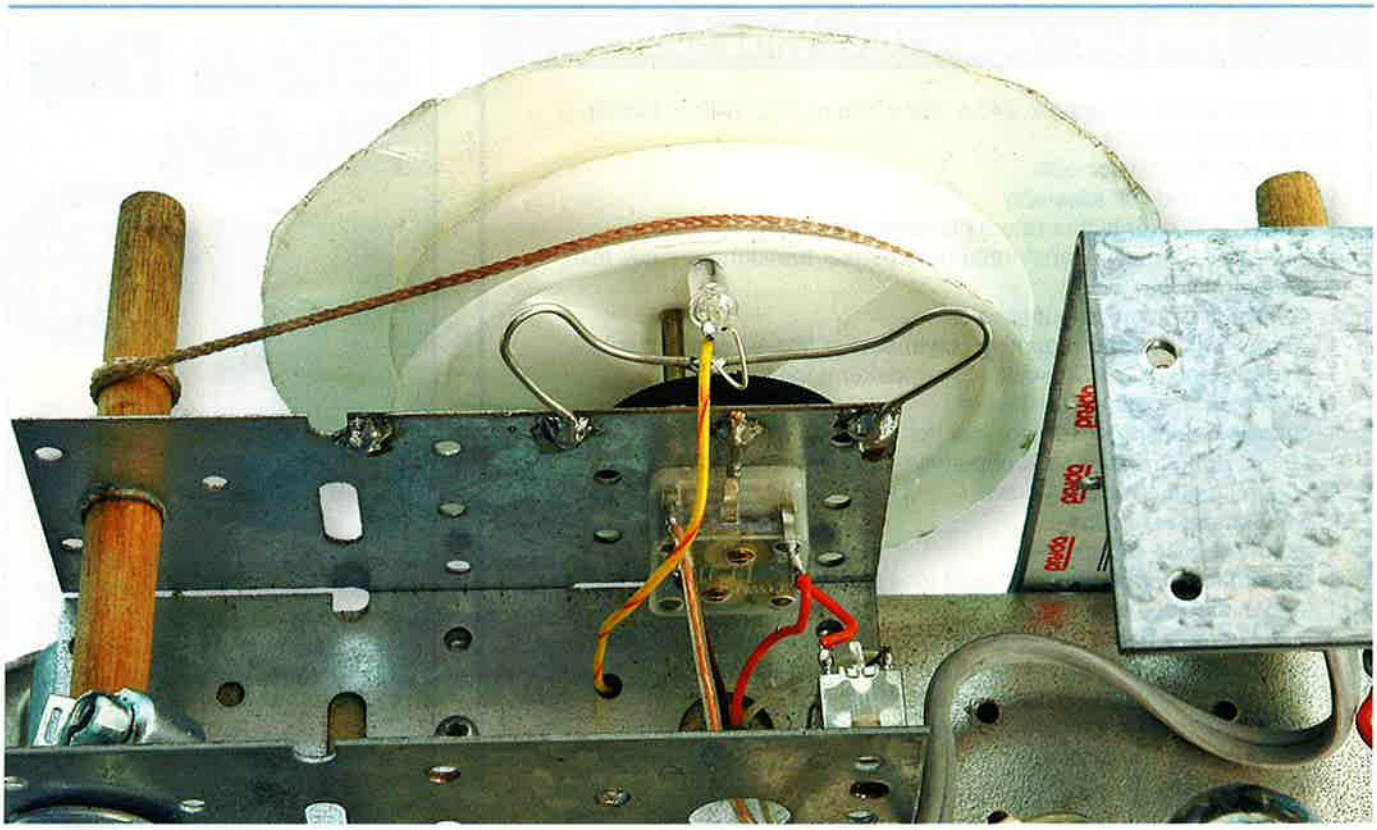
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The "dial" is made from an old CD, the dial drive is a length of dowel held in by hose clamps, the dial cord is brickies' string, the tuning assembly brackets are intended for pergolas . . . hang on, what's a LED doing in a valve radio?

Other components came from Dick Smith Electronics, Jaycar Electronics and Wagner Electronics.

This design uses three triode-pentode valves, two 6BL8s and one 6BM8. These are old 1950s-era "workhorses" that are still easy to get from Wagner Electronicss and other suppliers (check the internet). Shop around and don't get suckered into buying so-called "audiophile" valves at inflated prices. They won't work any better than the regular types.

Low high voltage!

There is a common misconception that valve equipment needs dangerously high voltages to work properly. In fact, 100V is more than adequate for a radio like this and is much safer for the casual tinkerer. **Although 100V DC can theoretically give you a dangerous or even fatal shock in the wrong circumstances, with dry hands in a normal workshop situation, the worst you're likely to get from this circuit is a bit of a "nip".**

Circuit description

As already mentioned, the circuit of the Aussie Three is a conventional superheterodyne radio. This means that the incoming broadcast signal is mixed (ie, heterodyned) with the local oscillator signal and the difference frequency between these two signals becomes the "intermediate" frequency. This is amplified in the IF amplifier (funny, that) and then fed to the detector where the original audio modulation is recovered and fed to the audio amplifier stages and thence to the speaker.

And where does the "super" prefix come from in the word "superheterodyne"? This merely refers to the local oscillator signal being "above" or higher than the incoming broadcast signal.

In our circuit, the incoming signal is picked up in the ferrite rod antenna which is tuned by the 160pF section of the plastic dielectric tuning gang (using the terminal marked "A") and then fed to the grid of the pentode section of V1 (valve1, 6BL8).

The local oscillator uses a red "transistor" oscillator coil, L2. (Actually, this is not a coil but a conventional RF transformer with two windings). The secondary winding is tuned with the 60pF section of the plastic dielectric tuning gang (using the terminal marked "O") and then connected to the grid of the triode section of V1 via resistor R4 and capacitor C10. Oscillation is maintained by the feedback winding which is fed from the plate of the triode via capacitor C9.

The grid-cathode circuit acts as a diode that conducts slightly on the positive excursions of the grid signal, resulting in a standing DC bias (ie, voltage) across C10. This tends to reduce the gain of the triode, damping down the oscillation and so stabilising the output amplitude.

Note that all the coils and transformers in this circuit were originally designed to be used in low-voltage transistor radios. This is why all the windings are capacitively coupled, to keep high DC voltages away from the flimsy insulation of the coil wires.

Experienced vintage radio enthusiasts may have noticed that there appears to be no mechanism for coupling the oscillator signal into the pentode mixer. In fact, the oscillator signal is fed to the mixer using just stray capacitive coupling! This works well, possibly due to the high gain of the valve.

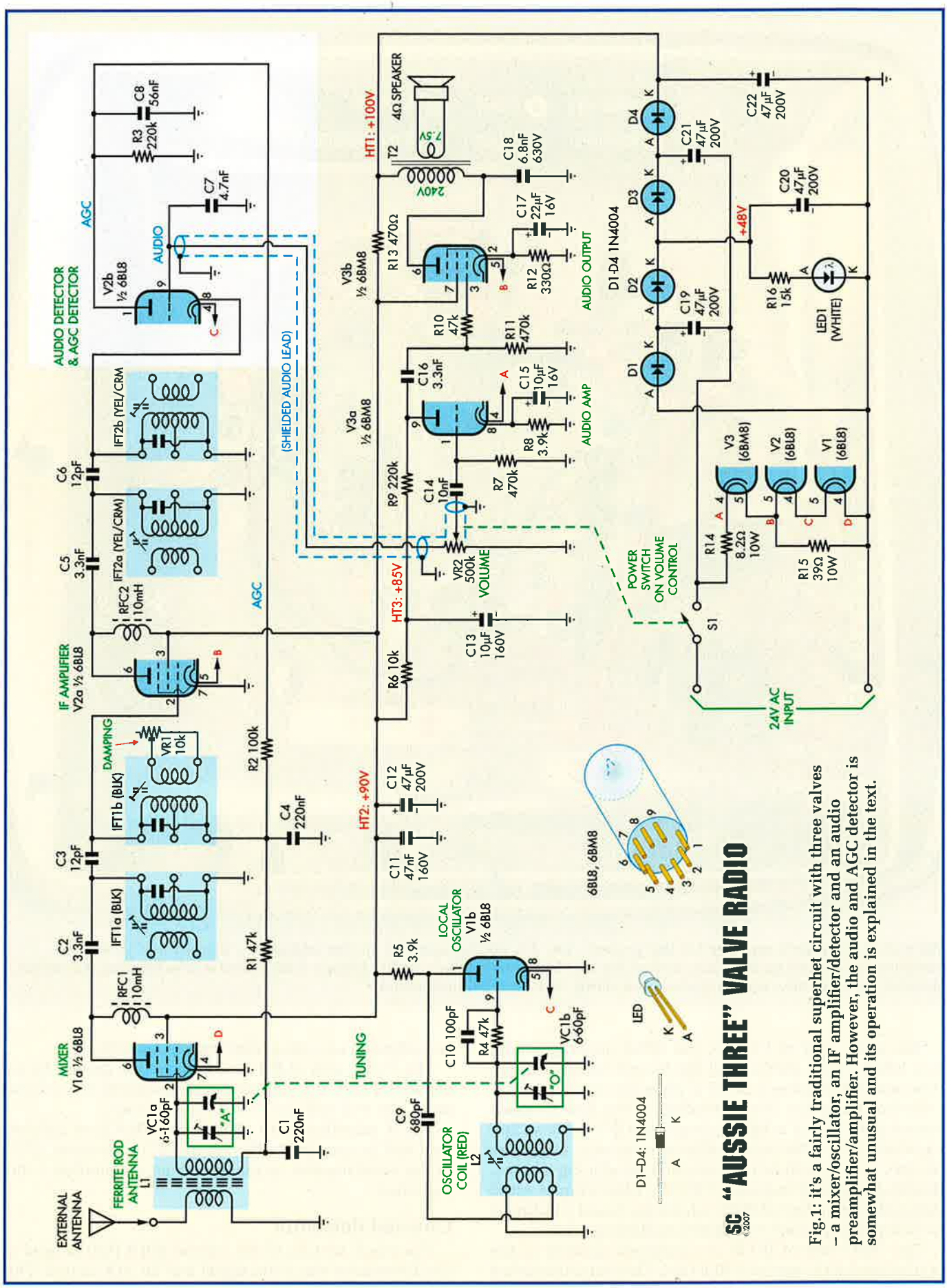
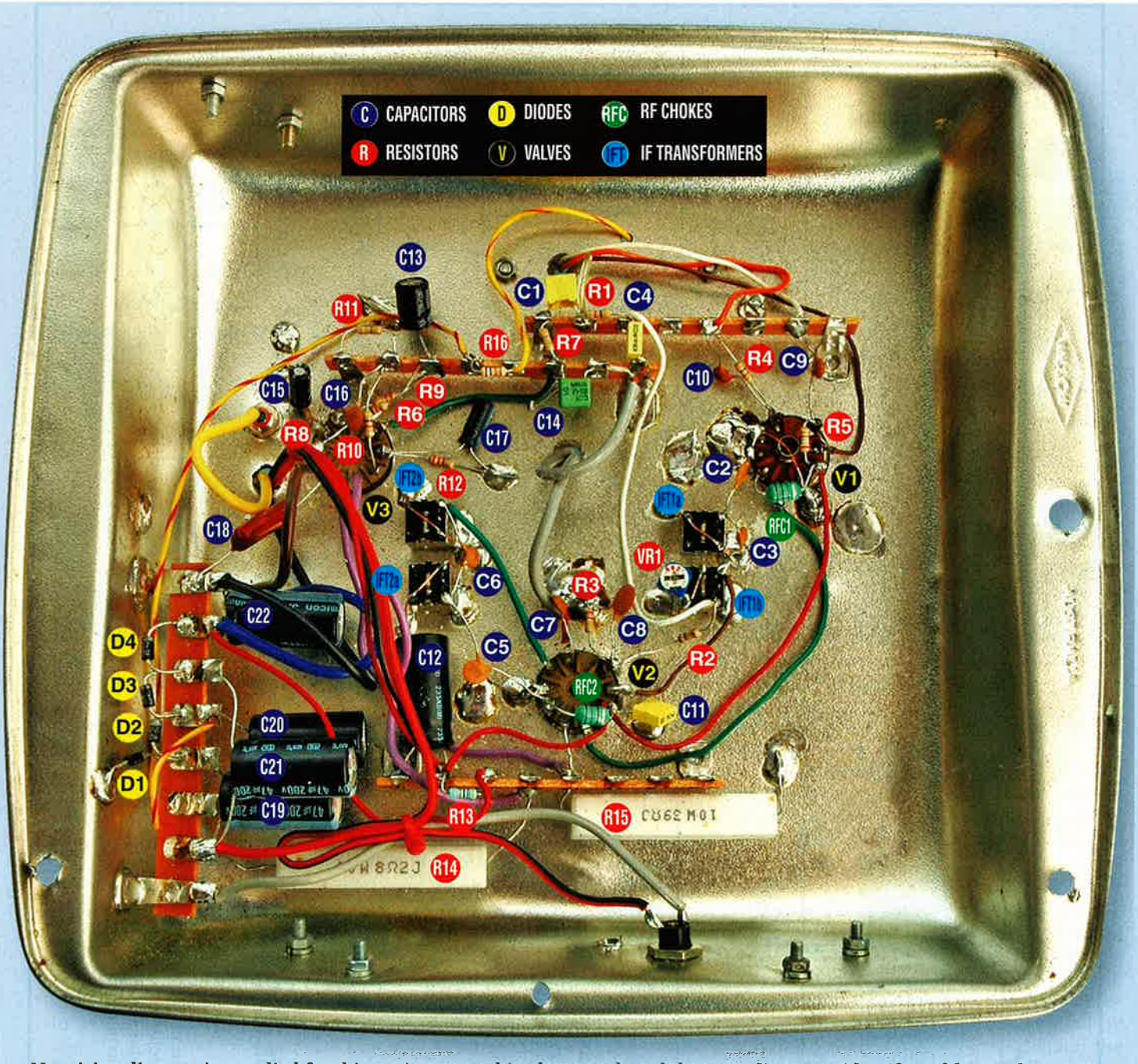


Fig.1: it's a fairly traditional superhet circuit with three valves – a mixer/oscillator, an IF amplifier/detector and an audio preamplifier/amplifier. However, the audio and AGC detector is somewhat unusual and its operation is explained in the text.



No wiring diagram is supplied for this project – use this photograph and the one adjacent to identify and locate the components. It's not particularly critical but this layout should be roughly followed because it works (moving the valves around, for example, could introduce instability or unwanted interaction).

The plate load of V1a (ie, the 6BL8 mixer pentode) is a 10mH choke (RFC1) and the mixer's output (ie, the intermediate frequency, or IF) is capacitively coupled via capacitor C2 to the tuned winding of the first IF transformer IFT1. IFT1a is lightly coupled to IFT1b via a 12pF capacitor (C3). This small value is necessary, otherwise the two coils would be over-coupled, producing a broad, double-humped IF response. VR1, the 10kΩ trimpot wired across the secondary of IFT1, allows the tuned winding to be damped to prevent unwanted oscillation.

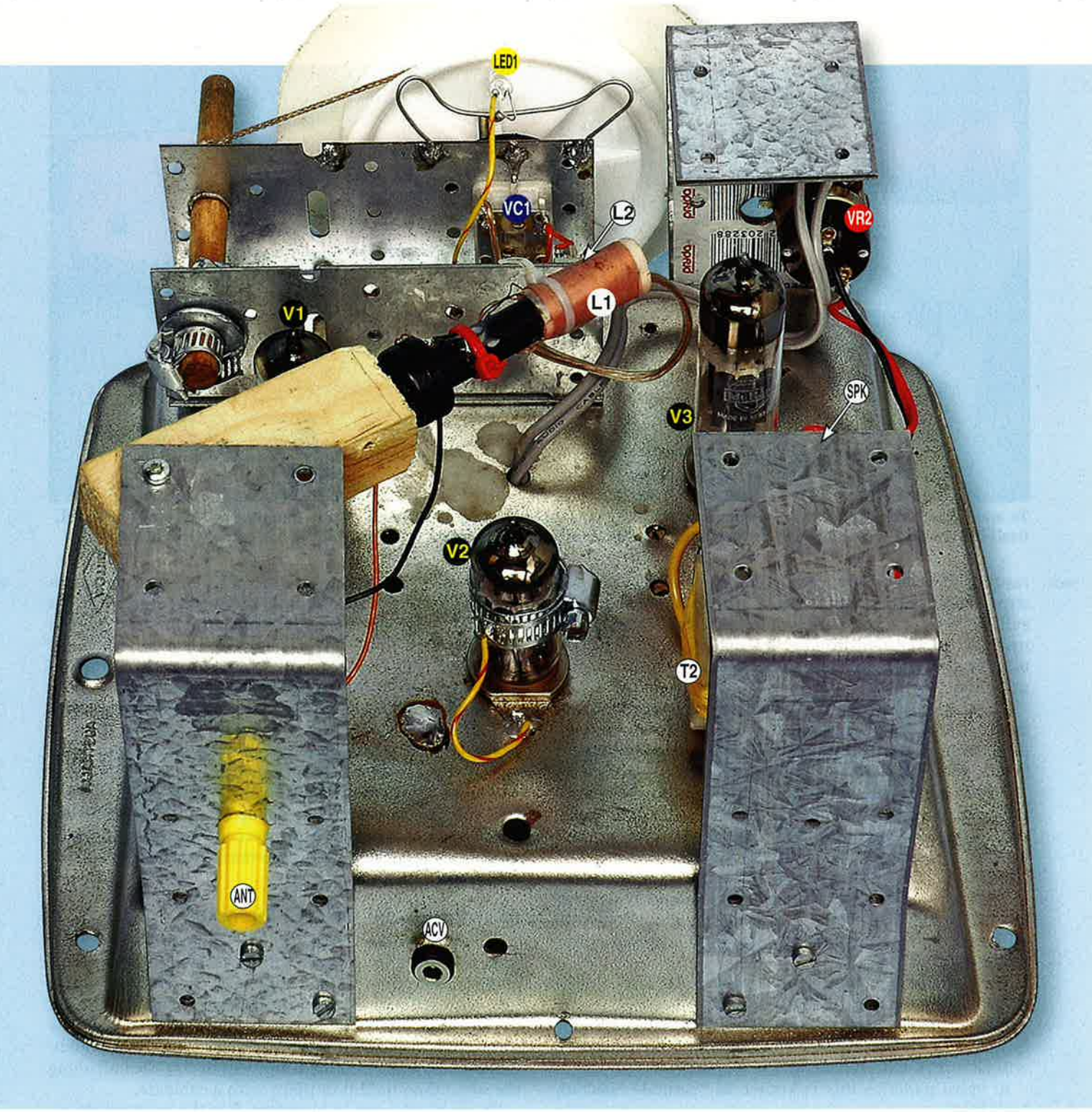
The "hot" end of IFT1b is connected directly to the control grid of the second 6BL8 (V2). This pentode section is configured as a straightforward IF amplifier.

The "cold" end of IFT1b is bypassed to ground by capacitor C4 and AGC (automatic gain control) is fed to this point. We will talk about AGC in a moment.

The IF amplifier has a 10mH choke (RFC2) as its plate load and is coupled to the second IF transformer, IFT2, in the same manner as for the mixer, via another 3.3nF capacitor.

Unusual detectors

The triode section of the second 6BL8 (V2) is used as the detector for the audio signal and for AGC signal. This



is unconventional, as most old valve radios used the same diode for both signal detection and AGC, which results in audio distortion, particularly with the heavily compressed near-100% modulation routinely used these days.

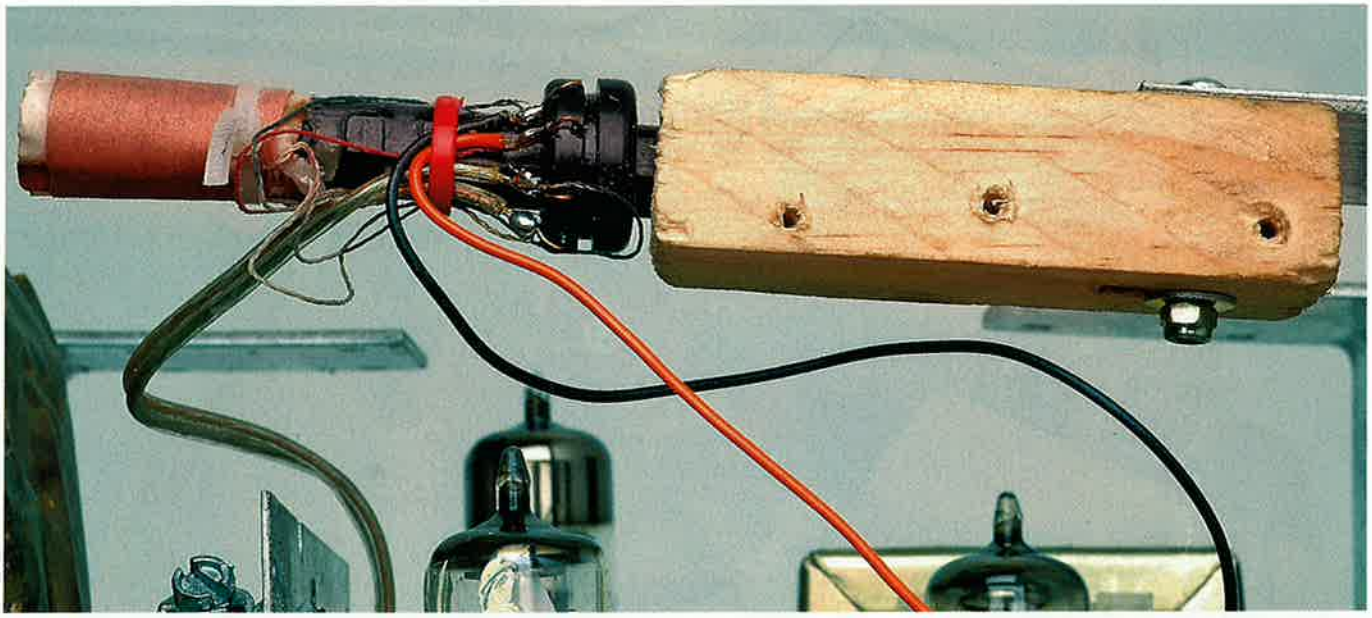
(Back in earlier days, radio stations modulated their carrier at less than (and often significantly less than) 100%. Apart from being less taxing on transmitter equipment, one reason for this is that the lower the modulation, the less power was consumed (and therefore lower transmitter electricity bills for the station!).

In this circuit, the IF signal is applied to the cathode of the triode and the grid and plate act as the anodes of separate diodes. The diodes conduct on the negative swing of the modulated IF signal and the result is a negative DC voltage. The audio signal is taken from the grid and the AGC from the plate of the triode.

AGC

Gain is controlled in the traditional manner by applying the negative voltage generated by the AGC diode to the grids of the mixer (V1a, via the antenna coil) and IF amplifier (V2a, via IFT1b) valves.

As the signal strength increases, so does the negative control voltage, which reduces the gain of the valves. The



To make the ferrite rod antenna movable, so it can be aligned to the wanted stations, it was mounted in this block of wood, itself hinged on a screw through the bracket. The grommet is used to protect and attach to the very fine wires of the coil.

result is that the difference in volume between weak and strong stations is greatly reduced. (In the old days it was called "AVC" – Automatic Volume Control but this isn't really an appropriate term for the same principle applied to other types of receivers, so the term AGC came to be preferred).

As mentioned earlier, the detected audio signal is taken from the grid of V2b, serving as the plate of a diode. The diode load is the 500kΩ volume control potentiometer (VR2), which is bypassed by C7.

Purists may argue about the validity of having DC across the volume control potentiometer as it can cause it to become noisy. A separate detector load resistor could have been used, with a coupling capacitor to the volume control, but this would introduce some detector distortion.

The audio amplifier uses the triode and pentode sections of a 6BM8 (V3). The triode is a standard connection with grid cathode bias generated by the voltage drop across the 3.9kΩ cathode resistor.

To briefly explain, the gain and operation of any valve is controlled by the negative DC voltage applied to the grid – ie, the grid must be negative with respect to the cathode. In this case, the cathode is at about +0.75V, so the grid will be -0.75V with respect to the cathode.

In valve parlance this is known as "cathode bias" or "self bias".

The same bias scheme is applied to the pentode which drives the speaker transformer in class-A mode. No negative feedback is used around the transformer as it was found to cause operating problems.

Power supply

The power supply is based on a 24V AC supply (in fact, a Christmas lights transformer). The valve heaters are wired in series across the 24V AC supply, together with series and shunt resistors to make sure that each heater filament operates at the correct voltage.

Pin 4 of the oscillator/mixer 6BL8 (V1) is connected to earth, as it is the one most likely to be subject to induced hum from the heater supply. Pin 5 of V1 is connected to pin 4 of the IF 6BL8 (V2) and pin 5 of V2 goes to pin 5 of the 6BM8 (V3). R15 is connected from pin 5 of V2 to ground to compensate for the lower heater current requirements of V1 and V2. Pin 4 of V3 connects to the 24V AC input via R14, which drops the 24V down to the necessary 18V.

The high voltage supply uses two voltage-doubling rectifiers (diodes D1-D4). The cold end of the second doubler (D3, D4) is returned to the output of the first, rather than ground. Each doubler gives about 2 x 1.4 x 24 = 67V or so, which means the open-circuit voltage is about 135V. This will drop to around 100V, depending on the particular 6BM8 used. The 24VAC supply is switched by the volume control, although of course, the external power transformer will remain on all the time.

Aerial coil and tuning capacitor

The aerial coil is a standard AM radio ferrite slab/coil unit, used by the hundreds of millions in transistor radios, and available cheaply from DSE and Jaycar. I used a DSE unit and although it works quite well "as is" I replaced the supplied ferrite slab with one of their 100mm ferrite rods, which fits nicely inside the aerial coil. Adjustment of the inductance is made simply by sliding the coil along the rod. I then held it in place with a cable tie.

To enable the rod to be oriented to the appropriate radio station, I drilled a 10mm hole in the end of a piece of wood and glued one end of the ferrite rod into it. I then mounted the piece of wood with a nut and bolt as shown. To make solder tags so I could lengthen the flimsy wires of the antenna coil, I fitted a rubber grommet over the ferrite rod and pushed some short loops of copper wire through the rubber.

The tiny tuning capacitor (again intended for a small transistor radio) is mounted on a right-angle metal bracket from Bunnings. Because they sell these things by the thousand, they're very cheap. There is a 20mm diameter hole punched on each face and by filing semicircular notches on opposite sides of the hole, the tuning capacitor can

be mounted nice and firmly with the supplied 2.5mm screws!

Order of construction

A sensible order of construction is to drill and modify the chassis as required, solder in the tagstrips and valve sockets (as these handle the point-to-point wiring) and then start with the electronics.

As mentioned earlier, the chassis for the radio is actually a "Willow" brand tinplate cake tin, presently available from Big W for $2.60. Start by cutting the holes for the three valves in the positions shown in the photographs. You'll need a 20mm hole saw for this but you don't need to spend a lot of money as you're only cutting into tinplate. Even cheapie hole saws from a bargain shop should be fine.

The actual positions of the valves are not critical; just remember to leave room for the capacitor mounting bracket (you'll get a good idea from the photographs). The layout is designed to keep the audio output valve as far away from the mixer as possible in the interests of RF stability.

You could drill six extra holes and use 3mm nuts and bolts to attach the valve sockets but you'll find it quite easy to simply solder them in. The same applies to the tag strips.

A good place to start actual electronic construction is the power supply section, since without that, nothing else will work. Using the labelled photograph as a guide, solder the four capacitors and four diodes onto the tagstrip. You should find the cake tin is easy to solder to.

Whether you solder this tagstrip in first or solder the components to the tagstrip then solder it in is up to you – both have their advantages. Just remember that the outer two positions of the tagstrip go to earth so don't solder components to these!

Be careful with polarities – all of these components are polarised. The diodes are easy because they are all cathode to anode, with the anode of D1 soldering to earth (the cake tin). When soldering the electrolytic capacitors in, make sure their leads don't short to anything.

Testing the supply

Before soldering in the 10W heater resistors, (carefully!) check your power supply by temporarily connecting the 24V AC. Make sure that you have about 130V or so across C22 and 50V or so across C20. (As we mentioned, these voltages will drop to those shown on the circuit when current is being drawn). If OK, install the tagstrip holding R15 and solder it and R14 in place – but remember that the unloaded electros will take some time to discharge – a 1kΩ 1W resistor on a pair of alligator clips makes a useful discharger.

Capacitor Codes

❑	No.	Value	µF Code	IEC Code	EIA Code
❑	2	220nF	0.22µF	220n	224
❑	1	56nF	.056µF	56n	563
❑	1	47nF	.047µF	47n	473
❑	1	10nF	.01µF	10n	103
❑	1	6.8nF	.0068µF	6n8	682
❑	1	4.7nF	.0047µF	4n7	472
❑	3	3.3nF	.0033µF	3n3	332
❑	1	680pF	n/a	680p	681
❑	1	100pF	n/a	100p	101
❑	2	12pF	n/a	12p	12

Check the heater line

It's a good idea to check the resistance of the valve heaters before going any further – naturally, you'll need to have completed the valve heater wiring to all three valves before this check.

Make sure that you don't have either the power connected or any valves plugged in. As you would expect, the heater line (ie, between points A and D on the circuit) should measure open-circuit. With just the 6BM8 plugged in you should measure about 50Ω and about 14Ω with all three valves plugged in. (Just as with a lamp filament, this resistance will increase as the valves heat up).

Audio preamp and amplifier

Once you have the power supply finished, the next logical step is to get the audio amplifier stage built and working. The amplifier stage includes all capacitors from C11-C18, resistors from R6-R13, the wiring to the speaker transformer (and obviously speaker) and the connections to the power supply. As these components are spread across the other three tagstrips it makes sense to solder them in now.

Construction of the amplifier stage is fairly straightforward but be careful where components cross over each other that they don't short.

Modifying the speaker transformer

It's becoming more and more difficult (and expensive!)

Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	2	470kΩ	yellow purple yellow brown	yellow purple black orange brown
❑	2	220kΩ	red red yellow brown	red red black orange brown
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	3	47kΩ	yellow purple orange brown	yellow purple black red brown
❑	1	15kΩ	brown green orange brown	brown green black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	2	3.9kΩ	orange white red brown	orange white black brown brown
❑	1	470Ω	yellow purple brown brown	yellow purple black black brown
❑	1	330Ω	orange orange brown brown	orange orange black black brown



No, the hose clamp is not used in case of a grid leak. And it doesn't hold the valve together! The earthed hose clamp is effectively a magnetic shield to reduce instability at the low end of the band. Don't knock it: it works!

to buy speaker transformers. So the "speaker transformer" is actually a DSE 240V to 30V mains transformer with tappings at 7.5V, 15V, 22.5V and 30V. I used the 7.5V section with a 4Ω speaker.

The transformer will work as it comes from the manufacturer but it can be made better by removing and re-stacking the laminated iron core. The core consists of equal numbers of "E" and "I" shaped pieces, interleaved so that half the "I" sections are on one side and half are on the other side. This is fine for a power transformer because it minimises magnetic flux leakage, giving the best efficiency. However, the transformer has DC flowing through the primary and this will magnetise the core, which can lead to distortion if the core saturates on peak plate current excursions. It also tends to limit the high-frequency response of the transformer.

If you pull the core stack apart and rearrange the pieces so that all the "E" sections are on one side and the "I" sections are on the other, this will tend to prevent saturation. It will make the transformer less efficient at low frequencies but this radio won't be reproducing much below 150Hz.

The transformer is easy to pull apart and reassemble. All you have to do is pull the aluminium frame off with a pair of pliers, put the stack in a vice and pull out one of the "E" sections, also with pliers. Once you get the first one out, the others will pull out much more easily, and after that it will more or less fall apart.

When reassembled, mount the transformer on the top of the chassis, soldering its feet to the chassis. You may need to scrape away some of the passivation on the transformer feet to get a clean surface to solder to. Connect its primary leads to the top of C18 and to HT1.

Testing the amplifier

You can easily test the amplifier section using the audio from the headphone socket of a portable CD or MP3 player. Temporarily, wire the player output directly across the volume control (outer terminals).

Connect your speaker to the transformer secondary (0V and 7.5V taps), plug in the 6BM8 valve and apply power. Naturally, you'll have to wait a little while for the valves to heat up but then you should hear music coming from the speaker – and its level should be adjustable with the volume pot.

The headphone output from a personal stereo should be able to drive the speaker at a reasonable volume, depending on the particular player. Don't expect it sound like your hifi system; 20% harmonic distortion in a domestic mantel radio at full output was considered average, 5% was high fidelity!

An alternative is the "blurt" test – a damp finger on the pot wiper (say at mid-range) should get you a healthy raspberry from the speaker! If you can't get any sound from the audio stage refer to the troubleshooting section later in this article.

Topside hardware

We'll leave the underside of the chassis briefly and look at the hardware on the top side. You can see what we have added to the cake tin in our photographs.

The metal L-shaped "legs" fitted to three corners of the chassis are pieces of cheap pergola ironmongery and their main purpose is simply to allow you to turn the chassis upside down without breaking the valves! At the same time, they make handy mounts for the volume control and ferrite rod antenna.

They come pre-drilled and in this case I'd recommend the use of small nuts and screws for mounting, as they are quite thick and would be hard to solder without a really large iron.

The front two (horizontal) L-shaped brackets screw together to form a "U" shape. These hold the oscillator coil, the tuning capacitor with its dial drum and the tuning drive shaft.

The tuning drive shaft is actually a piece of 9.5mm Tasmanian Oak wooden dowel! 10mm holes are drilled in the front and rear brackets, the holes are smoothed down with sandpaper, a bit of grease is applied, and the shaft turns as smooth as silk! If wood sounds like an unlikely material, remember that in days gone by, wooden wagons used to go for hundreds of miles with wheels that turned on "bearings" like this! A pair of small diameter rubber hose clamps (from a $2 bag of 10 from a cheap shop!) keeps the shaft from moving out of position.

The tuning capacitor mounting plate obviously mounts between the two front chassis "legs". For a drive cord, I used some "brickies' twine" which is a slightly stretchy polyester string but I have also used dental floss quite successfully. (You can of course get some real dial cord from Wagners!)

Since the dial cord doesn't directly drive a station display (with a pointer and so on), the stringing is not particularly critical. More adventurous constructors could try their hand at a traditional slide rule display, possibly running the string across a couple of pulleys mounted on the front legs. A suitable source of such pulleys might be a discarded venetian blind assembly.

Hose clamps

We've mentioned the hose clamps on the dial drive assembly – but what's that hose clamp doing around V1 (the IF amplifier valve)?

Ideally, this valve should have a socket that incorporates a shielding can to reduce the possibility of instability at

the low end of the broadcast band. However, I found a makeshift shield made from a piece of aluminium foil and held on with an earthed hose lamp worked fine! And then I found just the earthed hose clamp was enough!

When you tighten this clamp, don't overdo it. You don't want to let the air into V1 (or let the smoke out when you turn it on!).

The coils

The IF, aerial and oscillator coils will require some care with their mounting, as they are quite small and fragile. If you are experienced with metalwork, you could drill a set of small holes in the tinplate chassis and mount the coils more or less in the traditional manner but this will require accurate drilling and great care with the soldering.

Another approach is to make 10mm holes with a wood drill, carefully file them out so that the coil pins don't touch the chassis, and then solder the metal cans to the chassis via their mounting lugs. The problem with this approach is that as you unscrew the ferrite cores, there is a tendency for them to push the coil assembly out through the bottom of the can. You can prevent this by directly soldering the coils' earth connection pins to the chassis but this will make the coils difficult to remove if that becomes necessary.

When soldering wires to the pins, only use flexible hookup wire (from rainbow cable or the like). The coils are wound with very thin enamelled wire, with no slack where it attaches to the pins, and any tension on solid-core wire will tend to twist the coil pins and break the connection.

Just in case you hadn't worked it out from the photos, the aerial coil and IF transformers mount under the chassis, while the oscillator coil mounts on a bracket close to the tuning capacitor on top of the chassis.

The rest . . .

Once you have the audio working, you can tackle the tuner, IF and detector stages. Capacitors C1-C10, resistors R1-R5, two valves (V1&V2) and all the IF transformers and coils make up this section.

There are no tricks to this – you just wire it as per the photographs and it should work straight off, at least after a fashion.

I've made four versions of this circuit now and provided everything is correctly wired, the chances are that, with a reasonable antenna, you'll pick up stations straight off. If the radio sounds completely "dead" even with the volume turned right up, you most likely have a wiring fault. Once again, refer to the troubleshooting section.

However assuming that you have everything wired up correctly and are receiving stations of some sort, the next step is alignment of all the tuned circuits.

Alignment – it's not too daunting

The best way to align any AM radio receiver is with a 455kHz oscillator, modulated at about 400Hz. If you don't have one, check out the Minispot Modulated Oscillator in this month's SILICON CHIP – see page 72.

Connect the oscillator's output to pin 2 (pentode grid) of V1. With any luck (and if you haven't fiddled with the cores of the IF transformers), you should hear some sort of 400Hz tone from the speaker. Using a proper core-adjusting tool (or a sharpened knitting needle, NOT a metal-bladed screwdriver), adjust the cores for maximum volume from the speaker. (As the volume increases, turn down the output level of the test box, not the volume of the radio).

More critical adjustment requires measuring the AGC voltage across C4, preferably using a digital multimeter or any other meter with a sufficiently high input impedance. You can just do it by ear if you keep the input signal level right down. You'll find there is some interaction between the adjustments, so you may need to go over them a couple of times to get it exactly right.

If you don't have an accurate source of 455kHz but you have access to a basic digital frequency counter (even one built to a multimeter), you can still accurately align the IF by a more roundabout route. First, you need to find out the frequency of one of your local radio stations. The announcer or station jingle usually tells you what their frequency is quite often, or if you have access to any sort

Audio Troubleshooting

If you can't get any sound form the audio stage, the time-honoured checklist is as follows:

- *Is the valve heater glowing?*
- *Does the glass envelope feel hot? (Not just warm).*
- *Pull the valve out while it is still running. Do you hear a loud click or thump from the speaker? If not, check the speaker and the speaker wiring.*

If all the above check out, you'll have to start comparing the voltages on the valve pins with those marked on the circuit. The most likely cause of problems is simply incorrect wiring or poor soldering.

You should measure around 6V on pin 2 (cathode) of the 6BM8, indicating a plate current of about 18mA. If the plate and screen voltages are significantly higher than 100V and there is no cathode voltage, it means that the valve is not drawing current and may be faulty.

If all that checks out, try touching the grid (pin 3) with your finger (or with the shaft of a metal screwdriver held in your fingers). If the pentode is working properly, you should hear a 50Hz buzz from the speaker. If you do, the pentode amplifier is working but there's something wrong with the triode preamp.

Check and double check your wiring and components.

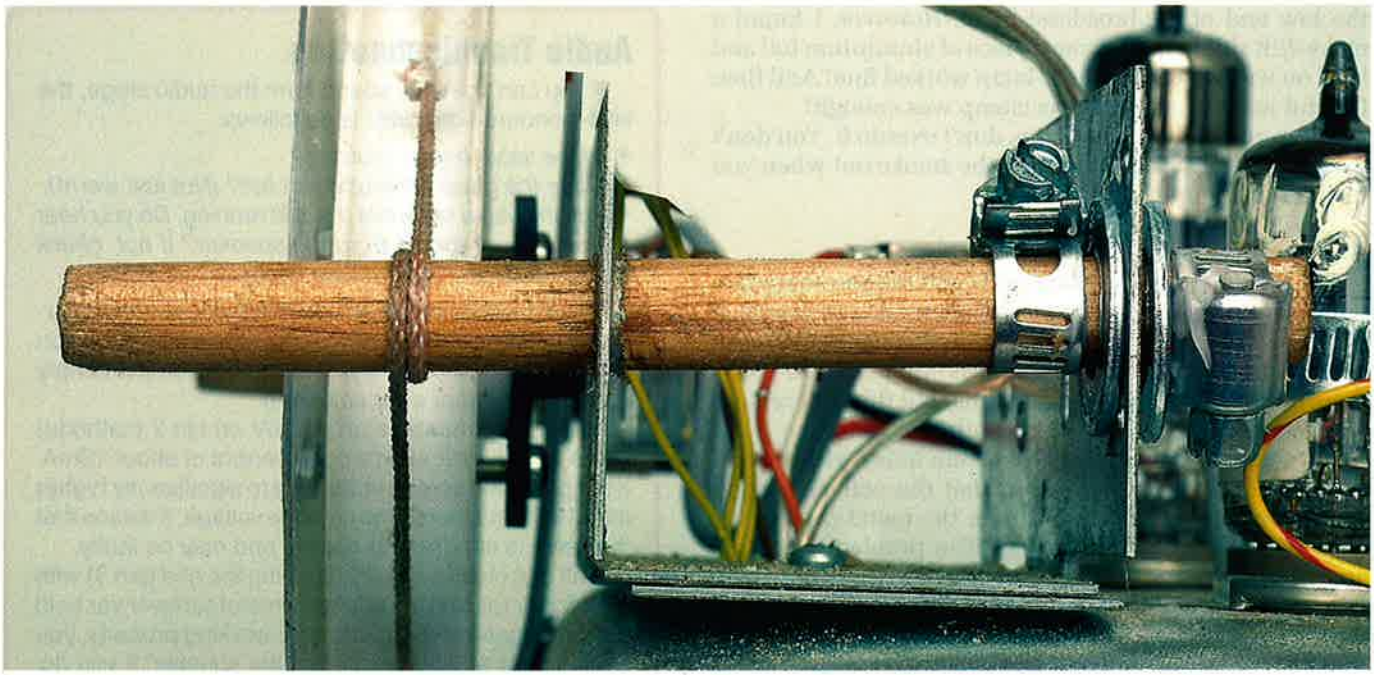
Tuner/IF Troubleshooting

Assuming you have the audio section working, if you can't find anything obvious, you'll need to check some voltages.

First check the screen and anode pins (3 & 6) of the 6BL8s. You should measure about 90-100V.

If that seems in order, check pin 1 of V1b which is the oscillator triode anode. It should measure around 60V. If the voltage is too low, check pin 9, the oscillator grid. If the oscillator is working, you should measure a negative voltage somewhere between 12-18V.

If not, the most likely cause is either incorrect wiring, poor soldering . . . or an open-circuit oscillator coil, possibly damaged during the construction process.



Here's a close-up view of that "unique" dial drive assembly we talked about earlier – a length of dowel held in place by a couple of hose clamps. You can also see the two "L" brackets that combine to form the U-shaped mounting bracket.

of radio with a digital tuner you can identify it that way.

In this example, we'll use Sydney station 2SM, on a frequency of 1269kHz. If you're in another location, choose a reasonably strong station towards the top of the band.

What you have to do is monitor the frequency of your radio's local oscillator at the junction of the oscillator coil and C3 and adjust the radio's tuning until you get a reading of the chosen station's carrier frequency plus 455kHz. In the case of 2SM it will be 1269 + 455 = 1724kHz.

It's then simply a matter of adjusting the IF cores for maximum output of 2SM's signal. (Caution: it is entirely possible to mistune all the IF coils to some frequency other than 455kHz and so pick up some other station, so just be sure you *are* listening to 2SM or whatever!)

If you don't have access to any sort of test equipment, you can simply tune the radio to any station you can find and simply peak up the IF coils for maximum volume. While this will still work, you may not get coverage over both ends of the broadcast band (more about this later).

Adjusting the oscillator circuit

Once the IF is aligned, you then need to adjust the oscillator circuit so that the radio covers the entire AM band and adjust the aerial tuning to match. Here is where some compromise may be needed. If you simply want a standard radio that covers from 530kHz to 1602kHz, the aerial and oscillator alignment will be quite straightforward and will present no surprises to anyone experienced with vintage radios.

However, in Australia, the AM band has been extended up to 1.7MHz, mostly for special interest stations (mostly ethnic broadcasts entirely in foreign languages). It is just possible to get this radio to tune up to 1.7MHz but only at the expense of the "bottom" end of the band. However, not everybody needs to tune right down to the bottom of the AM band and for those who do, chances are they may not need the extra coverage at the high end.

In commercial receivers, the alignment procedure was generally based around getting the receiver tuning to line up with the frequency or station markers printed on the dial scale. However, since we are going to make our own scale, in this case it's simply a matter of getting it to tune over the desired frequency range.

If you have access to a modulated signal generator, the procedure is quite easy. (We'll just describe the standard tuning range here to start with). You start by setting the signal generator to 1602kHz and with the tuning capacitor turned fully clockwise, you adjust the oscillator trimmer capacitor until you clearly hear the 1602kHz signal. You then adjust the aerial trimmer capacitor to give maximum sensitivity at that frequency, measuring the AGC as you did for the IF alignment.

Next, turn the tuning capacitor fully anti-clockwise, reset the signal generator to 530kHz and adjust the oscillator coil's ferrite core until you clearly hear the 530kHz signal. That done, adjust the position of the antenna coil on the ferrite rod for maximum sensitivity. If you now turn the tuning capacitor fully anti-clockwise again, you'll find that your previous adjustments will now be slightly off and so some readjustment will be needed. Old repair manuals used to state that you need to repeat these adjustments several times but twice should be good enough.

If you don't have access to a signal generator but have a frequency counter, you can measure the local oscillator frequency instead. To receiving 1602kHz, you need a local oscillator frequency of 2.057MHz and to receive 530kHz, an oscillator frequency of 985kHz. This will get the tuning range right but to adjust the aerial trimmer and aerial coil, you'll need to find two stations as close as possible to 1602kHz and 530kHz. If you do this at night with a reasonable aerial connected, you should have no trouble finding suitable stations, and setting the aerial tuning is easier with weaker stations anyway.

If you want your radio to tune up to 1.7MHz, you will

probably need to adjust the oscillator trimmer to its minimum position and also screw the core of the oscillator coil out slightly to get coverage of those frequencies. The only problem with that is that you will probably find the radio will no longer tune right down to 530kHz, although this will depend on the actual tuning capacitor used. You may also find that the aerial trimmer still has too much capacitance even at its minimum position and you may have to compromise with the position of the aerial coil.

The dial drive, pointer and scale

The reduction drive assembly is unconventional in construction but works extremely well. I used a plastic trolley wheel from Bunnings, with the rubber tyre pulled off. This was and attached it to the tuning knob that comes with the Jaycar tuning capacitor. The actual tuning dial was made from a discarded recordable CD (or DVD)!

The dial pointer was made from a large diameter plastic cable gland, simply pushed through a hole cut in the front of the cabinet. The dial cursor is simply a sewing needle pushed through the slots in the gland.

The assembly of the dial scale is as follows: first, carefully ream out the centre hole of the CD so that it just fits snugly on the axle part of the trolley wheel. It has to be tight enough that it won't move by itself but not so tight that you can't easily adjust its position with respect to the dial pointer.

Wrap sufficient insulation tape around the centre boss of the tuning knob that comes with the tuning capacitor, so that it fits snugly in the axle hole of the trolley wheel, and push it in onto the same side that the CD will be mounted on.

Drill or otherwise cut a hole in a scrap piece of wood so that the trolley wheel can lie down flat on it. Draw a line through the centre of the tuning knob and drill two 3mm holes on the line, on opposite sides of the hole. The drill holes need to go through the knob and the trolley wheel, and you need to drill them as straight as you can. If at all possible, use a drill press. (The $79.95 ones you often see in hardware stores are more than adequate for the job and are well worth considering – you'll wonder how you got by for so long without one!)

Once the holes are drilled, pull the tuning knob out, remove the tape and using two 25mm M3 screws, attach it to the *opposite* side of the trolley wheel. After that, you simply mount the original knob onto the tuning capacitor as the manufacturer intended, with the supplied screw.

After the radio has been constructed and aligned, the dial-scale markings are made by first fitting the CD to the trolley wheel boss and then mounting the chassis in its correct position in the cabinet. You then have to identify all the stations and write their positions on the CD with a fine-tipped CD marker or similar, using the sewing needle cursor to rule guide lines. If you have a frequency counter, and know the station frequencies, the easiest way to do this is to set the local oscillator frequency to the station carrier frequency plus 455kHz and mark the dial accordingly.

You could just make a "generic" frequency dial similar to those found on commercial radios today but most vintage radios have the actual station markings (which may not be terribly accurate anymore!). Of course, there's nothing to stop you from providing both!

Once you've got all the stations marked, remove the CD from the assembly and scan it into a photo editing program such as Photoshop. The actual procedure from here will vary with the particular software you have but basically you create a new layer on top of the scanned image (usually referred to as the "background") and overwrite your handwritten station markings with whatever font you think looks authentic! More advanced packages allow you to distort the shape of text so you can produce even fancier results.

Some packages such as Corel Photo-Paint allow you to copy and paste WordArt objects from Microsoft Word into a drawing and it's a very quick and easy way to import fancy lettering. Once you have the station markings done, you will then need to erase your handwritten ones from the background layer (leave the image of the CD itself as a guide to lining up the label), add whatever background colour you want, and print it out.

(Leaving aside jokes about blonde typists and whiteout on the screen, if you have an LCD computer monitor, a very useful technique is to cover the screen with a piece of Glad Wrap and rule your guide lines on to that with a fine-tipped felt pen!)

If you don't have a fancy drawing package that can do the necessary text rotation, you can always print the station call signs out on paper, and physically cut and paste the dial in the time-honoured fashion! More recent versions of Microsoft Word give you various "WordArt" options that allow you to print vertically. Then you can simply paste the printed call signs over your handwritten ones on your CD, scan that into the Paint program that comes with all copies of Windows, and do any touching-up necessary with that.

I originally tried printing the dial scale onto a stick-on CD label (these are A4–sized sheets of adhesive label paper with two CD stickers per sheet) but I found it difficult to get the positioning right and you only get one go at it! Since we're not worried about contaminating the CD surface, it's much easier to print out the label on ordinary photo-quality paper, cut it out with scissors and stick it on with spray-on adhesive, which will allow you to slide it into position before the glue sets. (You don't normally see the inner or outer edges of the label, so it doesn't have to be all that neat a cutting job). If you have one of the new printers that can print directly onto CDs or DVDs, well of course that will be even better!

If you want to have a back-lit display, you'll need to glue the paper onto a transparent CD-sized disc. Many "spindle" blank CD and DVD packages have a transparent plastic packing piece that is perfect for the job. Another possibility is cutting one out of one of the cheap round polythene "clamshell" CD cases. I tried soaking a white label CD in paint thinner but the whole thing started to dissolve! SC

Where do you get it?

It's unlikely that there will be a kit made up for this project. However, most electronic components are quite common and should be easy to obtain from normal parts retailers (eg, Dick Smith Electronics, Jaycar Electronics and Altronics). References are given in the text for some of the more obscure bits, especially the "hardware" items.

The valves (and many other parts) are available from Wagner Electronics in Sydney; (02) 9798 9233 or www.wagner.net.au



By MAURO GRASSI

Minispot 455kHz modulated oscillator

The Minispot produces a 455kHz carrier waveform which is amplitude-modulated with a 500Hz tone. You can use it to align the intermediate frequency (IF) stages of any AM broadcast or shortwave radio.

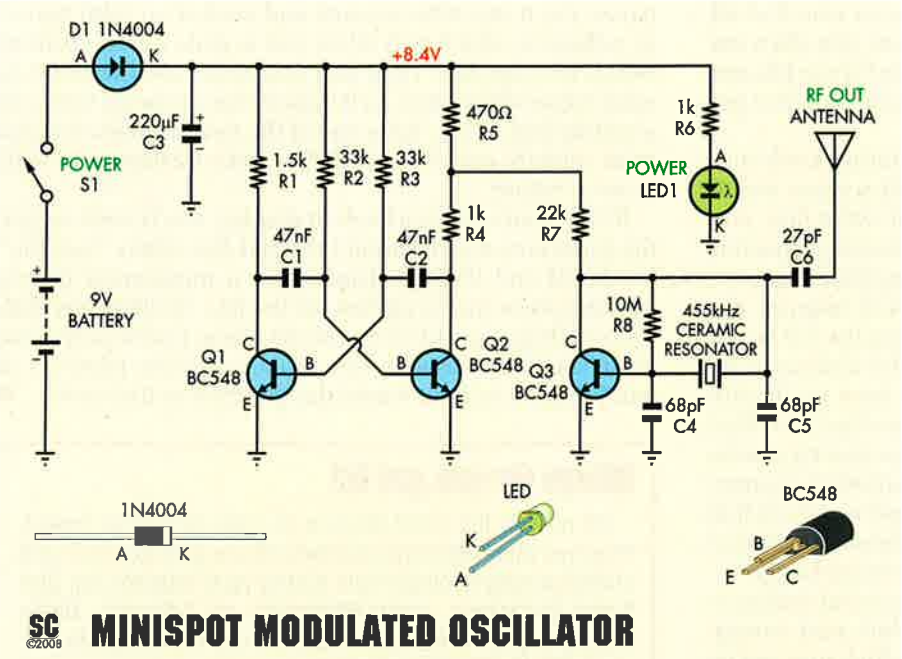


Fig.1: the circuit consists of a multivibrator (transistors Q1 & Q2) running at 500Hz and this modulates a 455kHz oscillator based on transistor Q3 and a ceramic resonator.

THIS PROJECT GENERATES an amplitude modulated 455kHz RF signal. It can be used to accurately align the intermediate frequency stages of heterodyne AM receivers.

If you are going to build the Aussie 3-Valve Radio described in this issue or if you are involved in restoring vintage radios, you will want this Minispot 455kHz modulated oscillator to accurately align the IF stages. For those readers with long memories, it is very similar to the Minispot circuit published in the February 1981 issue of "Electronics Australia" magazine.

The objectives of IF alignment are to ensure that all tuned circuits in the IF stages are tuned to the same frequency and that this frequency is the correct frequency, usually 455kHz.

If various parts of the IF stages are tuned to different frequencies, the sensitivity of the receiver will be poor. It may also be plagued with unwanted audible whistles appearing in the audio output. Therefore, cor-

rect IF alignment is essential to good performance.

There are various ways in which IF alignment can be achieved. The simplest is to align your receiver "by ear". This involves tuning to a broadcast signal and adjusting the IF stages until the maximum output from the loudspeaker is obtained. However, this method will almost certainly not give the best results.

Not only is it likely to result in having all stages aligned to the wrong frequency but there is also a difficulty in judging where the maximum output is obtained.

The ideal method is to have an RF signal generator set precisely to 455kHz and fed into the first IF stage (ie, after the mixer). As the alignment proceeds and the sensitivity improves, the output from the signal generator can be progressively reduced, to avoid activating the AGC (automatic gain control) circuit of the radio (which would otherwise act to reduce the receiver's sensitivity).

Ah, you say, "I don't have an RF signal generator". This is where this 455kHz modulated oscillator comes into play. It will do the same job but costs only a few dollars.

Circuit description

The circuit of Fig.1 can be divided into two parts. The first part consists of a 2-transistor multivibrator (Q1 & Q2) which generates a square wave at around 500Hz. The second part is a phase-shift oscillator (Q3) with a 455kHz ceramic resonator connected between the collector and base of the transistor. This would normally be referred to as a Pierce oscillator.

We use the multivibrator to "modulate" the 455kHz oscillator by varying its supply voltage. This is done simply by connecting R7, the 22kΩ collector load resistor for Q3, to the voltage divider resistors driven by Q2 (R4 & R5). But wait: we are getting a long way ahead of ourselves in describing how the circuit works. Let's just back up a bit and describe the operation of Q1 &Q2, the astable (free-running) multivibrator.

In essence, a multivibrator consists of two transistors which alternately switch on and off. In fact, the way that the transistors are biased ensures that only one transistor can be on at any time. The frequency of the alternate switching is determined by resistors R2 & R3 and capacitors C1 & C2.

To describe the operation, suppose Q1 is initially on while Q2 is off. Since Q1 is on, the collector end of C1 is near ground (0V) and so is the collector end of R1. Now C1 begins to charge through resistor R2 to 0.6V, eventually turning on Q2.

When Q2 turns on, its collector goes to 0V, pulling C2 down with it, causing the base of Q1 to be pulled below ground. So Q1 turns off. Now C2 is charged via R3 to 0.6V which then turns off Q2 and Q1 is turned back on.

This process repeats continually and the resulting output at either the collector of Q1 or Q2 is a square wave at a frequency dependent on the RC time constant formed by C1 and R2 or equivalently, C2 and R3.

The frequency of the square wave produced is given by the equation:

$$f = 1/(0.693(R2C1 + R3C2))$$
$$(approx.) = 1/(2 \times 0.693R2C1)$$

With the values used in this project (R2 = R3 = 33kΩ and C1 = C2 = 47nF), the expected frequency is approximately 465Hz. This will vary slightly according to the actual values of R2, R3, C1 and C2. In particular, if R2*C1 and R3*C2 are not exactly equal, the

Parts List

1 PC board, code 06101081, 72mm x 32mm
1 9V battery
1 9V battery clip
1 cable tie
1 SPDT toggle switch (Altronics S1325)
1 300mm length of wire for antenna
1 ZTB455 455kHz ceramic resonator

Semiconductors
3 BC548 NPN transistor (Q1-Q3)
1 1N4004 diode (D1)
1 3mm green LED (LED1)

Capacitors
1 220µF 16V electrolytic
2 47nF MKT polyester
2 68pF ceramic
1 27pF ceramic

Resistors (0.25W, 1%)

1 10MΩ	1 1.5kΩ
2 33kΩ	2 1kΩ
1 22kΩ	1 470Ω

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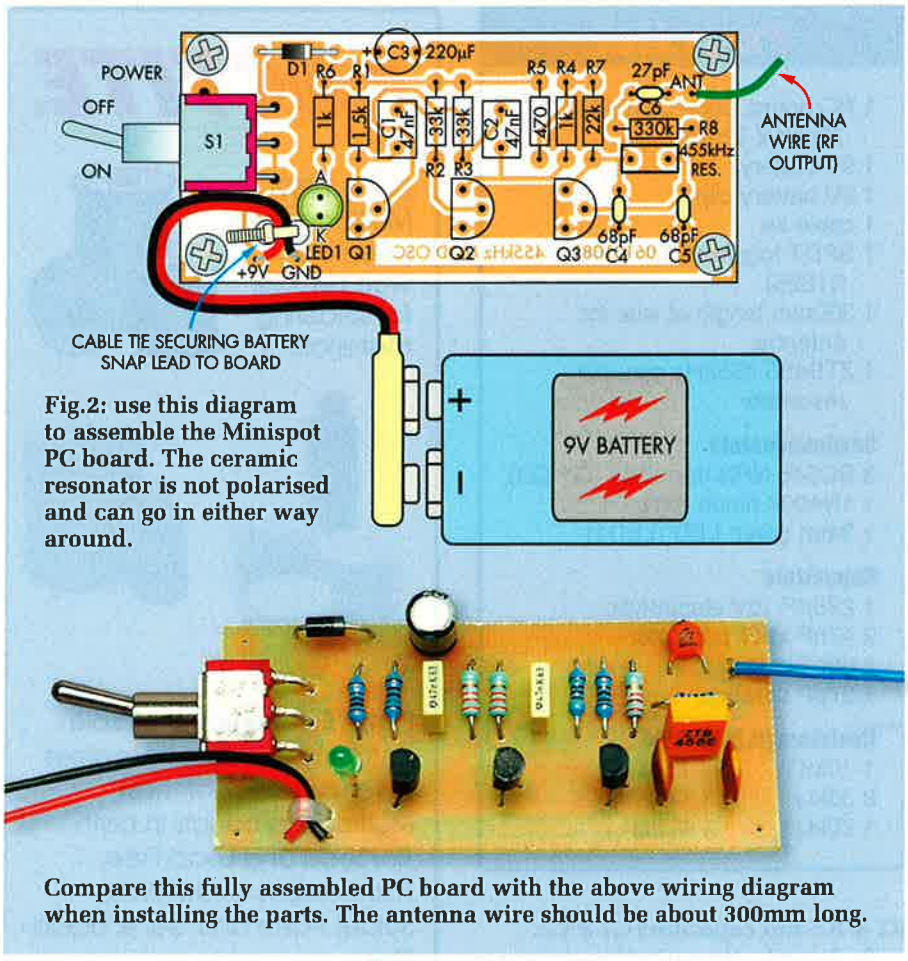


Fig.2: use this diagram to assemble the Minispot PC board. The ceramic resonator is not polarised and can go in either way around.

Compare this fully assembled PC board with the above wiring diagram when installing the parts. The antenna wire should be about 300mm long.

duty cycle will not be exactly 50%.

As noted above, the astable multivibrator is used to power the 455kHz oscillator via resistor R7. As we have seen, the collectors of Q1 and Q2 continually switch high and low. R7 is fed from the voltage divider formed by resistors R4 & R5 and since the collector of Q2 switches between about +0.2V and +8.4V (nominal), the junction of R4 & R5 will therefore be switched between about +8.4V and +5.5V (without allowing for the slight loading effect of R7).

Hence the supply voltage to the 455kHz oscillator is varied over these limits and so the amplitude of the output signal from the collector of Q3 will vary in direct proportion to the supply voltage; ie, it will be "amplitude modulated" at 455kHz.

The modulated output signal is AC-coupled by capacitor C6 to a length of wire which functions as an antenna.

A 9V battery is used to power the circuit via power switch S1. Diode D1 protects the circuit against reverse battery polarity.

Construction

The PC board for this project is coded 06101081 and measures 72mm x 31mm. The component overlay diagram is shown in Fig.2 while the same-size PC artwork can be downloaded from our website.

Start construction by soldering in the eight resistors. Make sure that the correct values are used, either by referring to the colour code table or better still, measuring the resistors with a multimeter before soldering them. Diode D1 can then go in, making sure that it is oriented correctly.

The capacitors are next on the list. Only the 220µF electrolytic (C3) is polarised, with its negative terminal connecting to the ground plane. The ceramic resonator can then be installed, followed by the three transistors and the LED.

Make sure that the transistors go in the right way around. The LED is soldered in with its cathode (shorter lead) connected to the ground plane.

Next, connect the battery clip, making sure that the red wire connects to the positive supply terminal and the black lead connects to the ground plane. Secure the leads of the battery clip with a cable tie. Two holes have been provided on the PC board to do this. You may now solder the toggle switch.

Finally, cut a length of insulated wire about 300mm long. This forms the antenna. Solder one end of the wire to the antenna pad on the PC board. That completes the construction of the Minispot oscillator.

Testing and troubleshooting

Applying power and flicking the toggle switch to the on position should result in the LED lighting up. If it does

Capacitor Codes

Value	µF Code	IEC Code	EIA Code
47nF	.047µF	47n	473
68pF	NA	68p	68
27pF	NA	27p	27

Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	10MΩ	brown black blue brown	brown black black green brown
❑	2	33kΩ	orange orange orange brown	orange orange black red brown
❑	1	22kΩ	red red orange brown	red red black red brown
❑	1	1.5kΩ	brown green red brown	brown green black brown brown
❑	2	1kΩ	brown black red brown	brown black black brown brown
❑	1	470Ω	yellow violet brown brown	yellow violet black black brown

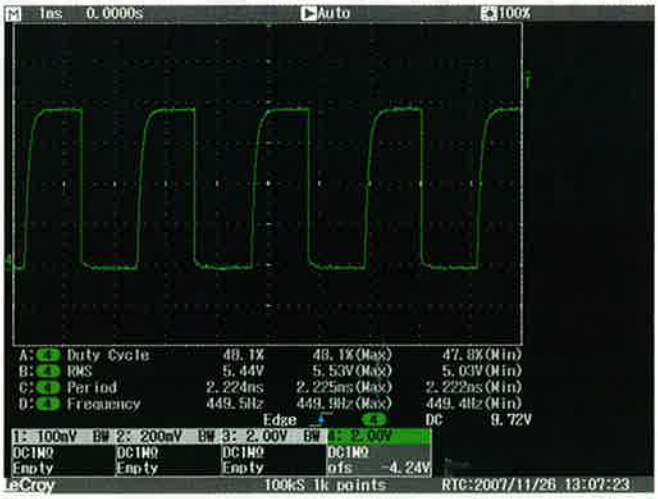


Fig 3: this oscilloscope screen shot shows the signal at the collector of transistor Q1. It is a square wave at 449Hz with an approximate duty cycle of 50%. Small variations in the values of resistors R2 & R3 and capacitors C1 & C2 account for the small deviations in the duty cycle and frequency from theoretical values.

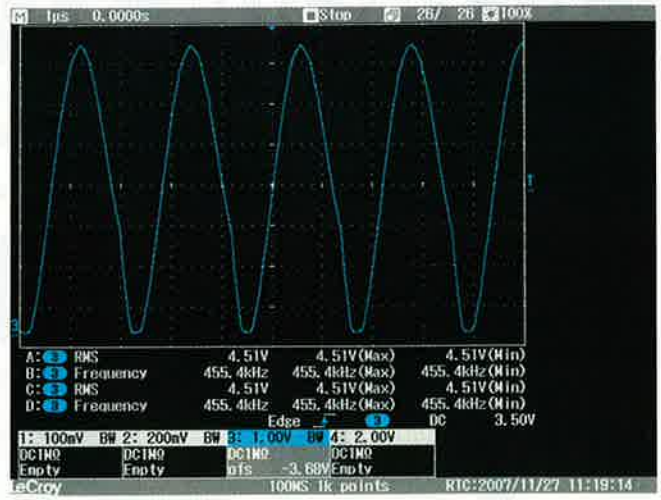


Fig 4: this oscilloscope screen grab shows the signal that appears at the collector of transistor Q3. At the relatively high timebase speed being used, the waveform appears as an approximate sinewave at 455kHz but slower timebase speeds will in fact show the amplitude as varying – see Fig.5.

not, it's possible that either diode D1 or the LED (or both) is reversed. That's not likely though, because you have carefully followed the preceding assembly instructions, haven't you?

Once power is applied and the LED is lit, the circuit should be producing a modulated 455kHz signal. You should be able to listen to it using an AM radio tuned to either 910kHz or 1365kHz, which are the second and third harmonics of the fundamental frequency. If it is working, you should hear a tone of around 500Hz when the antenna is close to the radio.

If you have an oscilloscope, you can check the waveforms which we have included with this article. The collectors of Q1 & Q2 should have a square wave around 500Hz, as shown in Fig 3. The collector of Q3 should be an approximate sinewave at 455kHz, whose amplitude should fluctuate – see Fig 4.

Conclusion

This simple project is easy to build and cost effective. It will greatly aid in the alignment of the IF stages of any AM radio. **SC**

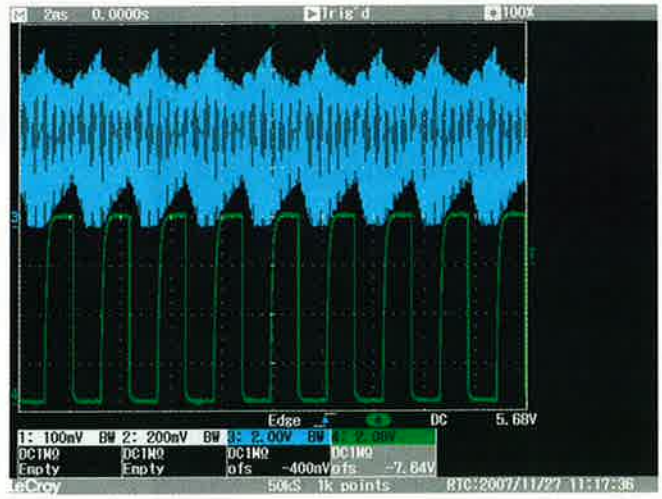


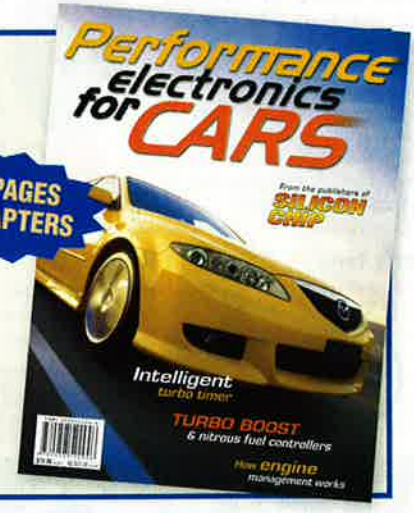
Fig.5: in this screen shot, the lower trace (green) is the audio waveform at the collector of Q1 while the top trace (cyan) is the resulting amplitude modulated 455kHz output at the collector of Q3. As shown, the modulation is not very clean but it is OK for the intended application.

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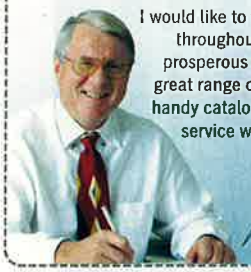
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$149 A 0987 NEW MODEL!

Portable Speaker System



SAVE OVER 25%

Now you can listen to music anywhere! Great for picnics, camping or music at your bedside table. Unique design suits almost any MP3 player or CD walkman! Powered by 4 x AAA batteries. *iPod not included.

$22 X 0800 RRP $29.95

Soldering Station FOR LIFE

Insist on a professional MICRON for your next soldering iron.



FREE! 1kg roll of solder (T 1115) & roll holder (T 2439) valued at $42.10

$229 T 2438S VALUE!

Featuring precision digital heating control for the best soldering experience you'll ever have! Features include: • Ceramic heating element • Zero-volt switching • Comfortable slim handle for all day use • Temperature lock • 200-490°C range • Antistatic strap point.

2 Year Warranty!

Great Sound While Working Out!



Compact design!

Contoured design, fits snug around the back of your head. Amazing crisp sound! Lightweight design is perfect for active lifestyles. 3.5mm plug.

$15 C 9008 RRP $18.95

Commercial Grade UHF Wireless Mic System

Import direct prices, save a fortune! No longer just for commercial players, now everyone can afford the freedom of a wireless mic.



Up to 100m range! *in ideal conditions

Fantastic performance for your social club or function centre! Includes a handy autoscan system allowing quick and easy interference free channel selection. Great for areas with existing systems in use nearby. High quality 6.35mm line or balanced XLR output. **C 8860 Series. Cat page 35.**

$314 Receiver + Handheld Mic.

$353 Receiver + Beltpack & Lapel Mic.

3 Way HDMI Switcher



With remote control. Designed to switch between 3 HD sources. **Features:** • Up to 1080p resolution • IR extender allows remote location of the unit • Includes plugpack

$159 A 3080 RRP $199

Distribute audio around the house with ease!



This compact unit allows you to connect up to two additional pairs of speakers to your amplifier without risk of damage or overloading. Each speaker "zone" has volume control and ON/OFF switch. 50W RMS per channel. Suitable for 4 or 8Ω speakers.

Easily connects to any home stereo amplifier!

$129 A 2384 RRP $149

Compact Mini Mixer



Totally portable! Powered by 9V battery or plug-pack (M 9237) this tiny mixer is perfect for home karaoke or small productions. It mixes four 6.35mm mics with total ease. Channel level controls, plus master in a robust steel chassis.

$24 A 2620 RRP $28.95

Cat5e Data Cable



Handy 100m size boxes, ideal for networking the average size house or for custom patch leads.

$70 per box W 2759 RRP $90

20% OFF!

A Touch of Class for Your Home AV System

SAVE $50



6.5" 30W 2 way ceiling / wall flush mount speakers. Expand your home audio system with these professional quality speakers which look and sound fantastic. They are well suited to home theatre / hi-fi use. The average home handyperson could install these in around an hour, its just that easy! **Sold in pairs.**

$169 C 0873 Round RRP $219

$199 C 0871 Rect. RRP $249

Drop Proof Announcers Microphone



VIRTUALLY INDESTRUCTIBLE! Unique designed super tough grill resists damage, even when dropped onto hard floors. Excellent choice for clubs, schools, places of worship etc.

Superb sound reproduction!

$35 C 0383 RRP $45



Control 4 AV devices with a single remote!

$25 A 1013 RRP $32

This compact water resistant remote control is ideal for use around the pool or spa. Supplied pre-programmed to suit most brands & types of AV equipment ie: TV, CD, VCR, DVD etc.

WATER RESISTANT FOR POOLSIDE USE!

Gaffa Tape



JUMBO 40m ROLL! Tough, sticky fibre tape for holding just about anything together! 48mm wide.

$20 T 2960A RRP $25

Nitto Self Bonding Tape



Great for waterproofing connectors and cables. 19mm wide, 10m roll

$17 T 2950 RRP $20.95

Calling All Muso's!

UP TO 25% OFF balanced 3 pin XLR male to female mic leads.



Part No.		RRP	Now...
P 0726	0.5m	$9.00	$7
P 0728	1m	$10.50	$8
P 0729	3m	$11.75	$9
P 0732	5m	$12.95	$10
P 0735	10m	$19.95	$15
P 0737	20m	$26.95	$20

Great for mics & mixers!



SAVE 20%!

Customisable Rack Cases

These pro quality cases allow internal subchassis to be mounted along the full width or height of the case. Great for test equipment, amplifiers etc. Aluminium front & rear panels. Supplied with internal panel and 4 mounting strips.

$69 H 5038 2U RRP $89

$79 H 5039 3U RRP $99

Allows easy mounting of internal PCB's

ALTRONICS ONE-STOP ELECTRONICS SHOP

3 Big Electronics Super-stores:

Perth WA: 174 Roe St Auburn NSW: 15 Short St Springvale VIC: 891 Princes Hwy

Handy Power Supplies & More...



Save up to $60!

Reliable 240V mains power anywhere, anytime!

These compact inverters generate mains power from your car, boat or 4WD's 12V battery! Great for camping, farmers, mobile trades people etc. Suitable for use with laptops, portable TV's, battery chargers and stereos. The higher capacity models are also great for power tools such as drills, angle grinders.

• Electrically isolated • Modified sine wave • Host of protection features • Soft start • High/low voltage shutdown • High surge wattage rating

$49	$59	$199	$299
M 8072 150W	M 8076 300W	M 8084 600W	M 8090 1000W
RRP $59.95	RRP $79.95	RRP $229	RRP $359



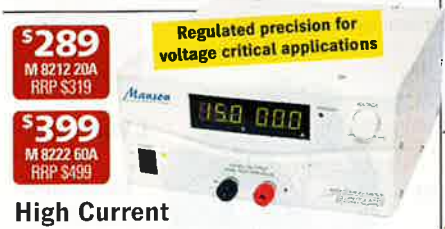
HUGE SAVINGS!

Laboratory Quality Benchtop Power Supplies

Fully adjustable with LCD meters for precision adjustments. Great for R&D, workshops or repair centres etc.

• Separate controls for voltage and current • Fixed 12V & 5V output rails • Precision LCD voltage & current meters • 0-30V adjustable • Fully regulated • Short circuit & overload protection.

$185	$235
M 8200A 3A	M 8205 5A
RRP $239	RRP $289



Regulated precision for voltage critical applications

$289	$399
M 8212 20A	M 8222 60A
RRP $319	RRP $499

High Current Regulated Lab Power Supplies

Compact switchmode design is both powerful and lightweight. Great for powering communications equipment, car audio amplifiers, camping fridges or other portable DC power appliances.

M 8212: 3 to 30V regulated @ 20A max.
M 8222: 1-15V regulated @ 60A max. Plus auxilliary 5A output on front panel.



ESR Meter Kit

Super value! **Now available from Altronics!**

(SC April '04) Allows quick "in-circuit" detection of defective electrolytic capacitors. 0.01-99Ω autoranging. A must have for repair technicians. Includes case & fully screened & punched front panel.

$89.95 K 2574 BARGAIN!

High Current DC Plugpacks

SAVE OVER 30% Supplied with 2.1mm DC jack.
M 8909-34 slimline case pictured.

Part No.		RRP	Now...
M 8909	5VDC 2.6A	$22.90	$16
M 8925	9VDC 1.7A	$22.90	$16
M 8934	12VDC 1.5A	$22.90	$16
M 8935	12VDC 2.5A	$27.50	$22



BARGAIN PRICES!

12V Auto Accessory Socket

Great for 4WD's, boats & caravans. Easy to build into cabinets for quick and easy appliance connection. 12V cigarette lighter socket.

$9.95 P 0654 HOT SELLER!



SAVE UP TO 25%

Bargain 100m Rolls of Fig '8'

Great for low current DC wiring in cars, 4WDs, caravans etc.

W 2121: 24/0.20 Heavy Duty Red/Black.
W 2136: 32/0.20 Extra Heavy Duty Red/Black.

$30/roll	$40/roll
W 2121	W 2136
RRP $40/roll	RRP $50/roll

In-line fuse holder

Add a fuse to power calbe with minimal fuss. Connects in-line with 4G or 8G cabling. Suits 5AG fuses (not included).

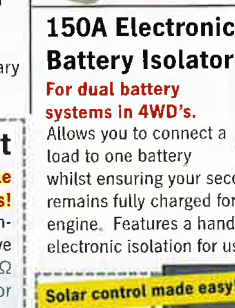
$8ea C 9780 RRP $11



Fuse Distribution Blocks

Splits single 4 gauge cable into multiple 8 gauge cables with fuses. 2 or 4 way. *Fuses not included

$10	$18
C 9760 2 Way	C 9770 4 Way
RRP $23.05	RRP $34.95



150A Electronic Battery Isolator

For dual battery systems in 4WD's.

Allows you to connect a load to one battery whilst ensuring your second battery remains fully charged for starting the engine. Features a handy charging circuit and full electronic isolation for use in modern cars.

$149 N 2102 RRP $169



Solar control made easy!

$149 N 2071A 12V N 2067 24V RRP $169

20A Solar Charge Controllers

These battery manager and solar regulator modules form the hub of an alternative power system. They ensure optimal charging for both wet cells and sealed lead acid batteries. A range of timer settings allow load to be powered at different times.

• Microprocessor controlled • Deep cycling for wet cells • Screen shows panel & battery output • Over charge & over temp protection • Low voltage disconnect • Back current protection • Over discharge & polarity protection • 20A max current.

High Current Connectors

Similar to Anderson® connectors. Massive 120A rating suitable for 4WD and recreational vehicles etc. Note: same plug is used for both male and female connection.

2 For $30	2 For $18
P 7840 120A	P 7835 50A
RRP $19.95ea	RRP $10.95ea

Pro Quality 8 Gauge Power Cable

Oxygen-free cabling for solar power & dual battery systems. 61A rated. ***Minimum buy 10m**

$1.50/m W 4100 Red W 4102 Black RRP $2.60/m

Save Power with Mains Timers

Switch appliances on or off anytime automatically, with these easy to use timers. Fool the burglars and automate your table lamps!

X 8010 Mechanical: Appliances may be switched on and off multiple times per 24 hours as desired.
X 8018 Digital: Can switch appliances on or off up to 10 times per day! Plus countdown timer & random modes.

BARGAIN!

$8.00	$20
X 8010	X 8018
RRP $9.50	RRP $24.95



HPM Smart Switch Timer

Ideal for when you go on holiday, by making it appear as if someone is living in your house! Press record to store information about when you use your appliances. When you go away, switch to play mode and your appliances will operate during periods you would normally use them.

$20 A 0315 RRP $24.95

Power up your battery devices!

This high quality desktop home charger features smart charging and discharging circuitry ensuring long reliable battery life. Suits AAA, AA, C, D, 9V. Charge up to 4 NiCad or NiMH batteries at once.

$25 A 0288 RRP $29.95 **Great value!**



*Note: batteries not included

NiMH SUPER SELLOUT!

Good for up to a 1000 recharges! Recoup the cost of these long life AA (1.8Ah), C (3.5Ah) & D (8Ah) cells batteries in just a few uses. **AA's sold in packs of 2, C & D sold individually.**

4 packs $16	4 For $30	4 For $68
S 4745A "AA"	S 4748A "C"	S 4753B "D"
RRP $5.35pk	RRP $10.50ea	RRP $20.75ea

SAVE 30%



12 Way Terminals

STOCK UP AND SAVE!

6A @ 400V rated.

10 for $10 P 2130 RRP $1.50ea



Powerful 4A Multivoltage Power Supply

25% OFF!

Selectable 3, 4.5, 5, 6, 7.5, 9 & 12V. Produces 4A (3-6V), 3A (7.5V-9V), 2.5A (12V) output. Supplied with 6 tip plugs to suit a majority of appliances.

$29 M 8232 RRP $39



Powertran® 300VA Toroidal

Manufacturer quality!

High output with 18+18V secondary windings. Primary 240V. Crimp connector leads.

LIMITED STOCKS!

$36 MA5518 RRP $50



Order Hotline 1300 797 007

TOOLBOX ESSENTIALS!



70W Enthusiast Gas Soldering Iron

Small, yet powerful! Ideal for the budding enthusiast. With built in stand. 30 minutes use from a full tank. **Kit version includes:** • Carry case • Blow torch • Hot air blower • Hot knife • Solder • Sponge

$50 T 2596 Kit RRP $59.95

$29 T 2595 Iron RRP $34.80

Precision Mini Drivers

With handy carry case!

Ideal for small electronic equipment. A toolbox essential for technicians & enthusiasts. Contains 5 flat blade and 3 phillips head drivers. All supplied in a robust carry case.



$16 T 2187A RRP $19.95

A third hand for hobbyists

Everyone could use a third hand when gluing, painting or soldering! These handy holders can help! Perfect for model makers, and electronic enthusiasts.



GREAT VALUE!

$7 T 1450 RRP $9.95

$10 T 1460 RRP $11.95

Metalwork made easy!

Great for cutting out odd shaped holes. Allows you to "nibble" aluminium, plastic or thin steel with amazing accuracy.



$15 T 2355 RRP $19.95

Also great for plastics!

Easy Solvent Dispenser

Safe and handy way to keep cleaning alcohol, PCB cleaner or solvents etc handy on your bench. Features a pump action lid which holds a few ml's. 180ml chamber.



$17 T 3030 RRP $22.95

ESD Safe!

Detect lethal AC voltages without contact



A must have for electricians!

$14 Q 3002 RRP $17.95

Non-contact pocket sized AC detector with LED flashlight. Essential for anyone operating with AC wiring. Lights up whenever it is near any AC source (100-600V @ 50-60Hz).

Measure Precisely

Engineer grade stainless steel vernier calipers. Fitted with an easy read dial guage. Thumbwheel slider and lock allows great flexibility when taking precise measurements. 0.02 to 150mm.



Ideal for the enthusiast or professional!

$35 T 2245 RRP $39.95

Nifty Service Aid

Multi-angle mini vice. Made from diecast alloy. Clamps to your work bench and provides total 360° freedom when working. Jaws open to 55 mm. Includes soft jaws for holding delicate connectors.



$30 T 2367 RRP $39.50

Like an extra pair of hands!

HIGH TECH DIGITAL TEST EQUIPMENT...

WATERPROOF True RMS DMM

Top of the range. Ideal for marine & mining technicians. Beware of cheaper models which may look similar but do not have all the features! Such as: • True RMS measurement • 40MHz Frequency counter with bar graph • Max/min recording • Capacitance to 40mF. **Plus these great features:** • Jumbo LCD • Temp measurement • 10A current range • Includes thermocouple • Data hold



$119 Q 1088 RRP $129

True RMS Autoranging DMM

20% OFF!

With features usually only found in meters twice the price! Capable of measuring AC waveforms with high accuracy, plus easy auto-ranging operation. **Features:** • ACV & DCV to 750V • 10A rating (AC/DC) • Resistance to 40MΩ • Capacitance to 100µf • Temp to 1000°C • Continuity • Frequency to 10MHz • Diode test • Auto power off • Rubber holster & test leads included. • Data hold & relative modes



$55 Q 1073 RRP $69.95

21 Range Digital LCR Meter

20% OFF!

This precision LCR meter is perfect for developing audio crossovers, switchmode power supplies, resonant filters & RF circuits. Allows quick measurements of inductance, capacitance and resistance. Test leads, carry case and holster included.



$79 Q 1155 RRP $99

Precision Frequency Counter



This high accuracy counter covers a frequency range of 10Hz to 2.7GHz in two ranges with separate inputs; Ch A 10Hz to 100MHz and Ch B 100MHz to 2.7GHz. Ideal for servicing and calibrating RF equipment such as radio mics, CB and amateur transceivers. **Features:** • 8 digit display • High input sensitivity • Period, frequency and pulse count (totalise) functions • x20 input

A must have for RF servicing!

$169 Q 1536 BARGAIN!

PROJECT PARTS...

3mm High Intensity LEDs

1600mcd brightness.



HALF PRICE!

10 For $16 Z 0708 RRP $3.20ea

BULK BRIDGES!

35A metal bridge rectifiers, KBPC3504 400V.



10 For $30 Z 0091 RRP $4.50ea

433MHz Data Transceivers



These compact units allow wireless data transmission over a 30m range. Perfect for remote monitoring devices, PC communications, inventions etc.

Great for inventors & experiments!

$8ea Z 6900 TX Z 6905 RX RRP $9.95

Optical Transmitter & Receiver



Build these optical communicators into your next project, or replace broken connectors on your home theatre equipment.

$2ea Z 1601 TX RRP $3.50

$3ea Z 1602 RX RRP $4.95

Compact LCD Meter



$20 Q 0571 RRP $25

SAVE 20% For projects requiring a professional volt meter with adjustable decimal point. Easy to integrate into your next DC project.

36 Way PCB Terminals



$9ea P 2030 RRP $12.55

Manufacturer quality! Cut to length.

Bargain voltage regs!

Save 30%.



10 For $8 Z 0505 5V Z 0510 12V RRP $1.20ea

1 Watt High Power Headband LED Torch



$19.95 X 0197 BARGAIN!

Ideal for camping, fishing, cycling and working in dark areas. High power long life LED lamp with 3 modes of operation (half, full & flashing). Includes 3 x AAA batteries.

LED "halogen type" globe



Replace halogens with efficient, low heat LED globes. Great for motorhome, caravan and boat lighting. Ideallly suited for feature & cabinet lighting. For 12V DC power applications. 1W light output.

2 For $30 X 2150 RRP $19.95ea

3W LED Lights -

Less heat! Less power!

Direct replacement for MR-16 halogen globes. Provides up to 100,000 hours of life, much more than ordinary halogens. Powered off a standard halogen transformer. 3W light output, 5W power consumption. 12-24V AC/DC operation. (note: switchmode transformers may require up to 4 LEDs per circuit to operate.)



30% OFF!

$60/pr X 2200B Cool White X 2206B Warm White RRP $44.95ea

ALTRONICS
ONE-STOP ELECTRONICS SHOP

No Risk 14 Day Money Back Guarantee

If you are dissatisfied with our goods for any reason, return to our premises within 14 days for a full refund (less transport costs). Returned items must be in NEW condition with all packaging and instructions (less transport costs).

Security Clearance...



6 zones for larger houses!

Protect your family, possessions and home! 6 Sector Home / Business Alarm System

At last a quality professional alarm system at an affordable price. Install it yourself and save a fortune! Supplied in 2 parts (main unit & keypad) and can be fully installed and programmed by **YOU** in just hours. Inbuilt dialler function can ring up to 4 different phone numbers when your alarm triggers. See plugpack and backup battery below. Extra keypads S 5265 (max of 4) $79.

$320 S 5264 RRP $399

In-built dialler calls you when your alarm triggers, why pay for expensive monitoring?



Alarm System Plugpack

$18 M 9332 RRP $23.50

16V AC, earthed type.



$12 S 5075B RRP $16.95

Backup Battery

Keeps your alarm armed in the event of a power failure! 12V 1.3Ah.



$20 S 5415 RRP $27.95

Handy combo strobe siren

Combination 12V siren & strobe in a weather proof housing. Saves you money and space!

2 In 1 Detector

Combines an infra red movement sensor & glass break detector. Save time and money installing multiple detectors! • 12VDC • Compact • Excellent immunity • 120° 12m PIR range • 9m glass break detection range.



$55 S 5318 RRP $69

Passive Infra Red Sensors

Pick up a bargain with these custom PIR detectors for security systems. Featuring a buffered transistor output. Suitable for use with a relay if required. Connection instructions provided.

$15 SX5306 BARGAIN!

OR BUY 4 FOR $50!



NEW!

Entryway Pressure Mat

$20 S 5184 RRP $29.95

Interface this pressure mat into your alarm system, shop door entry or home automation project. Circuit closes when stepped on. 80x54cm.

Keyless entry for your home or business



Interfaces with most alarm systems and door strikes to provide easy access for authorised users by simply waving a coded tag in front of the wallbox. Can be configured to require tag only entry or a combination of tag and pin number security. **Features:** 3 relay outputs • 12V operation • Additional tags $7.95 (S 5376). Credit card style tags $5.95 (S 5375).

$115 S 5374 RRP $169

Affordable professional security!

Combo Camera & Movement Detector



A great low cost total surveillance solution for home. Movement triggered or constant surveillance modes. **Colour CCD with audio.** Includes bracket. Requires M 9243 plugpack $18.

$50 OFF!

$199 S 9043 RRP $249

BARGAIN CCTV CAMERAS! - SAVE UP TO 50%

Great performer, even outdoors or water prone areas.



Underwater video down to 30m

$139 S 9080 B&W RRP $189

$220 S 9139 Colour RRP $265

These tiny cameras can also see in the dark! Great for outdoors, or aquarium use. M 9243 plugpack to suit S18.

"Cable-Free" 2.4GHz Camera

Wireless security made easy! This pro-grade black and white CCD camera offers superb clarity. Ideal for home or business. Inbuilt transmitter and C/CS lens mount. M 9243 plugpack to suit $18.

$164 S 8723 RRP $329

HALF PRICE!



Superb quality picture!



Bargain B&W Dome Camera

$65 S 9112A RRP $85

Utilises a high quality CCD sensor for an excellent, low noise picture. This compact dome camera easily mounts to ceilings, under eaves etc. Camera angle can be quickly adjusted. M 9243 plugpack to suit S18

Discrete Surveillance Made Easy

$149 S 9113A RRP $169

Looks just like a smoke detector! Record video discretely via this colour camera featuring a high performance Sony CCD sensor. Great for workplaces, offices, shops etc.



Easy to install!

Mini Pinhole Camera



Discrete surveillance solution for a bargain price! Professional quality. CCD sensor, B&W only. **Limited stocks**

$99 S 9008 RRP $149

$50 OFF!

Compact Reversing Camera



This all metal colour reversing camera can be easily flush mounted into the rear bumper of any car, caravan or trailer. Connect it up to an in dash monitor for easy viewing.

$150 S 9134 RRP $179

Handy image flip function shows video as if viewed in your cars mirrors.

Compact CMOS Colour Camera

$99 S 9060 RRP $149

Only 30mm high! Can be mounted just about anywhere. Great for home or business. Also features audio. **Limited stocks**



$50 OFF!

Sale Ends January 31st 2008

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Perth WA: 174 Roe St **Auburn NSW:** 15 Short St **Springvale VIC:** 891 Princes Hwy

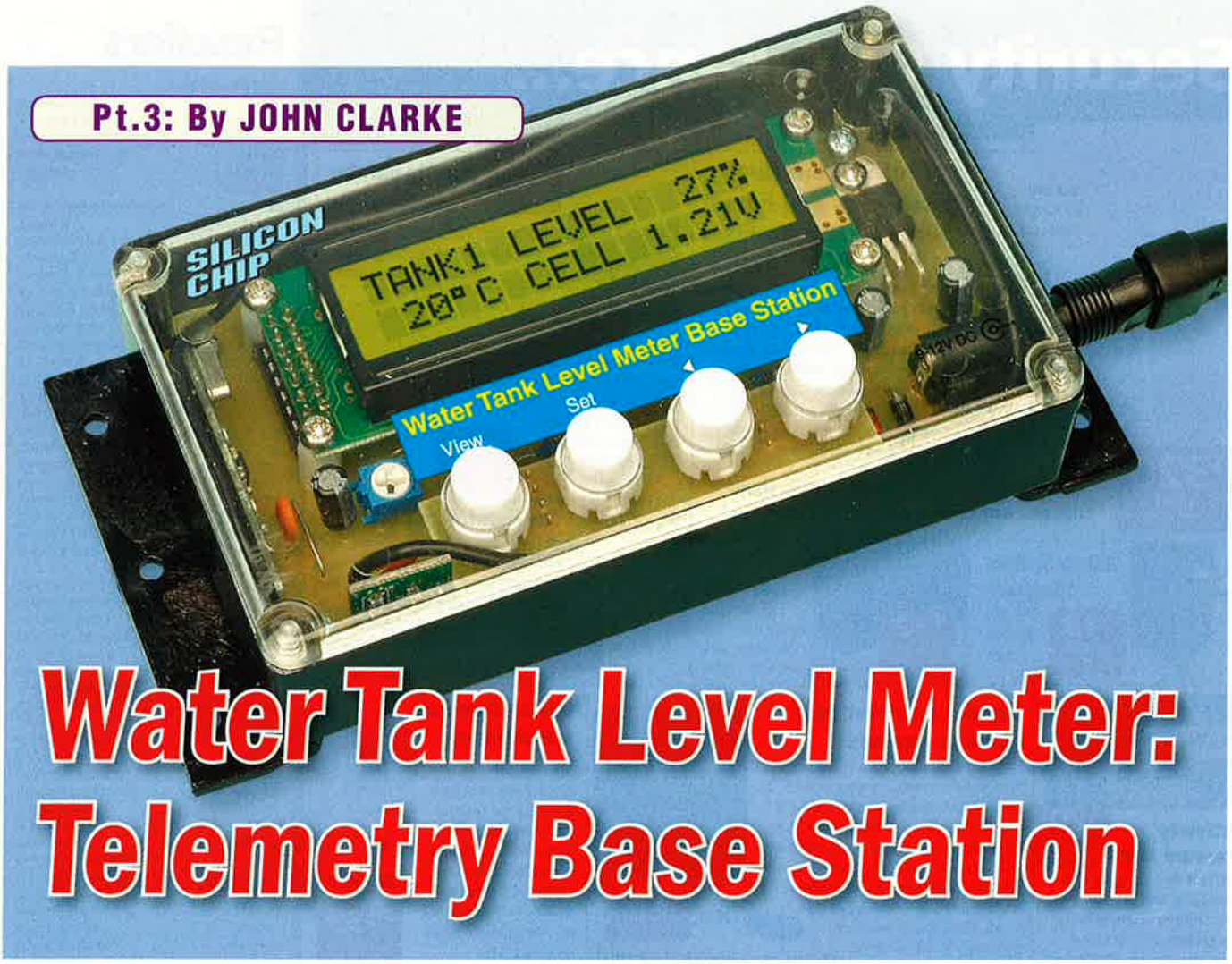
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Pakenham	Get Smart Hi-Fi & Repairs	5941 4886
Portland	PR Electronics	5521 1121
Preston	Preston Electronics	9484 0191
Swan Hill	Lateral Communications	5032 2322
Warrnambool	Koroit Street Electronics Services	5561 5111
Wodonga	Exact Computers and Electronics	6056 5746
Wonthaggi	Raneye Pty Ltd	5672 4774
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Ballina	Leading Edge Electronics	6686 3610
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Cobar	Cobar Electronics	6836 2962
Forster	Powerpoint Electronics	6554 5006
Griffith	Griffith Systems Plus	6964 5933
Gunnedah	Protronics	6742 2110
Lakehaven	Leading Edge Electronics	4393 2528
Newcastle West	Henchman Products	4956 7111
North Richmond	CPT	4571 4699
Parkes	Griffins Leading Edge	6862 2593
Penrith	Penrith Light and Sound	4722 2223
Port Macquarie	John Fettell Two Way Radio	6581 1341
Raymond Terrace	Leading Edge Electronics	4987 4909
San Souci	MarineConnect	9583 1710
Singleton	Singleton Hi-Fi	6572 2477
Smithfield	Chantronics	9609 7218
Taree	Powerpoint Electronics	6557 8000
Wagga Wagga	Wagga Car Radio & Hi-Fi	6925 6111
Waterloo	Herkes Electrical	9319 3133
Wetherill Park	Techtron Electronics	9604 9710
Windang	Mad Electronics	4297 7373
Wollongong	Newtek Electronics	4227 1620
Wyong	Pro Disc Entertainment	4353 1100
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Brisbane	Delsound Pty Ltd	3397 8155
Bowen Hills	Prime Electronic Components	3252 7466
Cairns	Pentacom	4032 1710
Caloundra	Leading Edge Electronics	5491 8533
Cloncurry	Access Electronics	4742 2590
Gladstone	Leading Edge Electronics	4972 6660
Hervey Bay	Leading Edge Electronics	4128 3055
Innisfail	Leading Edge Innisfail	4061 6214
Longreach	Access Electronics	4658 0500
Mackay	Stevens Electronics	4951 1723
Maroochydore	Ali Electronic Supplies	5443 6119
Maryborough	Leading Edge Electronics	4121 4559
Mossman	Leading Edge Electronics	4098 2200
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Townsville	Solex	4775 4522
SOUTH AUSTRALIA		
Adelaide	Aztronics	8212 6212
Brighton	Force Electronics	8377 0512
Enfield	Aztronics	8349 6340
Findon	Force Electronics	8347 1188
Holden Hill	Force Electronics	8261 7088
Mt Barker	Force Electronics	8391 1133
Mt Gambier	Anvil Electronics	8725 3366
Murray Bridge	Force Electronics	8532 1433
Woodville South	Force Electronics	8347 1188
TASMANIA		
Burnie	Electronics Plus	6432 2644
Hobart	Active Electronics	6231 0111
Launceston	Active Electronics	6334 7333
Launceston	CBD Electronics	6334 2777
NEW ZEALAND		
Christchurch	Global PC	3 377 6086
Papanui	Global PC	3 354 3333
Riccarton	Global PC	3 343 4475

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Pt.3: By JOHN CLARKE



Water Tank Level Meter: Telemetry Base Station

Designed to team with up to 10 Water Tank Level Meters, this Base Station lets you monitor water levels from a remote location (eg, inside your home). As a bonus, it also includes an option for electric pump control.

THE ABILITY TO MONITOR water tank levels from a remote location can be very useful in certain circumstances. This particularly applies if you have several water tanks or if the tanks are hard to access, or you want to include automatic pump control.

This Base Station is intended for use with the telemetry version of the Water Tank Level Meter described in the November & December 2007 issues of SILICON CHIP. It has an inbuilt 433MHz wireless receiver and can handle data transmissions from up to 10 level meters and display the results on a 2-line 32-character LCD module. In bargraph mode, it can show up to 10 tank levels simultaneously, while the digital readout mode shows individual tank levels to 1%.

As shown, the Base Station is a compact unit that can be placed on a shelf or a desk or attached to a wall via integral mounting brackets. The display is backlit so that it can be readily seen under all lighting conditions.

The only controls are four pushbutton switches situated in a line immediately below the LCD module. These are used to control the display format and to set up pump control. Power for the Base Station comes from a 9V DC 200mA plugpack.

Display format

As mentioned, the display can be switched to operate in one of two formats. The first format shows all enabled tanks and their levels as an 8-level bargraph on the one display (All Tanks View diagram). In this format, the top line shows the word "LEVEL" and the tank levels are displayed as a rectangular tank with sides.

Each tank level is shown by the height of the bars in the tank and each bar corresponds to a 12% or 13% step in level. So, for example, with only the bottom bar showing, the level is above 12%. For two bars the level is above 25%, while four bars represent a level above 50%.

If the tank is full (ie, at 100%), the tank symbol is just a full rectangular block (ie, all bars are on). Conversely, an empty tank or one that is below 12% in level shows an "e" for empty.

The second line in the display shows the word "TANK" and the number of each tank is displayed directly beneath each of the tank level bargraphs. As mentioned last month, each Water Tank Level Meter is assigned a tank

number using a 0-9 BCD rotary switch. These selected numbers are the ones that are displayed for each tank.

Note that only the tanks that are monitored with a Water Tank Level Meter need to be shown on the display. So if you only are monitoring Tank 1 for example, then that number is all that needs to be displayed.

Basically, you can enable which tank numbers the display will show. If only five tanks are enabled and they utilise numbers from 1-5, then each consecutive number will be separated by a space. If there are more than five tanks or if numbers above five are used, then there is no space between each consecutive tank number on the display.

In practice, the tanks are displayed from left to right in a 1-9 and then 0 sequence. However, if one or more of these tank numbers is not enabled, the display will include a space where the tank number would otherwise be positioned.

View switch

Pressing the View switch accesses the alternative digital display format (Individual Tank Detail diagram). In this mode, individual tank data is shown. For example, if tank 1 is selected, the first line will show: "TANK1" followed by "LEVEL" and then the water tank level value as a percentage. For example it may show "27%". The levels can range from 0-110%.

If no tanks are enabled in this mode, the display will show "TANK ERROR ENABLE A TANK!" (we describe how to do this a bit further on).

The second line in this display format shows the temperature reading in °C and this can range from -99°C through to +99°C (this is the temperature inside the corresponding Water Tank Level Meter). Following this is the word "CELL" and then the cell voltage (eg, 1.21V).

If the cell voltage is below 1.15V, then a small cross will be displayed just before the voltage value. This indicates that the cell in the level meter in not charging correctly which may soon prevent it from operating.

Each enabled tank can be checked in sequence using the Up (▸) or Down (◂) switches to select the tank number required. Note that only enabled tanks will be displayed. For example, if you have enabled tank 1, tank 3 and tank 4, then the Up switch will cycle between 1, 3, 4, 1, 3, 4, etc. Similarly, the Down switch will cycle between these numbers in the reverse sequence.



Data for the Telemetry Base Station is transmitted from one or more Water Tank Level Meters (up to 10), as described in the November & December 2007 issues of SILICON CHIP.

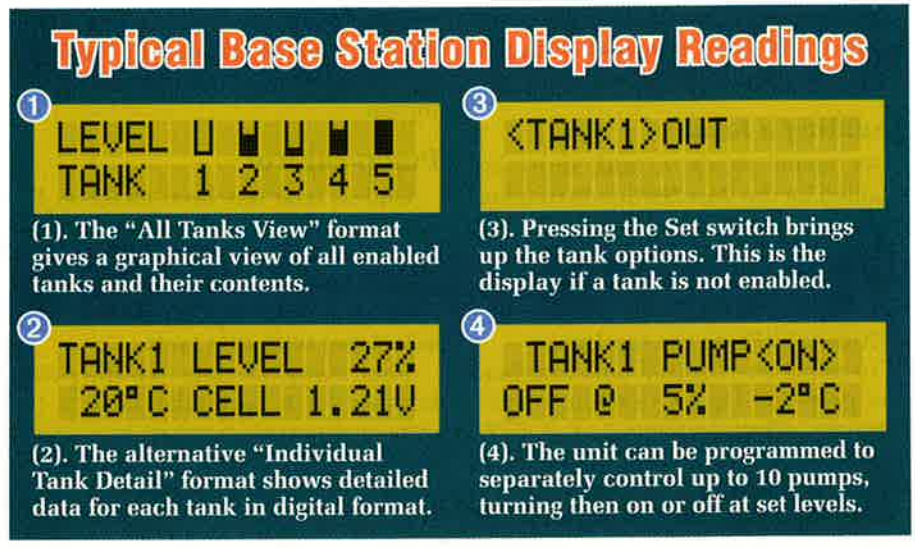
Note that if you have only enabled one tank, the Up and Down switches will have no effect.

If the base station has not received any data from the selected Water Tank Level Meter it will show a question mark (?) in the space that normally shows tank level. In greater detail, this will be shown in place of the bargraph for the "All Tanks View" mode and in place of the the level and temperature value portions for the "Individual Tank Detail" format.

In addition, a '?' is initially displayed for level, temperature and cell voltage when the Base Station is switched on, before it receives data from the Water Tank Level Meter. The '?' will reappear after data for that particular tank has not been received for more than an hour. However, the cell voltage will still be displayed and will show the last measured voltage before transmission was lost.

Loss of reception for over an hour

Typical Base Station Display Readings



Feature & Specifications

Features

Monitors up to 10 Water Tank Level Meters

Digital readout shows 1% level resolution for individual tanks

Switchable bargraph level display for monitoring all tanks simultaneously

Temperature and cell voltage monitoring for each tank meter

Can automatically control up to 10 electric pumps

Automatic pump-off switching with water level and temperature

Water level threshold adjustment for pump off

Temperature threshold adjustment for pump off

Specifications

Number of tanks monitored: 10 maximum

Bargraph display: eight levels plus "e" for empty, corresponding to levels of 0, 12, 25, 37, 50, 62, 75, 87 & 99%

Individual display: percentage display from 10-110% in 1% steps; temperature from -99°C to +99°C.; cell voltage with 2-digit 10mV resolution

Pump Control: up to 10 pumps

Temperature threshold: pump switches off for temperatures below the setting from -9°C to +99°C; adjustment can be made in 1°C steps.

Level threshold: pump switches off for level settings below 50%. Alternatively, pump switches on for level settings above 50%. Adjustment is available in 1% steps from 0-100%

Invalid data: displays shows a "?" if no valid data at power up and after one hour without fresh data.

Power: 9-12V DC @ 100mA

Encode: 16 selections to help prevent reception of a neighbouring signal

can mean that the Water Tank Level Meter has a low cell voltage and has ceased transmitting. The last measured cell voltage before data was lost can help solve the problem. Cell voltages at or below 1.10V reveal that the cell is discharged.

Alternatively, the Water Tank Level Meter could have met with a much more catastrophic disaster!

Enabling a tank

As noted above, a tank must be enabled for the Base Station to display its data. To do this, you first press the Set switch so that the tank options are displayed. If a tank is not enabled, the display will show, for example, <TANK1>OUT on the top line.

To select the required tank number, you press the Up (▸) switch to successively select numbers 3, 4, 5, 6, 7, 8, 9, 0, 1, 2, etc. That done, you enable the selected tank by pressing the Down (◂) switch. This changes the display so that it now shows the PUMP ON or OFF indication and settings on the second line of the LCD.

Once a tank has been enabled, you can continue to enable more tanks by pressing the Up switch to find the tank number and then the Down switch to enable the tank as required. That done, it's just a matter of pressing the View switch to return to the main display format.

Pump control

Once a tank has been enabled, the menu for its pump control can be displayed by pressing the Set switch. The display then shows various options for controlling an electric pump associated with that tank.

First, however, note that the pump number for a particular tank is the same as the tank number; ie, a pump associated with tank 1 is pump 1, a pump associated with tank 2 is pump 2 and so on.

Initially, when a tank is first enabled, the pump is set to OFF. To turn the pump on, first press the Set switch to display <OFF> following the word PUMP. The setting is then changed from OFF to ON by pressing either the Up (▸) or Down (◂) switch

When this is done, the pump switches on and the word "ON" will be displayed, provided the pump control threshold values are OK.

The pump control threshold values are shown on the second line of the LCD. This line starts with "OFF @" (off at), followed by a level setting in percent (eg, 5%) and a temperature setting in °C (eg, -2°C).

In practice, the pump will not switch on if the temperature is below the threshold value or if the water level is beyond the threshold value. Conversely, if a pump is on, it will switch off if the values received from the level meter are below the temperature threshold or beyond the water level threshold setting.

The water level setting threshold works in two ways. First, suppose you are using a pump to extract water from a tank, as is normal if the tank is used to supply water for a house. In this case, the unit would be set to automatically switch off the pump when the tank water drops below the set threshold. This is done to prevent the pump running continuously when the tank water has been depleted.

Basically, the unit will switch off the pump if the level threshold is set to 50% or less. Typically, the threshold would be set well below 50%, at say 15% or 10%.

Conversely, you might want to use a pump to fill a tank from another supply; eg, from a bore or from another tank. In this case, you want the pump to switch off when the water level reaches the preset value so the tank does not overflow. For the Base Station pump control, a level setting that is over 50% will switch the pump off when the water level reaches the set threshold.

So the pump automatically switches off for rising or falling levels, depending on whether the setting is above or below the 50% threshold.

Note that the Base Station does not directly control the pump (or pumps). Instead, it transmits a UHF signal to a UHF Remote Control Mains Switch and this in turn switches the pump on or off. The UHF Remote Control Mains

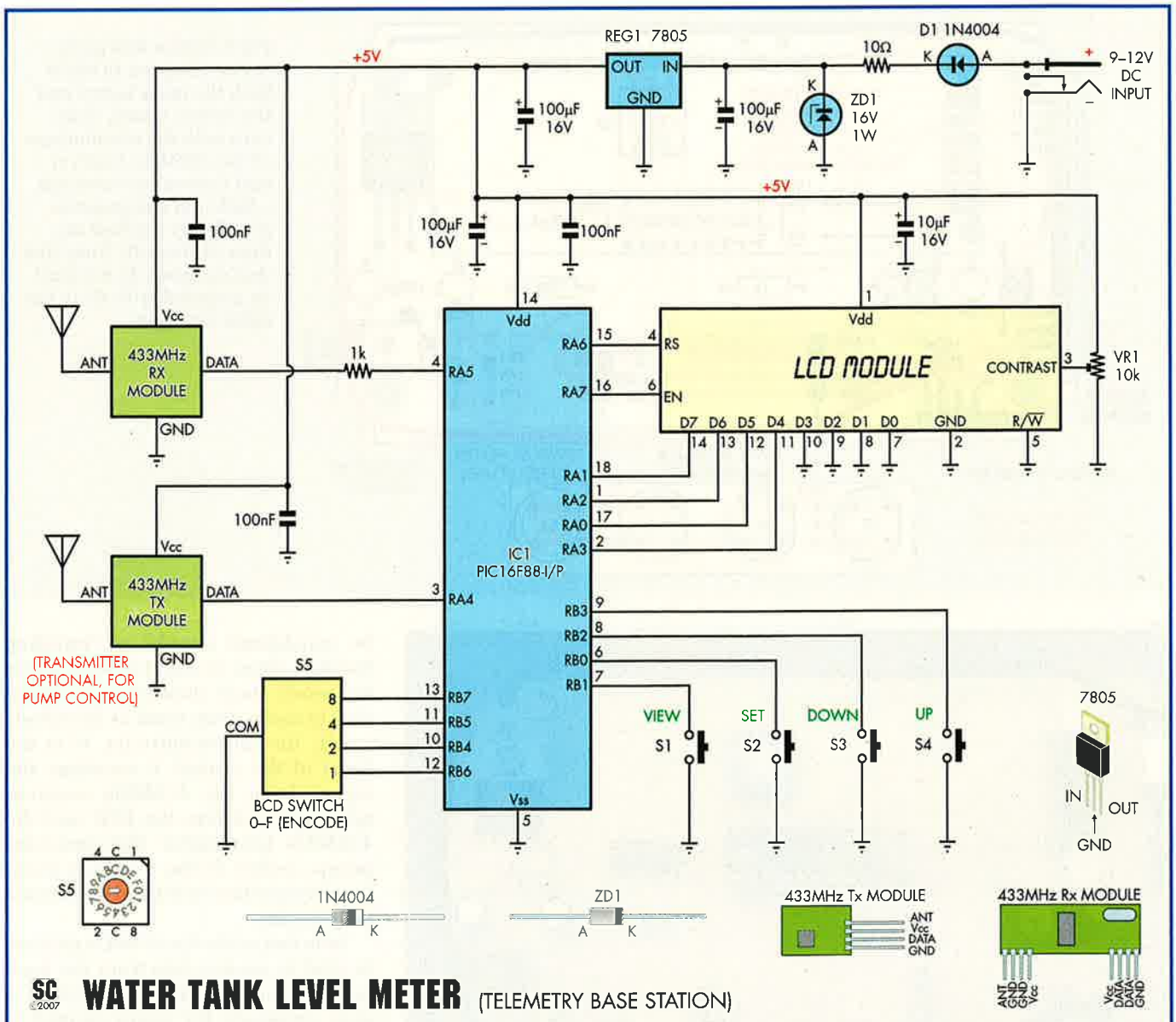


Fig.1: the Base Station uses a 433MHz receiver module to pick up data from the Water Tank Level Meter(s). This data is then fed to PIC micro IC1 which in turn drives the LCD module. The 433MHz transmitter is only necessary for pump control.

Switch will be described in SILICON CHIP next month and you will need to build one of these for each pump you wish to control.

Temperature control

If the outside temperature is at or below 0°C, the water in the pipes that connect to the tank may freeze. If that happens, then having a pump start up could destroy both the pump itself and the connecting hoses.

For this reason, the unit includes temperature control. This feature automatically switches the pump off if the temperature drops below a preset threshold.

The actual threshold setting will depend on the climate at your location and how well the pipes are protected from the environment. If your pipes are underground, then they may never freeze up. Conversely, if the pipes are exposed, then they may easily freeze.

Generally, you would set the temperature to around -2° C. That's because the water in the pipes is not likely to freeze until the temperature drops several degrees below zero for a reasonable period of time.

Remote Control Mains Switch

In operation, the UHF Remote Control Mains Switches receive the on or off signals from the Base Station to control the pumps. These switches are each assigned a number from 0-9, corresponding to the tank number and its pump. This ensures that the correct UHF Remote Control Mains Switches respond to signals from the Base Station.

Another important feature of each UHF Remote Control Mains Switch is brownout detection. A brownout occurs when the mains voltage drops well below its normal value, due to a fault condition in the mains supply. This not only affects the brightness of lights but more seriously, can cause

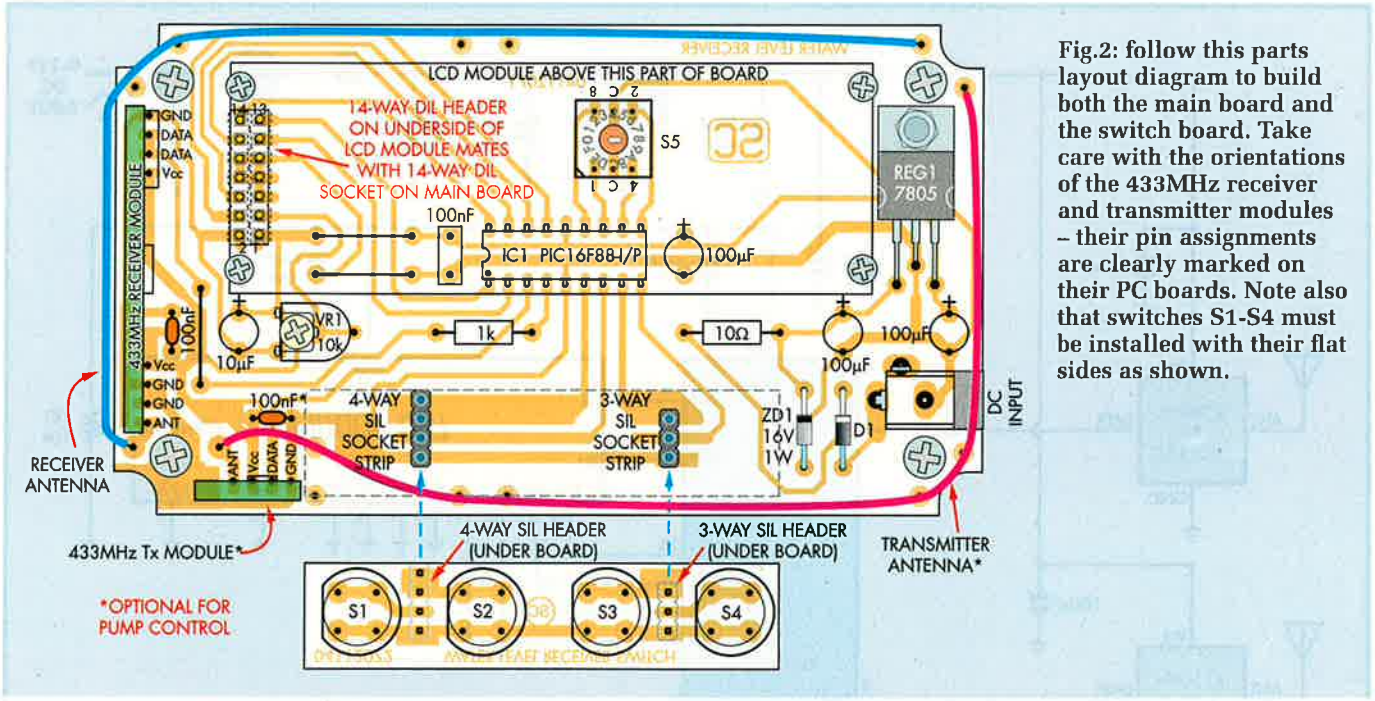
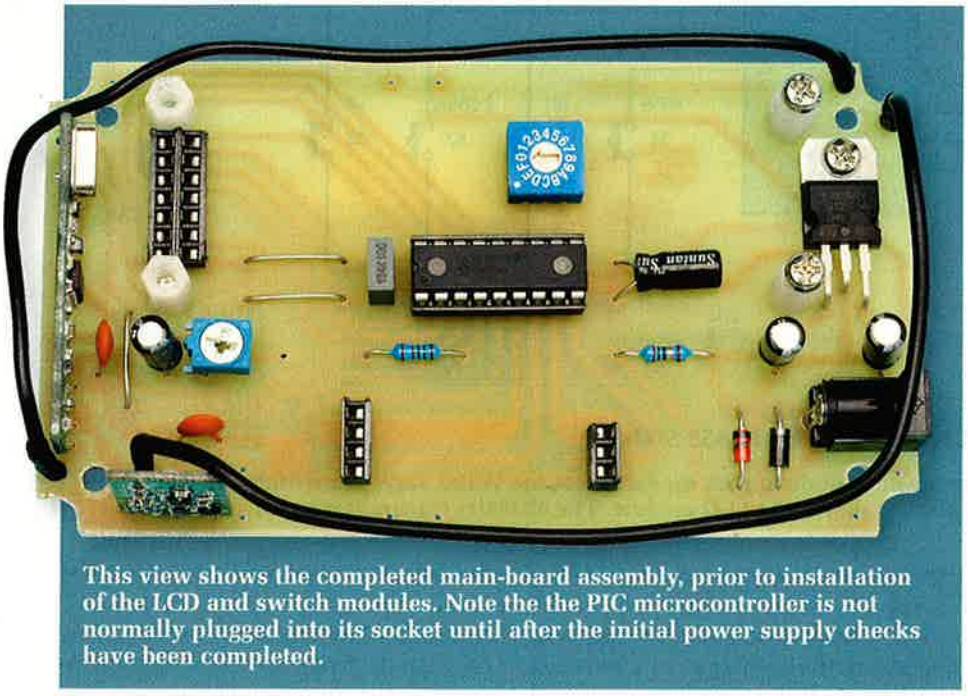


Fig.2: follow this parts layout diagram to build both the main board and the switch board. Take care with the orientations of the 433MHz receiver and transmitter modules – their pin assignments are clearly marked on their PC boards. Note also that switches S1-S4 must be installed with their flat sides as shown.



This view shows the completed main-board assembly, prior to installation of the LCD and switch modules. Note the the PIC microcontroller is not normally plugged into its socket until after the initial power supply checks have been completed.

pumps and other electric motors to burn out. That's because, at low voltage, electric motors draw excessive current (and thus overheat) when they do not spin at their normal RPM.

To prevent this, the UHF Remote Control Mains Switch switches off the supply to the pump if a brownout is detected (more on this next month).

Circuit details

The circuit for the Water Tank Level Meter Base Station is really quite simple. As shown in Fig.1, it's based on a PIC16F88 microcontroller (IC1) and a 2-line x 16 character LCD module. Apart from that, there's just a couple of 433MHz receiver & transmitter modules, a BCD switch, four pushbutton switches and a few sundry bits that are mainly in the power supply.

Of course, some of the components are quite complex in themselves, such as the 433MHz receiver and transmitter modules, the LCD module and the microcontroller. However, these can be considered simply as "building blocks", since we don't need to know too much about their internal operation to make them work as intended.

IC1, the microcontroller, is at the heart of the circuit. It monitors the signal from the 433MHz receiver and in turn drives the LCD and the 433MHz transmitter that provides pump control. It also monitors push-button switches S1-S4 and the encode switch (S5).

Note that while the 433MHz receiver is vital to receive data from the level meters, the 433MHz transmitter is only necessary for pump control. If you don't intend to use this unit for pump control, then the transmitter can be omitted.

As shown in Fig.1, the data received by the 433MHz Rx (receiver) module is applied to the RA5 input of IC1 via a 1kΩ current limiting resistor. This resistor is included because IC1 can latch up if excessive current flows into or out of this pin if the input goes above +5V or below 0V.

In operation, IC1 reads the data signal by clocking it in at a rate set by the transmission locking pulse. This data is then accepted by IC1 if the format is correct and the encode value matches the setting of BCD switch S5 (ie, the encode switches in the level meters and the Base Station must match each other).

If the encode settings do not match, then the data signal will be rejected.

S5 is connected to the RB4, RB5, RB6 and RB7 inputs of IC1 and can pull these inputs to ground when its '2', '4', '1' & '8' switches are closed respectively. Basically, it is a rotary switch with 16 settings ranging from 0-9 and A-F. For the 0 setting, all switches are open and for the F setting all switches are closed. Settings in between 0 and F have different combinations of open and closed switches.

For example a '1' position will tie IC1's RB6 input to ground. Conversely, each RB4-RB7 input will be pulled to the +5V supply rail when its corresponding switch is open. That's because each of these inputs has an internal pull-up resistor of about 20kΩ.

In operation, each switch setting can be checked by IC1 because a low voltage on the input means that the switch is closed, while a high voltage means that the switch is open.

Switches S1-S4 (View, Set, Down & Up) on the RB0-RB3 inputs are monitored in a similar way.

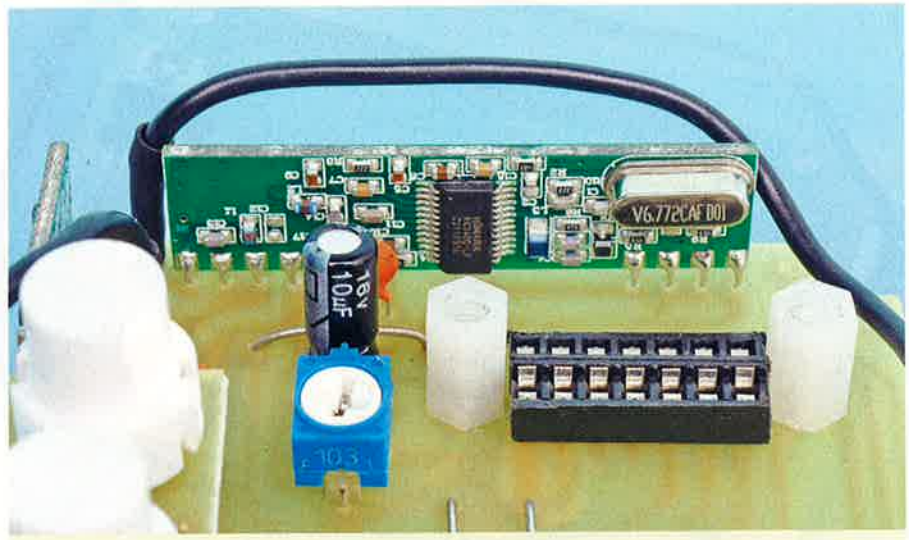
Ports RA0-RA3 & RA6-RA7 are used to drive the LCD module. As shown, RA0-RA3 drive the D4-D7 data lines, while RA6 & RA7 drive the register select (RS) and enable (EN) lines respectively. Trimpot VR1 sets the display contrast voltage.

Driving the transmitter

The pump control signal appears at IC1's RA4 (pin 3) output and is fed to the 433MHz transmitter. In practice, the Base Station can individually control up to 10 UHF Remote Control Main Switches, which in turn switch the pumps on and off as required.

The data transmission protocol is as follows: initially a 50ms transmission is sent to set up the receiver so that it is ready to accept data. That done, a 16ms locking signal is sent, followed by a 4-bit encode number and a 4-bit tank number.

An 8-bit pump-on or pump-off signal is then sent. This is either 162 for pump-on or 150 for pump-off. Finally, an 8-bit stop code with a value of 204 is sent. These stop bits indicate that the signal is for pump control and differ from those used for the transmissions from the Water Tank Level Meters.



Installing The 433MHz Receiver & Transmitter Modules

These larger-than-life-size photos clearly show how the receiver (top) and transmitter (right) modules are installed on the main PC board. You can leave the transmitter module out if you don't intend to use the pump control feature.



Power supply

Power for the circuit comes from an external 9-12V DC plugpack supply. Diode D1 provides reverse polarity protection, while zener diode ZD1 clamps any voltage spikes to 16V. A 10Ω resistor in series with the supply rail provides current limiting.

A 100µF capacitor decouples the supply rail which is then fed to 3-terminal regulator REG1. This produces a regulated +5V supply rail, with further supply bypassing provided by another 100µF capacitor directly across REG1's output.

Additional 100µF, 10µF and 100nF bypass capacitors are also used to decouple the supply to microcontroller IC1, the LCD module and the 433MHz transmitter and receiver modules.

Construction

The Water Tank Level Meter Base Station is built using two PC boards – a main board coded 04101081 (115 x 65mm) and a switch board coded 04101082 (63 x 15mm). The latter carries just four pushbutton switches (S1-S4) and two 4-way SIL header strips.

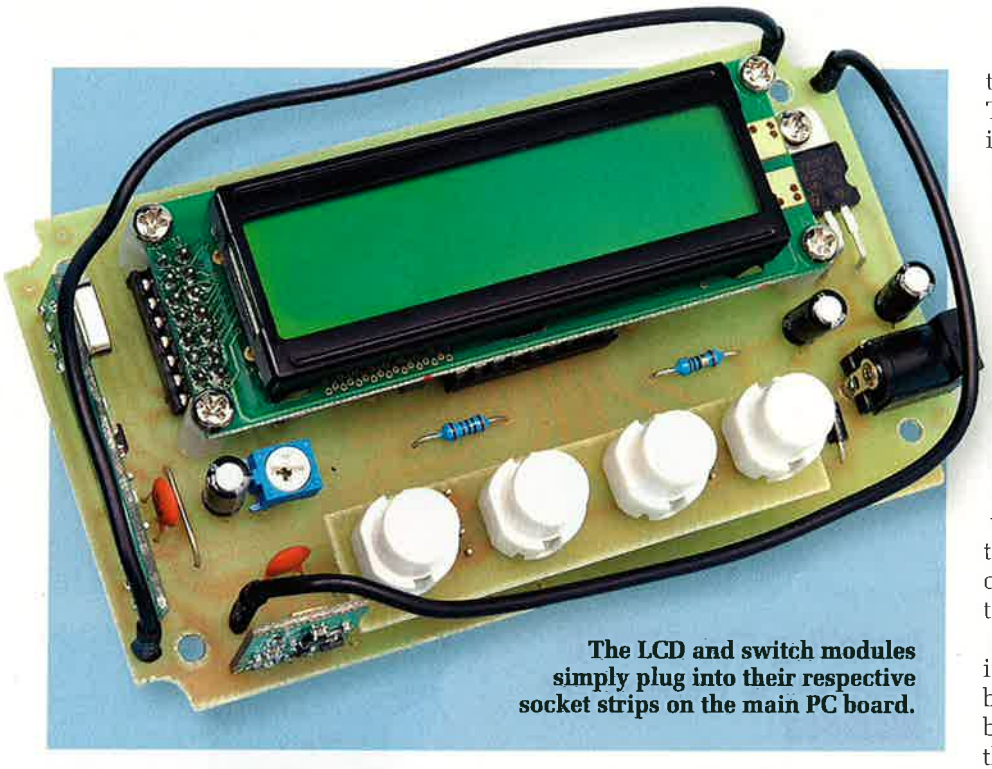
These boards are housed in a bulkhead style case fitted with a clear lid and measuring just 120 x 70 x 30mm. Note that if you intend including

Capacitor Code

Value	µF Code	IEC Code	EIA Code
100nF	0.1µF	100n	104

Resistor Colour Codes (Receiver)

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	1	10Ω	brown black black brown	brown black black gold brown



The LCD and switch modules simply plug into their respective socket strips on the main PC board.

pump control, then the 433MHz transmitter and its associated components must be installed.

Begin construction by checking the PC boards for any defects such as shorted tracks or breaks in the copper areas. That done, check that the hole sizes are correct. In particular, the holes for the four corner mounting screws, the four LCD mounting points and for REG1 should be 3mm in diameter.

Check also that the main PC board fits into the box. It should have a circular cut-out at each corner so that it clears the corner pillars. If necessary, cut these out and file the edges of the board until it is a neat fit.

That done, you can now begin installing the parts. Fig.2 shows the parts layout diagram. Install the two resistors first, taking care to use the correct value at each location. It's just a matter of using a digital multimeter to check their values, before soldering them in position.

The three wire links can go in next, followed by PC stakes for the receiver antenna connections. You should also install additional PC stakes for the transmitter antenna connections if pump control is to be used.

Follow these with diode D1 and zener diode ZD1, taking care with their orientation. That done, install a socket for IC1, making sure that the notched end goes to the left; ie, towards the 100nF capacitor. Don't install IC1 yet, though – that step comes later, after some initial power supply checks.

Next on the list are the 4-way and 3-way SIL (single in-line) sockets (used later to mount the switch PC board). These two sockets can be made by using a sharp knife to cut down an 8-pin DIL (dual in-line) IC socket. Clean up the edges with a small file before mounting the sockets.

Similarly, you also need to install two 7-way SIL socket strips to accept the connections for the LCD module. These can be made by cutting and filing a 14-pin DIL IC socket.

Now for the capacitors. Note that three of these are electrolytic types and must be oriented with their polarity as shown. In addition, the 100µF capacitor to the right of IC1 must lie horizontally on the PC board; ie, it's installed with its leads bent down by 90° (see photo).

Note also that there are three 100nF capacitors on the board. The two ceramic types go in adjacent to the 433MHz receiver and transmitter modules, while the 100nF MKT capacitor is positioned immediately to the left of IC1.

Regulator REG1 is installed so that its metal tab sits flat against the PC board. The procedure here is to first bend the regulator's centre lead down through 90° some 5mm from its body, after which its two outer leads can be bent down about 7mm from the body. That done, the device is fitted to the board and fastened using an M3 x 6mm screw and nut before soldering its leads.

Don't solder the leads before bolting the device to the PC board. If you do, you could stress and fracture the PC tracks as the device is tightened down.

The DC socket, BCD switch S5 and trimpot VR1 can now go in. Be sure to orient the BCD switch exactly as shown and set it to the same number as the encode switches in the Water Tank Level Meters.

The main board assembly can now be completed by installing the 433MHz receiver and transmitter modules. As previously stated, the latter is only necessary if pump control is required, otherwise simply leave it out. Make sure that these parts are correctly oriented (see photos) – their pins are clearly marked.

You will also need to install the antennas for these modules. These antennas are made using 170mm lengths of hook-up wire, each running from its module's antenna PC stake to a PC stake at the opposite corner of the board.

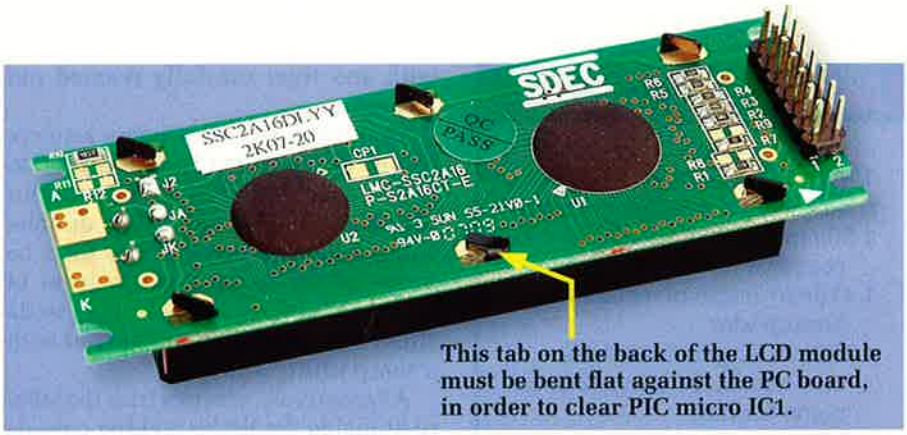


This view shows how the 3-way & 4-way pin headers are installed on the switch board – see text.

Switch board

The switch board should only take a few minutes to assemble.

Begin by installing the four push-button switches, making sure that



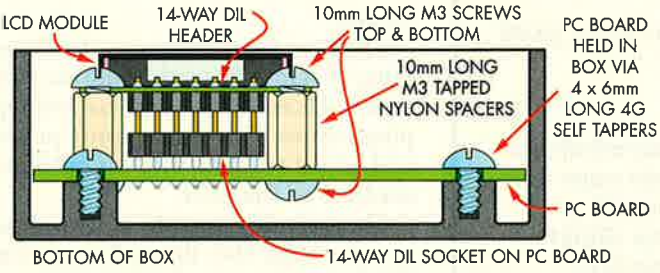


Fig.3: the LCD module plugs into the 14-way DIL header and is supported on four M3 x 10mm tapped Nylon spacers.

each switch has its flat side oriented as shown. That done, the 3-way and 4-way headers can be installed.

These headers are installed on the track side of the PC board (see photo). Install each one so that its pins protrude about 1mm above the board surface, then solder the pins and slide the plastic spacer towards the PC board until it rests against the solder joints. The assembled switch board can then be plugged into the main board.

Mounting the LCD module

The LCD module is connected in similar fashion to the switch board. In this case, you have to carefully solder a 14-pin DIL header to the module and once again, this has to be installed from the underside of the PC board.

Push the header in so that its pin length below the PC board is exactly 8mm (an 8mm-wide cardboard strip makes a handy alignment tool). That done, carefully tack solder a couple of pins, make any adjustments as necessary, then complete the soldering.

Note that you will need a soldering iron with a very fine tip for this job, to avoid butchering the fine tracks on the top of the LCD module.

Applying power

Now for the smoke test. This is done with IC1 out of its socket and the LCD module unplugged.

First, apply power and check that there is 5V between pins 14 & 5 of IC1's socket. If this is correct, switch off and install IC1 with its notched end towards the 100nF capacitor (see Fig.2).

Next, install four M3 x 10mm tapped Nylon spacers on the main board to mount the LCD module. Secure these using M3 x 6mm screws, then plug the LCD module in and secure it to the spacers using another four M3 x 6mm screws.

Note that there is a tab beneath the LCD module which interferes with IC1 when you attempt to mount the module in place. This tab must be bent over to lie flat against the LCD module's PC board to avoid this problem.

The completed assembly can now be installed in its case. If you are building from a kit, the case will probably be supplied with a screen-printed label and with all the necessary holes drilled. If not, then you will have to drill the holes yourself.

You will need four 10mm holes in the lid of the case to clear the switch caps, plus a 6mm hole in the side of the case to give access to the DC socket. The latter is located 9mm down from top of base and 12mm in from the side.

The switch holes in the lid can be drilled using the front panel label shown in Fig.4 as a template. These can initially be drilled out to about 5mm using a small pilot hole to start

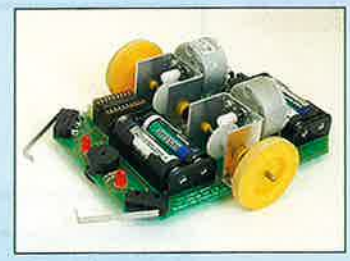
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Parts List

1 PC board, code 04101081, 115 x 65mm
1 PC board, coded 04101082, 63 x 15mm
1 bulkhead case with clear top, 120 x 70 x 30mm (Jaycar HB-6082 or equivalent)
1 9VDC 200mA plugpack
1 LCD module with backlight (Jaycar QP-5516 or equivalent)
1 PC-mount 2.5mm DC socket
1 433MHz receiver module (Jaycar ZW-3102 or equivalent)
1 433MHz transmitter module (Jaycar ZW-3100 or equivalent) (optional for pump control)
4 click-action PC-mount switches (S1-S4)
1 0-F 16-position BCD switch (S5)
1 14-pin DIL header (2.54mm pin spacing)
1 4-way SIL header (2.54mm pin spacing)
1 3-way SIL header (2.54mm pin spacing)
1 14-pin DIL IC socket (cut to suit the 14-pin DIL header)
1 8-pin DIL IC socket (cut to make 4-way & 3-way SIL sockets)
1 18-pin DIL IC socket
4 M3 x 9mm or M3 x 10mm tapped Nylon spacers
9 M3 x 6mm screws
1 M3 nut
4 No.4 x 6mm self-tapping screws
1 80mm length of 0.7mm tinned copper wire
1 170mm length of medium-duty hookup wire
1 170mm length of medium-duty hookup wire (optional for pump control)
2 PC stakes
2 PC stakes (optional for pump control)
1 10kΩ horizontal trimpot (code 103) (VR1)

Semiconductors
1 PIC16F88-I/P microcontroller programmed with water tank level receiver.hex (IC1)
1 7805 5V regulator (REG1)
1 1N4004 1A diode (D1)
1 16V 1W zener diode (ZD1)

Capacitors
3 100µF 16V PC electrolytic
1 10µF 16V PC electrolytic
1 100nF MKT polyester
1 100nF ceramic
1 100nF ceramic (optional for pump control)

Resistors (0.25W, 1%)
1 1kΩ
1 10Ω

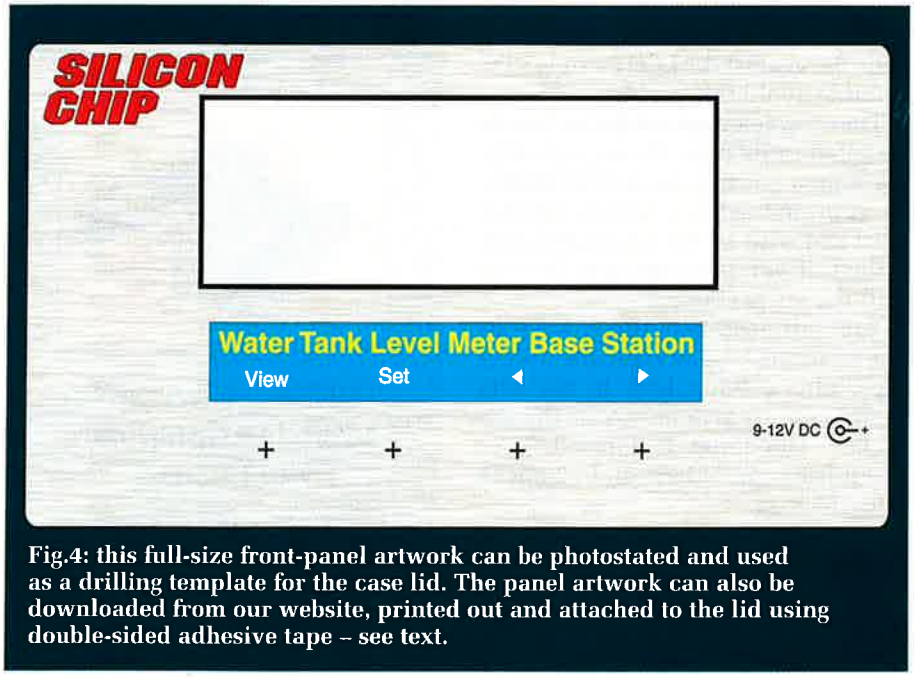


Fig.4: this full-size front-panel artwork can be photostated and used as a drilling template for the case lid. The panel artwork can also be downloaded from our website, printed out and attached to the lid using double-sided adhesive tape – see text.

with and then carefully reamed out to 10mm.

That done, the front-panel artwork can be downloaded from the SILICON CHIP website, printed out on a colour printer and attached using double-sided adhesive tape. It can then be protected by using a single layer of clear self-adhesive film (eg, wide sticky tape) and the holes cut out with a sharp utility knife.

Alternatively, you can trim the label to fit inside the lid by making cutouts for the corner pillars. It can be attached using a smear of clear silicone sealant.

The board assembly simply sits on integral standoffs on the bottom of the case and is secured using No.4 self-tapping screws. That done, apply power, and adjust trimpot VR1 for optimum contrast on the LCD.

The assembly can now be completed by attaching the lid and mounting brackets using the four screws supplied with the case.

Setting up

At this stage, when power is applied, the display should show a question mark (ie, "?") for tank 1's level. You now need to enable the tanks that are to be monitored using the procedure described earlier. Once that's done, the correct level will be displayed for each tank.

The Base Station needs to be positioned so that it can receive signals from all the Water Tank Level Meters that are to be monitored. In each case, when a valid signal is received, the display will show the signal level for that tank instead of a question mark.

During our trials, we found that there were places inside the house where the reception was unreliable, particularly when the Water Tank Level Meter was more than 100m away. In practice, it's a matter of finding the best place to receive signals from all the level meters.

In addition, it may be necessary to position each level meter so that it is on the side of the tank that faces the Base Station. The antenna can also play a role here and an antenna consisting of a length of 1mm wire that extends straight out of the Water Tank Level Meter (ie, from the transmitter) can improve reception at the Base Station. Some experimentation with the antenna orientation may also be necessary. SC

Addendum: improving the pressure sensor

As detailed in the last two articles, the Water Tank Level Meter uses a pressure sensor to measure the water level. Here's a few tips on improving the set-up plus an improved method for mounting the pressure sensor externally.

AS ORIGINALLY DESCRIBED in November 2007, our Water Tank Level Meter used a pressure sensor that was mounted inside the case (ie, on the PC board). This sensor was connected to a tube that was then inserted into the tank, with one end close to the bottom.

The resultant air pressure within the tube thus provided a measurement of water level.

An alternative method was subsequently described in the December issue and this involved mounting the pressure sensor in a sealed box at the bottom of the water tank. The electrical output from the sensor was then fed back via a cable to the Level Meter.

Since publication of these articles it has come to our attention that the "tube in tank" method is only valid for short-term water level measurements. Unfortunately, the measurements will become inaccurate after an extended period of time. This is due to some diffusion of the air into the water, resulting in loss of pressure.

As a result, our first measurement technique (ie, where the sensor is mounted on the PC board) is no longer recommended for long term monitoring. By contrast, the in-tank sensor measurement technique described in the December article is suitable, because this is not affected by pressure loss due to the diffusion of air into the water.

Making it better

Assuming that you do mount the pressure sensor inside the tank (see pages 86-87, Dec. 2007), there are a few things you should do to improve reliability.

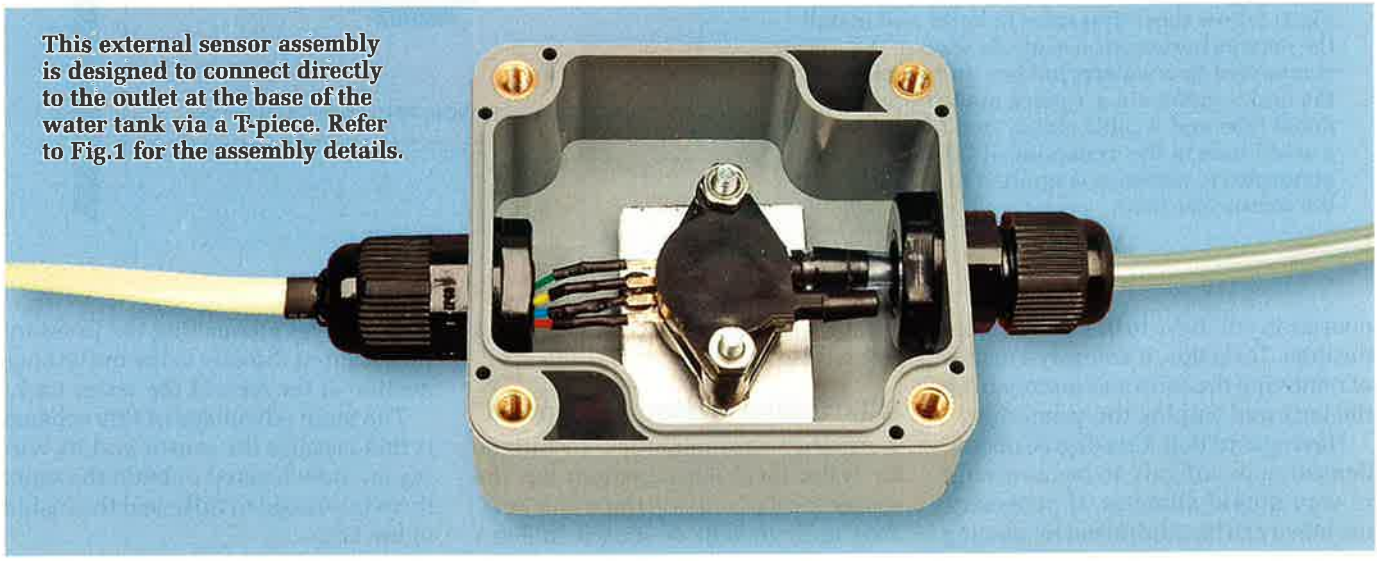
First, a short squirt of silicone water repellent (eg, Selleys Water Shield) should be directed into both sensor ports, to improve water protection at the sensor's gauge. In addition, a few drops of mineral oil should be placed in the tube, so that an air pocket and oil trap is formed just above where the tubing is clamped to the box. This is to prevent direct contact between the sensor and the water at port 1.

Note that there should be a small amount of air left between port 1 and the oil. The oil repellent action of the silicone spray is also helpful here. Note that mineral oil is available from pharmacies as baby oil.

Water in the vent tube

One problem is that the vent tube for port 2 may ultimately contain water in the lower portion of the "U"-shaped section in the sealed box at the bottom of the water tank. This is due to water condensation from the air and if enough water condenses to close off the tube, this will lead to inaccuracies in the pressure reading due to incorrect pressure at port 2 with barometric changes.

As a result, if the water level readings appear to be inaccurate, the con-



This external sensor assembly is designed to connect directly to the outlet at the base of the water tank via a T-piece. Refer to Fig.1 for the assembly details.

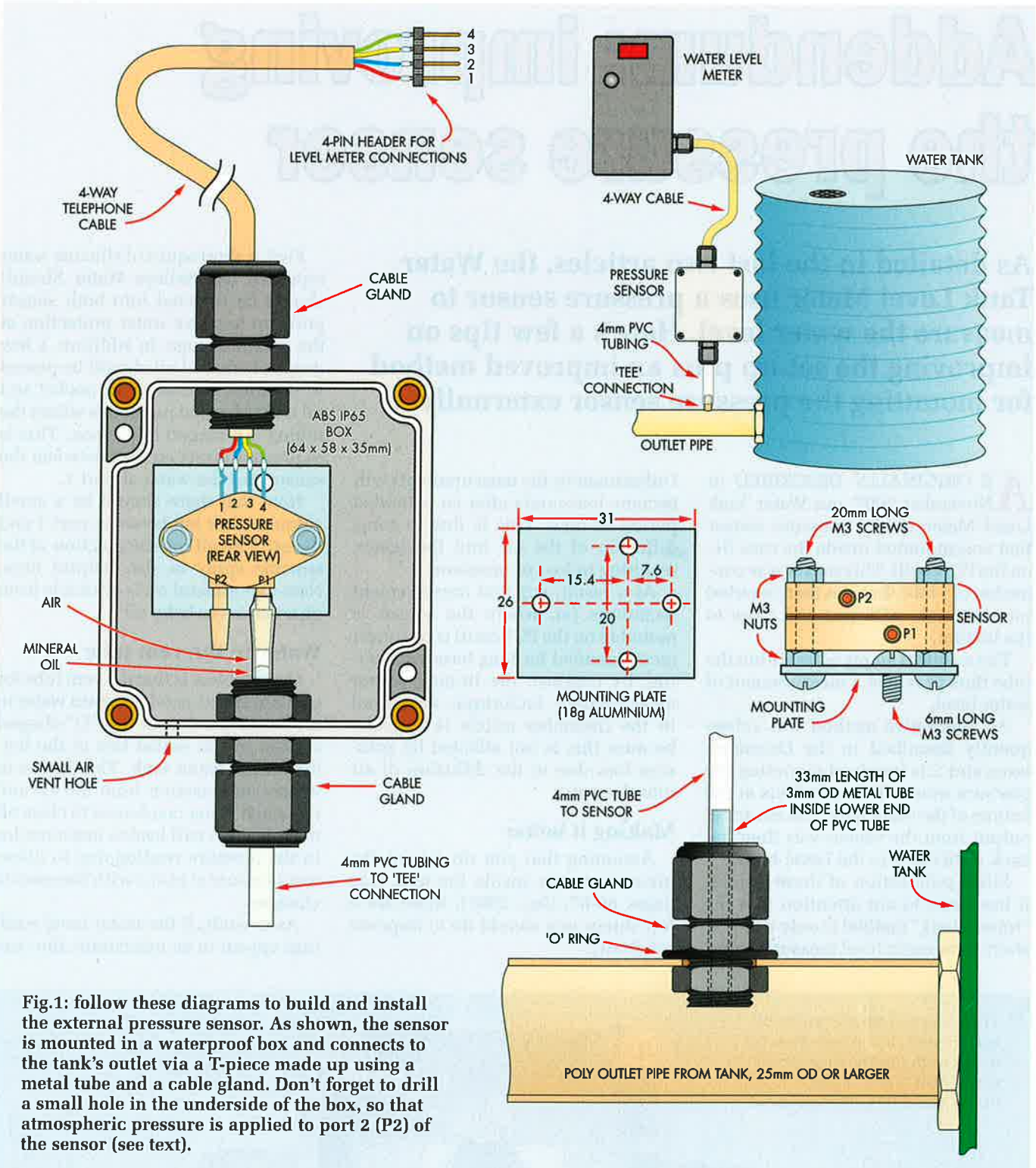


Fig.1: follow these diagrams to build and install the external pressure sensor. As shown, the sensor is mounted in a waterproof box and connects to the tank's outlet via a T-piece made up using a metal tube and a cable gland. Don't forget to drill a small hole in the underside of the box, so that atmospheric pressure is applied to port 2 (P2) of the sensor (see text).

densation will have to be drained from the tube. To do this, it's simply a matter of removing the sensor assembly from the tank and tipping the water out.

Having said that, this degree of condensation is unlikely to occur except in very humid climates. If necessary, the effect can be minimised by placing a water-absorbing desiccant (eg, silica gel) within the tube.

Alternative sensor placement

Another recommended technique for water level measurement has the sensor located outside the water tank. This arrangement is shown in Fig.1 and involves connecting the pressure sensor input directly to the outlet connection at the base of the water tank.

The main advantage of this scheme is that because the sensor and its wiring are now located outside the tank, there is no need to fully seal the inside of the box.

Parts List

1 IP65 sealed enclosure 64 x 58 x 35mmmm (Jaycar HB-6120 or equivalent)
1 31 x 26mm sheet of 18g Aluminium
2 3-6mm waterproof cable glands
3 M3 x 6mm screws
2 M3 x 20mm screws
4 M3 nuts
1 4-way pin header
1 50mm length of 4mm PVC tubing
1 4-way sheathed cable (length to suit application)
1 set of fittings suitable for water tank 4mm tubing connection

The connection to the tank's outlet can be made using a "Tee connector". This can be obtained from an irrigation supplier (eg, a T-piece as used for drip irrigation) or you can fashion your own fitting. An alternative is to use a small metal tube inserted into a metal tap fitting, which would then accept the PVC tubing from the sensor. This metal tube can be brazed, soldered or glued in place.

If you are using 25mm or larger poly pipe at the tank outlet, then a T-piece can be made by first drilling a hole in the side of the pipe close to its end, to accept a 3-6mm cable gland. This hole needs to be positioned close to the end so that access is available to flatten down the tube at the mounting area and to provide access to the gland nut inside the tube.

The seal between the gland and poly pipe can be improved by using an 'O' ring (as shown in Fig.1) or by using a silicone sealant that's suited for wet areas (or you can use both). A 3mm OD metal (or hard plastic) tube then needs to be placed inside the PVC tube so that the gland will not close off the PVC tube when it is tightened down. Metal tubing this size can be salvaged from a telescopic antenna.

As shown, the sensor is mounted on a small aluminium plate within a sealed enclosure. This baseplate is made up using sheet aluminium measuring 31 x 26mm and is attached to the two central internal mountings posts using M3 x 6mm screws. The sensor itself is attached to the baseplate using two M3 x 20mm screws and M3 nuts.

As shown in Fig.1, the port 1 connection comprises a 3mm PVC tube that connects to the T-piece in the water tank's outlet. Port 2 vents to the atmosphere.

A 4-way cable (eg, telephone cable) is connected to the four sensor pins and exits from the top or side of the box through a cable gland. Note that you must orient the sensor so that port 1 is connected to the tubing. **As shown, the sensor is mounted with pin 1 (the notched pin) to the left.** Make a note of the wire colour used for each connection to the sensor.

At the other end, this wiring connects to the socket in the Water Tank Level Meter via a 4-way pin header connection. Make sure that this connection is made with the correct orientation and don't get the wiring mixed up.

Making it water-tight

Note that if you are using a flat 4-way cable, it will not form a watertight seal within the gland. This can be fixed by applying a small amount of silicone sealant around the wire at the entry and exit points of the gland, so that the box is waterproof.

In addition, a small hole must be drilled in the box to allow the air pressure to vary inside the box for the sensor's P2 port. This hole should be drilled so that it is in a bottom panel when the box is mounted in position, to keep water out.

A hole size of just 1.5mm is all that's required.

The same recommendations we made above for the in-tank sensor installation also apply here. These are to improve reliability from the sensor – ie, use a squirt of silicone water repellent into both sensor ports and place a few drops of mineral oil in the tube so that air and oil can then be trapped just above where the tubing is clamped in the gland.

As before, the oil is to prevent direct contact between the port 1 sensor and the tank water. Don't overtighten the cable gland for the port 1 tube – you don't want to close off the tube completely.

Mounting it in place

The box can be mounted on the side of the tank, so that the port 1 tube sits vertically. This keeps the mineral oil floating on top of the water.

Note that it's important to keep the port 1 sensor input as low as possible, so that it sits just above the tank's outlet. That way, the full range of the tank can be measured. Also, try to prime the tubing with water up to the gland before attaching to the tank T-piece, so that the initial calibration will be correct. If there is too much air, you may need to recalibrate after the air has diffused into the water.

Note that the box has two mounting points that are effectively outside the box's sealed section but are covered by the lid. So to access the mounting holes, you have to remove the lid.

The unit can be mounted on brackets or directly onto a wall or the tank. To mount it to the side of the tank, first mount two lengths of 19 x 19 x 70mm hardwood, spaced apart to match the box's mounting holes. This timber can be secured to the tank using builder's adhesive or silicone sealant. The box is then attached using suitable wood screws into the timber (but not so long that they can penetrate the wall of the tank).

As with the in-tank sensor, temperature compensation is not required and the unit should be left at the zero compensation setting. As for the Water Tank Level Meter itself, this can be mounted in any convenient location, even if it is exposed to sunlight (since the temperature sensor no longer has to correct for the air temperature in the tube). SC

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Vintage Radio

By RODNEY CHAMPNESS, VK3UG



The simple Aristone M1 4-valve mantel receiver

The Aristone M1 is a 4-valve superhet receiver that was sold during the late 1950s & early 1960s. Designed for the budget end of the market, it was typical of the re-badged sets that appeared during that era.

There were many small radio receiver manufacturers in Australia until the Japanese began to dominate the radio manufacturing industry in the mid-1970s. In most cases, these small Australian firms made radios for much larger organisations like Myers and similar chain stores. The sets were branded to suit Myers and the various other organisations that did not make radios themselves.

This re-badging has been part of the radio and TV consumer market almost since radio made its appearance early last century. Of course, once a set was opened up, its true manufacturer was usually obvious to an experienced serviceman.

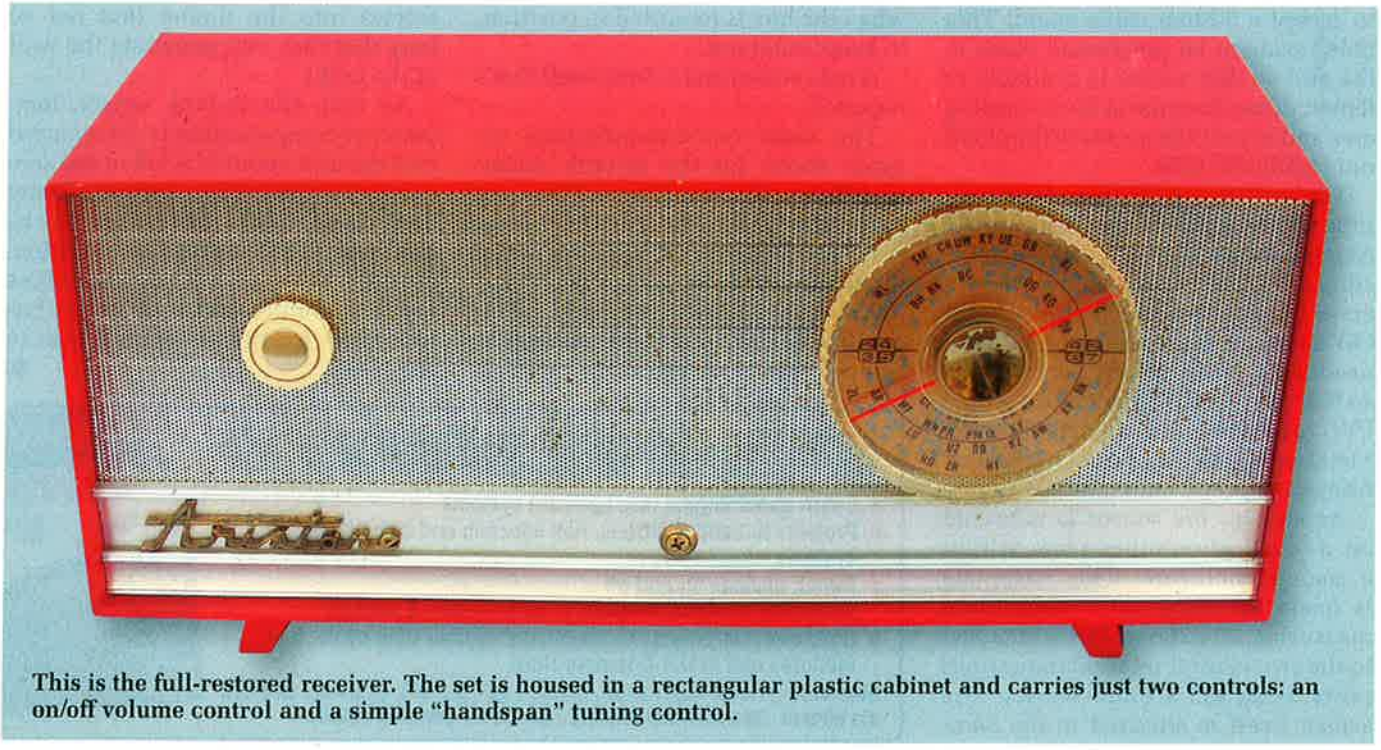
The Aristone M1

The Aristone M1 is one such set that was made by a small manufacturer for a large retailer, in this case Myers. As far as I can determine, "Aristone" was the name Myers used on the radios badged for them but I have not been able to discover who actually made the Aristone sets.

The M1 was a fairly standard 4-valve mantel receiver that came housed in a plastic case. It employs a conventional superhet circuit, with a 6AN7A converter stage followed by a 6N8 as the 455kHz intermediate frequency (IF) amplifier – see Fig.1.

The diodes in the 6N8 are used as the detector and for the delayed AGC system. From there, the detected audio is passed through the volume control and then to the 6M5 audio output valve.

The power supply uses a 6V4 as



This is the full-restored receiver. The set is housed in a rectangular plastic cabinet and carries just two controls: an on/off volume control and a simple "handspan" tuning control.

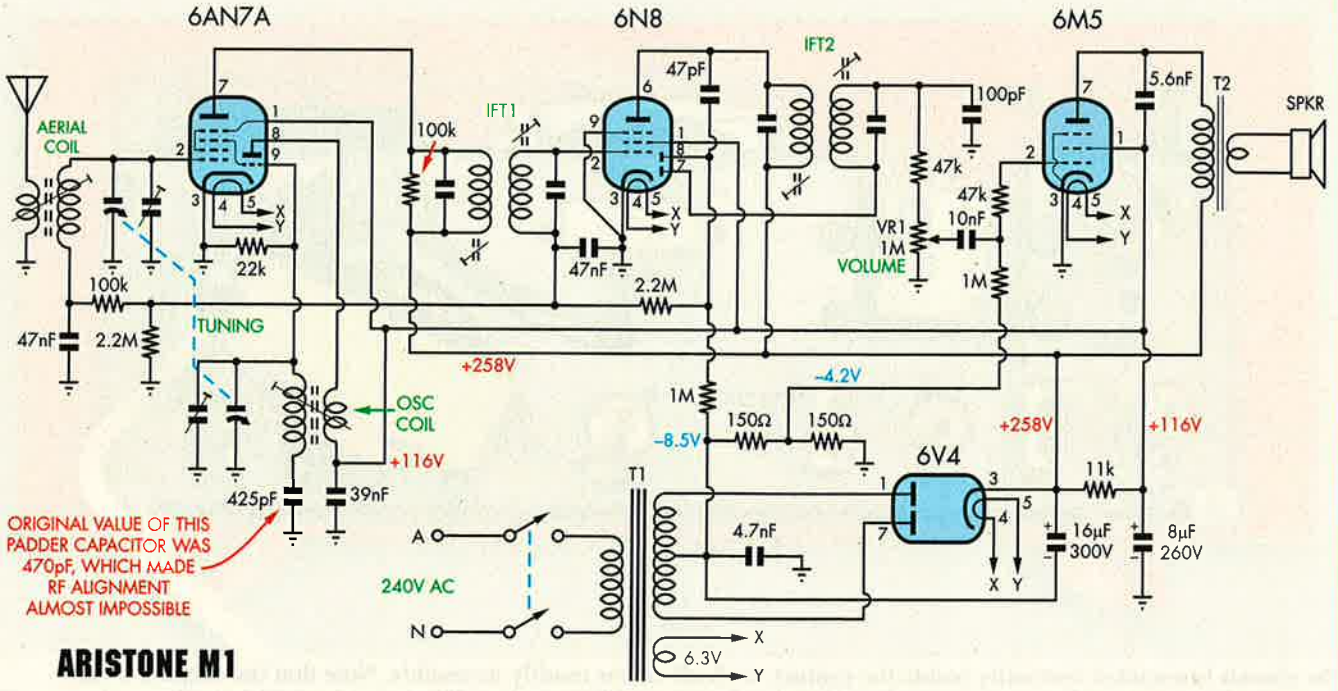


Fig.1: the Aristone M1 uses four valves in a superhet configuration. A 6AN7 functions as the converter stage and is followed by a 6N8 IF amplifier and detector stage. The detected signal is then fed to a 6M5 audio output stage. The power supply is conventional and is based on mains transformer T1 and a 6V4 rectifier valve.

a full-wave rectifier. This provides around 260V DC at its cathode, which is then fed directly to the plate circuits of all the amplifying valves.

By contrast, the screens and the oscillator plate circuit are fed via a dropping resistor and receive around 116V DC. This voltage is really a bit high for the RF valves which are nominally rated at 85V. Bias for the valves and the AGC bias are both obtained from the back-bias developed across the resistors in series between the HT secondary winding centre-tap and the chassis.

Cabinet details

The M1 is mounted in a rectangular plastic cabinet, which is rather large for a simple, 4-valve mantel receiver. There are two controls on the front of the set: an on-off/volume control and a "handspan" direct-drive tuning control. The circular dial scale has markings for stations in all states.

While writing this article, it occurred to me that the Aristone's cabinet was similar to the cabinet used for the Admiral 5BW (described in the September 2006 issue). Sure enough, when I placed the two cabinets side-by-side, they were identical, except that the front escutcheons are different and the Aristone is red whereas the Admiral is cream.

So it would seem that the cabinets for the Admiral and the Aristone came out of the same factory and that they were available in at least two different colours. In fact, I believe that the cabinet was designed for the Admiral, as there is a cutout for a serial number on the back cover. This corresponds to where the serial number is on the Admiral chassis.

By contrast, the Aristone chassis is recessed 75mm from the back of the set and its serial number is at the opposite end of the chassis from the serial number cutout. In fact, the physical layouts of the two sets are quite different and the chassis were definitely made by different manufacturers.

Undoing three self-tapping screws allows the back to be removed. This reveals that the chassis is mounted vertically and consists mainly of a flat piece of steel attached to the front of the cabinet. Because the cabinet is so large, the components mounted on the top of the chassis plate are well spread out, which makes them easily accessible.

In order to remove the chassis, it's necessary to first remove both control knobs. The on-off/volume knob simply pulls straight off but the tuning control knob is slightly more complicated. It's removed by first rotating the control so that the tuning gang is closed and then continuing to rotate it while pulling on the dial until it comes off.

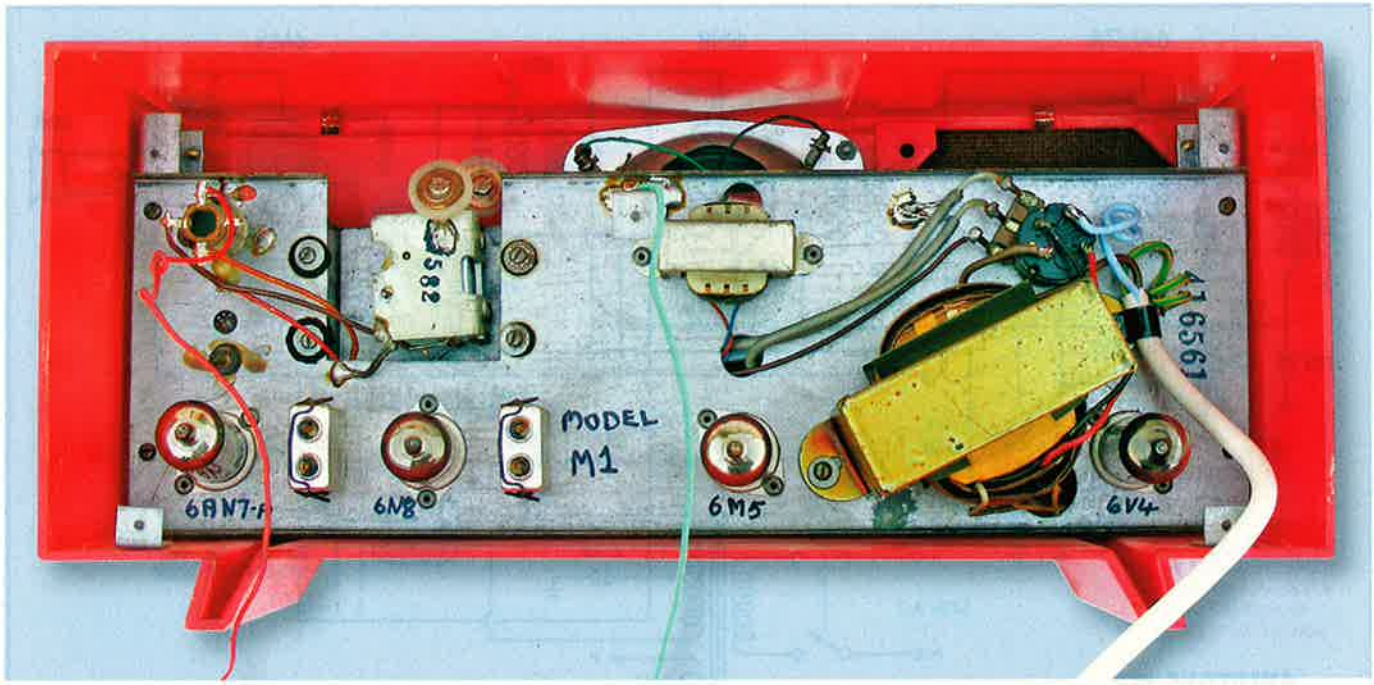
Next, four screws in the back of the set that hold the chassis plate in position are removed. That done, the two loudspeaker leads are removed using a pair of long-nosed pliers, after which the chassis plate can be removed.

Once it's out, the under-chassis layout can be inspected. Like the top of the chassis, there is a lot of space to mount the components and they are well spread out, with no overcrowding. The wiring is also extremely tidy for what must have been a budget-priced receiver. Single-core hook-up wire has been used to maintain the neat look but a bit more variety in the colour of the insulation would have been a good idea to assist circuit tracing.

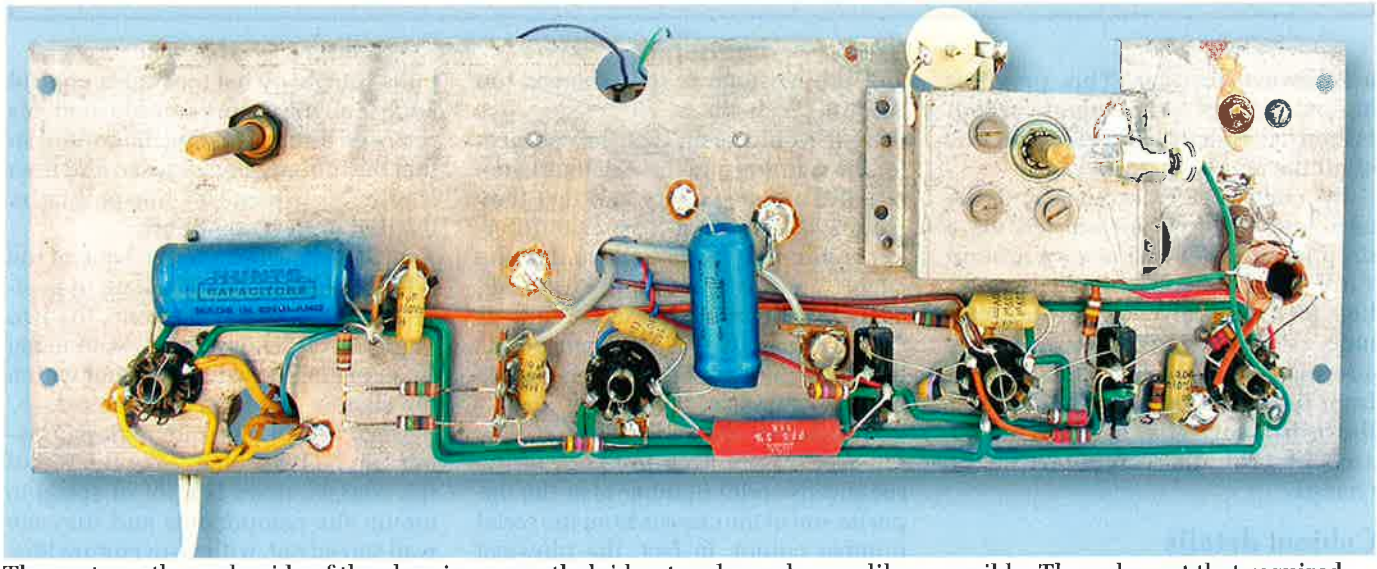
Restoration

When I obtained the set, some work had already been done on it so only a small amount of extra work was required to restore it to full operation.

First, the cabinet needed cleaning up and a light rub-down with a some automotive cut and polish compound



The chassis is mounted vertically inside the cabinet, with all valves readily accessible. Note that the original 2-core power lead was replaced by a 3-core lead, so that the chassis could be earthed. It's shown here with its clamp temporarily secured by a transformer mounting screw. The clamp was later separately secured to the chassis using a machine screw, lock washer & nut, to comply with current standards.



The parts on the underside of the chassis are neatly laid out and are also readily accessible. The only part that required replacement was the paper bypass capacitor for the screen circuit.

did the trick. That done, it was time to turn my attention to the chassis components.

The majority of the fixed capacitors were Philips polyester types and none of these needed replacement. However, the bypass capacitor for the screen circuits was a paper type and so this was replaced with a polyester unit.

All the other components appeared to be in good order and a visual inspection was easily carried out, as the layout is so open. I also checked for shorts and partial shorts on the high-tension (HT) line. (partial shorts can be caused by defective electrolytic capacitors). I then checked the speaker transformer and found that its primary winding was continuous. This is an important step, as an open-circuit speaker transformer primary can result in damage to the output valve.

Smoke test

It was now time for the smoke test. I connected my multimeter across the HT line, switched it to the 400V range and turned the set on. I then allowed it to warm-up, all the time keeping an eye on the meter reading and the rectifier valve.

When the voltage had risen to around 100V, I switched off the power and waited until the electrolytic capacitors had discharged. This procedure was then repeated several times over the next few minutes, each time allowing the voltage to rise a little

higher before switching off. The rectifier showed no sign of overload during this procedure which was necessary to reform the electrolytic capacitors.

I then ran the set for around half an hour to make sure the power transformer was not overheating. That done, it was time to check and adjust the set for best performance.

Checking the performance

There are basically only four points on the chassis where the voltages needed to be checked. First, the HT voltages can be measured at the positive terminals of the 16µF and 8µF electrolytic capacitors. These two points measured 258V and 116V respectively, with the mains at 245V AC. Note that if the mains voltage had been 240V AC, these two voltages would more likely have been 250V and 110V.

The HT voltage to the plates is quite normal, although I believe that the designers were pushing the two RF valves a bit by applying 110V (nominal) to their screens (the recommended screen voltage is around 85V). The 6M5 on the other hand is run with a relatively low screen voltage, which will not do it any harm.

Checking the bias

The back-bias was checked next and I was initially a little surprised at the measured voltages and just where they were applied in the set. With no input signal, the back-bias voltages measured -4.2V and -8.8V. I had expected to see the -8.8V applied to the 6M5 rather than to the RF valves as the latter usually have around -2V applied to them.

As shown in Fig.1, the -8.8V bias is applied via a voltage divider network consisting of a 1MΩ resistor and two 2.2MΩ resistors to chassis. There is around -7V at the junction of the 1MΩ and the 2M2 resistors, which is the delay voltage for the AGC system. This reduces to around -3.5V (relative to chassis) at the junction of the two 2.2MΩ AGC resistors, which is the standing bias for the two RF valves.

With such a high delay voltage on the AGC diode, the RF signal needs to be quite substantial for any AGC to be developed. The two 2.2MΩ resistors then divide this AGC voltage in half, so not a lot of AGC is applied to the two RF valves unless the signals are quite strong.

So why have such a high delay on the AGC and then only apply half the available voltage to control the RF valves? In fact, there is a very good reason for this.

Basically, there has to be a reasonably high output level from the detector in order to drive the 6M5 stage to full audio output. However, if a low level of delay and full AGC were applied to the front-end of the set, the output level from the detector would be more constant for all signals (weak or strong) and so we would not be able to obtain full audio output (even with the volume control turned full up).

On the other hand, if the set had a 2-stage audio amplifier, this method of obtaining full audio output would not be required. A few simple superhets use this system but I'm not all that keen on it as it is very much a design compromise.

Initially, I believed that the -4.2V of bias on the 6M5's grid was rather low. However, it really is quite adequate as the screen voltage is so low.

The converter (6AN7) and IF (6N8) stages are quite conventional, with quite high gain from the IF stage. Two miniature Philips 455kHz transformers do a good job in keeping the gain of the stage high.

The IF amplifier was stable but had a slight tendency to be regenerative if I brought my hand near it. One possibility was that the audio amplifier was receiving some 455kHz signal, amplifying it and then re-radiating it back into the IF stage. To check this, I connected an oscilloscope probe to the top of the volume control and found that there was a small amount of IF signal there.

Knowing what to look for

You have to know what you are looking for here and how to go about it. To inspect audio waveforms, the scan rate is set to around 5ms/cm. By contrast, to inspect the IF component of the audio signal, the scan rate has to be set to around 5µs/div.

In addition, the ratio of 455kHz signal to audio is quite low, so the sensitivity of the vertical deflection must be increased so that the audio waveform extends well outside the screen.

When there is no signal modulation, a sinewave signal will be seen on the screen, which is the 455kHz signal on the audio line. In this case, some 455kHz signal was observed so

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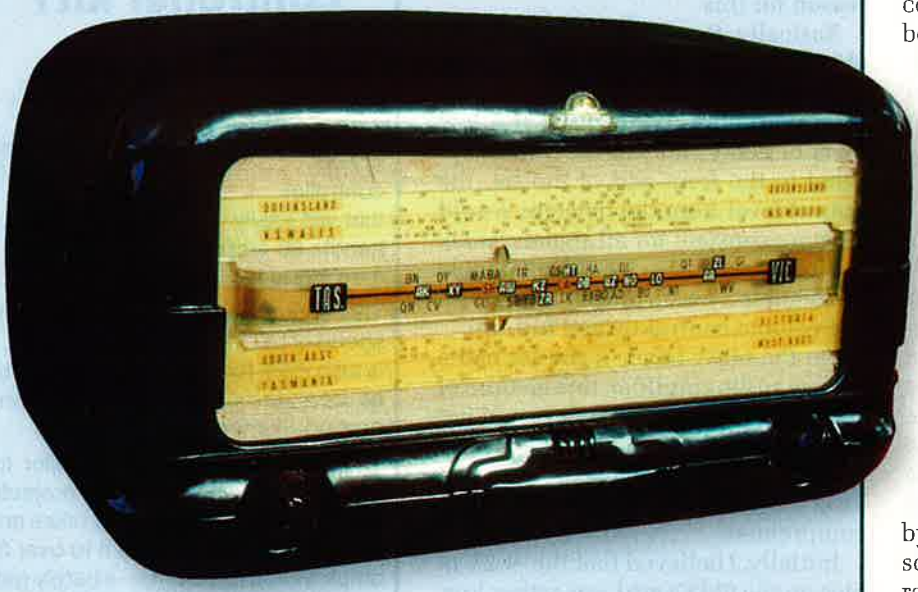
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Photo Gallery: 1949 Astor Model GJ



ANOTHER PRODUCT OF RADIO CORPORATION, MELBOURNE, the Astor Model GJ was produced in 1949 and is housed in a large bakelite cabinet with a large, easy-to-read tuning dial. In spite of the size of the set, it is only a 4-valve model.

The valves line-up was as follows: 6A8-G frequency changer; 6B8-G reflexed IF amplifier/1st audio amplifier/detector/AVC rectifier; 6V6-GT audio output; and 5Y3-GT rectifier. Photo: Historical Radio Society of Australia, Inc.

I then checked at the moving arm of the volume control. However, there was virtually no sign of the 455kHz signal at this point, which was what I was hoping for.

Shielded cable

It's interesting to note that shielded cable is used for the audio connections to the top of the volume potentiometer and to its wiper terminal. Fairly obviously, it's the stray capacitance of this shielded cable that attenuates the IF signal.

The shielded cable also helps prevent hum pick-up. It's a pity that more manufacturers of that era didn't shield the low-level audio lines.

The 6M5 audio output amplifier is simple and effective. Note that its plate circuit has a 5.6nF capacitor which connects to the screen. This filters out any residual IF signal that may have found its way through and acts as a top-cut filter on the audio.

Alignment

Alignment of the IF and RF sections in a set such as this should be a snack, as access is easy and there are only eight adjustments in total. We won't discuss the alignment procedure here – the full details are in the December 2002, January 2003 & February 2003 issues of SILICON CHIP.

The IF alignment went very well but when it came to the RF section, I found that the oscillator and aerial tuned circuits would not track correctly across the band. What was puzzling was that the set tuned easily to signals below 500kHz. This was unusual as most sets will not tune so low in frequency, even if a deliberate attempt is made to make them do so.

I looked around the circuit to see if there was anything that might cause this and eventually spotted the problem. The set had been fitted with a 470pF padder capacitor instead of the correct 425pF capacitor. As a result, I replaced the padder with a combination of styroseal capacitors (as I didn't have the right value) and tried the set again.

The alignment of the front-end was now a breeze. Because the tuned circuits were now tracking correctly, the dial readings were correct and the sensitivity had improved dramatically.

In fact, this set had probably been considered to be a "dog" all its life because someone, at the time of manufacture had put the wrong padder capacitor in the circuit. I wonder how many other sets of this model had the same inbuilt fault?

Power cord

In the interests of safety, I replaced the original 2-core power lead with a 3-core lead and added a cable clamp to secure it. This allows the chassis to be earthed and a cable clamp is much more secure than simply tying a knot in the lead (which is illegal these days).

By the way, one of the photos shows the cable clamp secured by one of the transformer mounting screws. This clamp was later separately secured to the chassis, to comply with current requirements.

Similarly, the power cord earth lead was secured to a separate earth lug that was securely bolted to another point on the chassis.

Summary

The Aristone M1 is a real "bitser" (ie, it has bits from all over the place). The cabinet probably came from an "end of run" Admiral set, the knob and handspan dial look suspiciously like AWA parts, and some of the other parts look like they were made by Kriesler and Philips. There was certainly nothing wrong with using these components, as they all did the job.

Aristone, or whoever the actual manufacturer was, produced quite a good receiver using these bits and pieces. In fact, if something like a 6BM8 had been used as a 2-stage audio amplifier along with a slightly redesigned AGC system, this radio would have been a really red hot performer.

The set is also easy to access, although longer speaker leads would have made servicing easier. The aerial coil could also have been positionted so that it could be adjusted when the chassis was installed in its cabinet.

This is certainly not a set that would have collectors crawling over broken glass to obtain. However, considering what it represents – a "bitser" made by a small manufacturer (probably from production over-runs by other manufacturers) – it's a nice little set that I'm happy to have in my collection. SC

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Query on speaker protector

I am building the Speaker Protector & Muting circuit featured in the July 2007 issue. I'm interested in it because it has both anti-thump capabilities as well as muting and it operates directly from the amplifier power supply.

Some of your stereo amplifiers use just the one transformer whereas the SC480 uses a separate power transformer for each amplifier. May I point out just one small thing in using your Speaker Protector for use with two SC480s?

It appears that the Speaker Protector will be powered by just one of the amplifiers with its 0V return. Won't it be necessary for the two amplifiers to be joined together via a common 0V return for the Protector to operate effectively with both amplifiers? (G. K., via email).

● It is true that the Loudspeaker Protector will be powered from only one power amplifier in a separately powered stereo amplifier pair. However, since all such systems will already have a common earth reference via the stereo program source, that should not present any operational problems. It is also true that a power supply failure in one amplifier would cause both speaker channels to be disabled by the Loudspeaker Protector. Again, that is not really a problem.

By the way, the power supply suggested for a single SC480, in the February 2003 issue, would be quite adequate for powering a stereo system in most situations. There is no real need for separate power supplies for each channel.

Calibrating the digital thermometer

I am building the Digital Thermometer published in the August 2002 issue and I have a question regarding the calibration. I am not sure what the "initial offset voltage of IC1" is (detailed in stage 8 of the set-up). Can you please help? Also, the buzzer is going off as I am setting up the unit. Is this normal? (E. P., via email).

● The initial offset is the output voltage from IC1 (at TP2) when its input voltage at pin 3 and the op amp's inverting at TP4 are both at ground (0V). For a perfect op amp (IC1), the output voltage will be the same as the pin 3 voltage or 0V (ground). In practice, the output will be different to this.

The measured offset voltage is used at step 5 of the calibration.

Query on Circuit Notebook charger

With regard to the Lithium-Polymer Peak Charger featured in the Circuit Notebook pages of the January 2005 issue, I built the circuit but it did not work. I was able to adjust VR2 for a reading of 8.4V and adjust VR1 for 0.6V on the base of Q1. No output voltage could be obtained upon pressing the "start" button.

In other words, neither output voltage nor current was obtained. I have carefully checked my wiring, soldering, etc but I am unable to find any errors. (Y. L., via email).

● Presumably if the transistor has 0.6V on its base then it should switch

Questions On The 20W Class-A Amplifier

I have followed with great enthusiasm your series on the 20W Class-A Stereo Amplifier. Congratulations on achieving such a refined design.

In my audio set-up, the Class-A Stereo Amplifier would be ideal if it could split-off the lower frequencies (<80Hz) for my subwoofer to reproduce and then send the rest via the class-A amplifiers. It seems to me that this would make better use of the 20W to produce sound level, compared to driving woofers as well as the mid & high drivers.

I note that you featured an Active Crossover design in the January 2003 issue. However, the noise and distortion figures of the crossover would negate the advantages of the Class-A Stereo Amplifier. Do you have any recommendations in this regard?

Also, I would have thought that headphones would be an ideal way to enjoy the low noise/distortion of the class-A stages. Is this difficult to achieve with the design? And how about an Auto-off feature? This would be nice to have, prompted by your excellent energy feature articles (the 100W light bulb calculations) and your subwoofer controller which uses an auto-off function.

Could the latter be adapted to switch off the Class-A Stereo Amplifier, perhaps? (P. C., via email).

● There is no easy way of greatly improving the S/N ratios of the Active Crossover, especially since it is based on quad op amps; there is no easy drop-in replacement op amp package which will improve things.

The best approach is to use a high-efficiency speaker system driven directly from the Class-A Stereo Amplifier. Have a look at the speaker system described in the December 2007 issue.

A headphone socket can be added by connecting a 330Ω resistor in series from each speaker output. However you also need to wire the headphone socket so that it switches off the loudspeakers. That might seem simple but the routing of the speaker leads within the chassis is very critical to obtaining the very low hum figures. Auto-off could be done but again, signal routing within the chassis is critical.

Component Quality In Class-A Stereo Amplifier

I have purchased the Class-A Stereo Amplifier kit from Altronics. My questions relate to components. I have decided to purchase components to replace those provided with the kit, in particular the capacitors and resistors.

I have purchased Nichicon KZ and ES parts. These parts are larger and their lead spacing and diameter are different. I could enlarge the PC board holes and bend their leads to make them fit. Please comment on the possible impact on performance from the proposed change (longer signal path, larger components).

I am researching very low noise resistors. The Vishay Dale RM55 and RM60D (CMF) are potential parts. Again my concern is that they are larger components. Please comment.

The capacitors supplied have a temperature rating of 85°C. The photos of your amplifier show Rubycon 105°C components. Should I be looking at using these (Rubycon ZA & ZL parts) instead?

I get the impression that SILICON CHIP does not believe in the "sound of a component" however given comment that appears on the Internet, maybe some components perform better than others? Given the cost and work in assembling the kit, I want the best performance. (P. B., Dee Why, NSW).

- You are right – we do not believe in component "sounds" unless of course, they are of abysmally poor quality. Virtually all the comment on the internet about component sound quality is made by the ratbag fringe element who have no way of checking the effect on performance of any of their component changes.

There is nothing to be gained by substituting capacitors or resistors. There will be no improvement in the virtually unmeasurable distortion or the residual noise

We would strongly recommend that you build the amplifier with the supplied components in the kit. Do not make any alterations until you have had the amplifier fully operational.

Then we suggest that you run the amplifier for at least a couple of weeks – the performance is quite superb. Only then, if you really must, make a few component changes to see if there is any audible effect – there won't be.

on and drive the relay. So press switch S1 and check that the relay switches on, as indicated by an audible click and LED1 lighting.

If this does not happen, then the relay wiring may be incorrect. It should have the 12V relay coil wired between the collector of Q1 and the +12V supply at the input to REG1. The contacts are wired with the normally-open (NO) contact to the LM317 output and the common to the battery pack.

Adjust VR1 so the maximum base voltage is available at Q1 when S1 is pressed. Transistor Q1 should hold the relay closed. When the current falls to below the C/10 value for your battery, adjust VR1 so that Q1 switches off.

Op amp substitution in headphone amplifier

I have built two of the recent Stereo Headphone Amplifier kits (SILICON CHIP, November 2005) successfully but I have a question about the dual op amp used. Is it permissible to use another dual op amp in place of the specified OPA2134?

I have used an LM833 on one of my kits and it works fine in place of the OPA2134, however I suspect that the kit is now oscillating at a very high frequency. Is this possible and what are the possible solutions, if any? (F. S., Ingham, Qld).

- The LM833 is not really suitable for this circuit since it is not intended to drive 600-ohm loads, as is the specified op amp. You may be able to stop the oscillation by increasing the 100Ω resistor at the output of the op amp but this will lead to lower performance than from the published circuit.

Heating & cooling with the Coolmaster

I have a question about the Coolmaster. At what temperature do I change the jumpers from cooling to heating? I want to keep my fridge running at 21°C if possible and was wondering if the fridge motor would do this or do I put a light globe or other means of heating in the fridge and run the circuit on heating and cut out the fridge motor altogether? (J. C., via email).

- Regrettably, there is no easy answer to your question. The problem is that you want to maintain the internal fridge temperature at a level which will be above the external ambient temperature at some times (ie, at night in winter) but below the external temperature at other times, such as during the day in summer. So you really need a system which involves both heating and cooling, not just one or the other.

Your best plan might well be to fit a small incandescent lamp or low-power heating element inside the fridge, powered on permanently so it will be trying to raise the temperature above 21°C. Then use the Coolmaster/Tempmaster in normal "cooling" mode, setting it to keep "fighting" the heater and cooling the internal temperature down to 21°C. You may only need a 15-20W lamp as the heating element.

Fuel Cut Defeater needs MAP sensor

I have built the Fuel Cut Defeater (SILICON CHIP, February 2007) and would like to install this on a Mazda MX-5 SE. I appreciate that this design is based on another vehicle.

The instructions indicate that for installation you need to locate the wire from the boost sensor that has around 1.4V at idle. My boost sensor has three wires, two of which have a voltage of around 2.4V and 5V, respectively. Therefore, I am curious if there is some adjustment that I need to make to ensure this device functions correctly. (M. K., via email).

- The Fuel Cut Defeater is not meant to connect to a boost sensor but to a MAP sensor. The signal from the MAP sensor will vary with engine load and in particular, at turbo boost the voltage will go up to close to 4V. It is this voltage that is intercepted and altered to prevent the ECU seeing the extra boost voltage.

The MAP sensor has three wires: 5V, 0V and signal. Use the signal wire (the one that varies with engine loading – ie, low voltage at low engine loads

Can CD-ROM Adaptor Control A Hard Disk?

I read the article on the ATAPI drive controller unit (SILICON CHIP, November 2007) but although it talks about controlling a hard drive with a microcontroller, I haven't as yet worked out whether a hard drive can be used in place of a CD-ROM drive.

Is it possible to use this controller board to run a hard disk? I want to make a unit that will start playing a sequence of songs indefinitely until the controller receives an input to tell it to stop.

Secondly, I see it uses a 16x2 LCD display. This is a very common display, yet despite my searching, I cannot find a plastic bezel/window which would enable the mounting of one of these displays into a panel on a cabinet.

Can you suggest a source? I have tried many companies in the USA, as well as sellers on Ebay and the like. No one seems to make a bezel for this size of display which is really bizarre for such a popular item. (S. W., Auckland, NZ).

● Since the physical interface that CD-ROM drives use is the same as for ATA hard drives, the same hardware can be used to control a hard drive. The only problem is that the interface will be relatively slow, since it uses only PIO. In fact, the speed of data transfers that can be achieved with this CD-ROM Playback Adaptor (when used with a hard drive) will be of the order of 25kB per second or worse, which is very slow.

To achieve higher data rates, DMA transfers are used in PCs. This adaptor does not have the relevant hardware needed to implement a DMA mode ATA interface. So, if you wish to use a hard drive with this adaptor, be prepared for low speeds.

Another problem is that the microcontroller used has very limited RAM. However, if you still wish to use a hard drive with this project it is possible but the firmware will need to be modified. The current firmware is written only for ATAPI devices, not hard drives, although a lot of the low level interface is identical in both cases.

Note, however, that while this project is useful for experimenting with hard drives, it is not really intended to access hard drives at the speeds necessary for streaming audio.

We do not know of any bezels for a standard 16x2 LCD module. The only ones we know of are for colour LCD screens. However, almost all LCD modules will have mounting holes for screws which, if you make an accurate enough cut in your case, can be used to mount the LCD so that it is flush with the lid of the case.

and a higher voltage at higher engine loads) for the "MAP in" connection.

The 3.9V threshold may need to be altered. You can do this by using a 5kΩ trimpot in place of the 3.9kΩ resistor at pin 5 of IC1b. Wire one side of the trimpot to the ground track and the wiper to pin 5. Adjust the trimpot to the voltage you wish to clamp at when in boost, to prevent the fuel-cut action.

Two-way active crossover wanted

I play in a band and also manage all the PA gear. I have made two 1.5-metre tall linear arrays, that go down to about 100Hz, which I use for vocals and instruments; they perform much better than I expected. The problem is the bass end.

I have been looking for a 2-way crossover that has a crossover frequency of 100Hz. The obvious choice would be a subwoofer controller but it doesn't have a high-pass filter at 100Hz to feed the linear array. The next choice would be a 3-way active crossover but that has a midrange and tweeter output and I already have the crossover in the box and I don't want to buy six amplifiers at $250 each.

So do you have a simple 2-way active crossover with a 100Hz crossover point? (S. P., Perth, WA).

● The simplest approach would be to modify our 3-Way Active Crossover (SILICON CHIP, January 2003) to provide 2-way operation. In effect, you would just omit the parts for the central passband section and make sure that the high-pass and low-pass sections had the same corner frequency.

Using the CD-ROM adaptor in a studio

I refer to your Playback Adaptor for CD-ROM Drives. I would like to use these in a broadcast studio situation and for that reason require that the software for the adapter do the following:

(1) Queue to start of selected track so that when play is invoked (START), there is no delay in the drive delivering audio from that track.

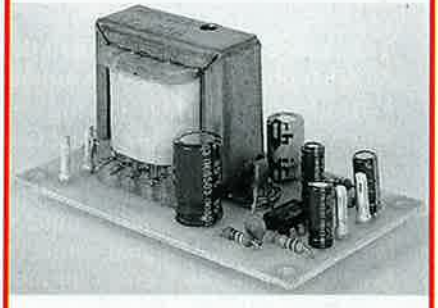
(2) Play the selected track and only that track – ie, the drive will stop at the end of the selected track and will not run into the following track.

If the experience of the community FM radio station where I work is any indication, these modifications to your existing project (or perhaps a special model) would be very well received. A commercially produced dual CD drive unit at present runs to about $1500 and our station just can't afford that.

If you could modify the software to meet these requirements, I'm sure that many other community-based radio stations would build one (or two). The only other proviso would be that the audio quality is up to broadcast standards.

Your article doesn't say whether the CD-ROM drives will accept MP3 CDs.

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Temperature Sensor May Be Open-Circuit

I have a question regarding the Fridge/Freezer Temperature Controller in the June 2005 issue. I have 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 range of 2-20°C it only varies from 35.7kΩ to around 36.5kΩ. I'm guessing that this small change isn't enough to give a 2-3V drop across pin 3; in fact, the voltage stays at 8.9V. If I remove the LM335 and replace it with say 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.

Measuring the resistance of the LM335 is not meaningful because it's very non-linear. In fact it behaves very much like a zener diode, whose reverse breakdown voltage varies in direct proportion to the absolute temperature in Kelvin. 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).

Notes & Errata

PIC-Based Water Tank Level Meter, Nov-Dec 2007: we no longer recommend mounting the pressure sensor on the PC board and using the "tube in tank" method for water level sensing. Instead, the sensor should be mounted inside the tank as described on page 86 of the December 2007 issue.

Alternatively, the sensor can be located in a separate box outside the tank and its input connected directly to the outlet at the base of the tank. The addendum on p89-91 of the January 2008 issue has the details for this method.

Can you please clarify that question? (P. S., via email).

- To answer your last question first, the CD-ROM Playback Adaptor will not play MP3 CDs (ie, CDs with MP3 files on them). This is because there is no hardware (or software) to decode MP3 files either on the drive or on the board. You will only be able to play audio CDs (native CD audio tracks).

Second, it is most probable that the ability to queue songs can be incorporated into the source code. You would need to select a track number and then press a "queue" button. This would load the TOC (table of contents) and from that select the starting address of the relevant track. It is then a matter of initiating playback of the track and then "pausing" it as soon as it starts.

Basically, the track would be in the play mode but "paused" until another button is pressed to allow the audio to be played from the paused state.

Regrettably though, we are not in a position to modify the software for this purpose.

Circuit for measuring injector duty cycle

I wonder if it would be simple to design a circuit which would give an indication of the duty cycle of fuel injectors? While not giving complete info, it could be of help in refining one's driving technique as related to fuel economy (A. B., Mackay, Qld).

- We published a fuel injector monitor in the August 1995 issue. This gave a direct reading of the injector duty cycle.

Varicap for GPS Frequency Reference

Can you please advise where I can obtain the BB119 varicap diode or equivalent for the GPS Frequency Reference (SILICON CHIP, March, April & May 2007)? (J. L., via email).

- It looks as if the BB119 is no longer available, even from surplus suppliers like Oatley Electronics.

We suggest using a readily available 12V 1W zener diode like the 1N4742 or you can chase up and substitute an SMD varicap diode like the BB202 (Philips, etc) or the ZMV933 (Zetex). The latter devices are very small and will be a bit tricky to use. SC

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely.

Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

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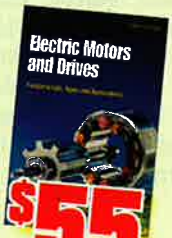
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